OTWAY BASIN 2DMC MARINE SEISMIC SURVEY

Environment Plan

Prepared for:

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BASIS OF REPORT

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EP SUMMARY

The Otway Basin 2DMC MSS EP summary has been prepared from material provided in this EP. The summary consists of the following as required by regulation 11(4):

EP Summary Material Requirement	Relevant Section of EP Containing EP Summary Material
The location of the activity	**Section 3.2** – Survey Location, pages 76-78
A description of the receiving environment	**Section 5.1** – Physical Environment, pages 112-120 **Section 5.2** – Biological Environment, pages 121-169 **Section 5.3 –** Coastal Environment – Marine Protected and Sensitive Areas, pages 170-203 **Section 5.4** – Cultural and Heritage Values, pages 204-209 **Section 5.5** – Socio-Economic Environment, pages 210-261
A description of the activity	**Section 3.3** – Timing & Duration, page 79 **Section 3.4.1** – Acoustic Source Configuration, pages 79-82 **Section 3.4.2** – Streamer Configuration, page 83 **Section 3.4.3** – Sail Lines, Line Turns and Infills, pages 84-85 **Section 3.4.4** – Survey Vessel, page 85 **Section 3.4.5** – Support Vessel, pages 85-86 **Section 3.4.6** – Refuelling Operations & Crew Changes, pages 86
Details of the environmental impacts and risks	**Section 6 –** Environmental Impact & Risk Assessment, pages 262-271 **Section 7.1** – Physical Presence of Seismic vessel & towed array, pages 272-310 **Section 7.2** – Acoustic Disturbance, pages 311-453 **Section 7.3** – Routine Permissible Waste Discharges, pages 454-464 **Section 7.4** – Atmospheric Emissions, pages 465-473 **Section 7.5** – Artificial Light Emissions, pages 474-484 **Section 8.1** – Invasive Marine Species, pages 485-494 **Section 8.2** – Streamer Loss, pages 495-502 **Section 8.3** – Vessel Collision & Hydrocarbon Spill, pages 503-526 **Section 8.4** – Hydrocarbon Spill Response, pages 527-537 **Section 8.5** – Accidental Release of Hazardous & Non-Hazardous Materials, pages 538-548 **Section 9** – Cumulative Effects, pages 549-557

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EP Summary Material Requirement	Relevant Section of EP Containing EP Summary Material
The control measures for the activity	**Section 3.4.7** – Marine Mammal Control Measures, pages 87-96 **Section 6.3** – Development of Control measures, page 264 **Section 6.4** – Environmental Performance of Controls, page 265 **Section 7.1.4** – Physical Presence, pages 293-301 **Section 7.2.5** – Acoustic Disturbance, pages 407-436 **Section 7.3.3** – Waste Discharges, pages 455-457 **Section 7.4.3** – Atmospheric Emissions, pages 465-468 **Section 7.5.3** – Artificial Light, pages 476-479 **Section 8.1.4** – Invasive Species, pages 486-489 **Section 8.2.3** – Streamer Loss, pages 495-497 **Section 8.3.4** – Vessel Collision, pages 510-519 **Section 8.4.2** – Hydrocarbon Spill Response, pages 530-532 **Section 8.5.3** – Accidental Release of Hazardous & Non-Hazardous Materials, pages 539-541
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 10.4** – Review of Environmental Performance, pages 567-575
Response arrangements in the oil pollution emergency plan	**Section 10.9** – Oil Pollution Emergency Plan, pages 584-599
Consultation already undertaken and plans for ongoing consultation	**Section 4.3** – Identification of Stakeholders, pages 98-99 **Section 4.4** – Stakeholder Engagement, pages 99-100 **Section 4.5** – Stakeholder Engagement Approach, pages 101-111 **Section 4.5.8** – Ongoing Stakeholder Engagement, pages 107-108 **Appendix B** – List of Stakeholders **Appendix C** – Full Unedited Stakeholder Correspondence **Appendix D** – Meeting Minutes and Memos **Appendix F** – Summary of Feedback Received and Responses Provided by Schlumberger **Appendix H** – SIV Consultation Feedback Report **Appendix J** – TSIC Industry Communication and Engagement Report
Details of the titleholders nominated liaison person for the activity	**Section 1.1** – Title Holder & Nominated Person, page 48

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Project Overview

Schlumberger Australia Pty Limited (**SLB**) is proposing to acquire a two dimensional (**2D**) Multiclient Marine Seismic Survey in the Otway Basin (**Otway Basin 2DMC MSS**). The proposed Operational Area, which covers a total of 93,000 km^2, is located off the coasts of South Australia, Victoria and Tasmania. The area sits outside of coastal waters and is mostly within the Exclusive Economic Zone; however, some parts of the Operational Area do overlap with the Territorial Sea, where, at its closest point, the Operational Area approaches to 3 NM from shore (off Portland, Victoria). The Operational Area spans a range of water depths from 50 m (at its shallowest inshore reaches) to 5,600 m (at its offshore limits). The vast majority (98%) of the survey lines are in water depths greater than 200 m, and 89% of the Operational Area is located in water depths greater than 1,000 m. The objective of the proposed survey is to identify and assist in the appraisal of potential recoverable hydrocarbon reserves in the Otway Basin.

In total the Otway Basin 2DMC MSS proposes to acquire seismic data over approximately 14,000 linear km (a total of 109 survey lines). Most of the survey lines are approximately 90 km long running in a northeast-southwest orientation and are 5 km apart. During data acquisition, the survey vessel will travel at approximately 4 – 5 knots, and at this speed each line will take approximately 11 hours to complete. The Operational Area also provides for 13 tie lines which extend inshore to the locations of historic exploration wells and two longer sail lines orientated northwest-southeast and which span the length of the Operational Area. In addition, there are six deep lines in the southern extent of the Operational Area, which form a “saw tooth’ off the main survey line plan.

The acoustic source selected for the Otway Basin 2DMC MSS will have an effective volume of 5,265 in^3. The selection of this source represents a compromise between optimal data resolution (where ideally a larger source with a greater effective volume would be used) and minimising acoustic impacts to the environment (where a smaller source would have a smaller acoustic footprint). The intermediate source size selected will yield sufficient data while minimizing environmental impacts. The acoustic source and a single seismic streamer of approximately 10 km long will be towed behind a dedicated seismic survey vessel, which will be accompanied by at least one support vessel at all times. The role of the support vessel is to manage any possible interactions with other vessels or maritime activities occurring in the area.

The Otway Basin 2DMC MSS is predicted to commence in October 2019 and seismic data acquisition is estimated to take approximately 100 days in total. An operational window of October 2019 to June 2020 has however been proposed to account for weather limitations, vessel availability and marine fauna mitigation downtime. During the survey the seismic vessel will return to port every five weeks for refuelling.

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This Environment Plan (**EP**) has been developed in accordance with SLB's Quality, Health, Safety and Environment Policy (**QHSE Policy**) and the requirements of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (**OPGGS Act**), and the associated Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (**Environment Regulations**). In accordance with these requirements, the EP details the processes involved in assessing the potential risks and impacts to the different receptors within the receiving environment and stakeholders that utilise the area. Included within this assessment are the proposed controls and operational procedures that will be implemented in order to reduce the potential adverse environmental impacts from the planned operational activities, and risks from unplanned events, to As Low As Reasonably Practicable (**ALARP**) and to **Acceptable Levels**. In addition, environmental performance standards have been developed to measure the performance of the controls and operational measures that will be implemented throughout the Otway Basin 2DMC MSS.

The EP also complies with the Environment Protection and Biodiversity Conservation Act 1999 (**EPBC Act**), and the associated EPBC Act Policy Statement 2.1 which sets out to minimise the risk of acoustic injury to whales in the vicinity of seismic operations and to minimise the risk of biological consequences to whales in biologically important habitat areas or during periods of critical behaviour.

An extensive stakeholder engagement programme was undertaken by SLB as a key part of the development of this EP. This involved consultation through the provision of distribution of information sheets, meetings, email and phone correspondence, a fisheries assessment and engagement of Seafood Industry Victoria for engaging with the Victorian licence holders and engaging Tasmanian Seafood Industry Council for engaging with the Tasmanian licence holders. The engagement programme aimed to help stakeholders understand the environmental impacts and risks associated with the proposed Otway Basin 2DMC MSS and to aid in the development of control measures to reduce impacts and risks to stakeholders. Information collected during this engagement process was used to populate the EP and to refine survey design where possible.

In accordance with the Environmental Regulations, the impacts and risks associated with planned activities (i.e. physical presence of the seismic vessel and towed equipment, acoustic disturbance, routine permissible waste discharges, atmospheric emissions, artificial light emissions, and physical effects of vessel presence sharing water with fisheries) and unplanned events (i.e. invasive marine species, streamer loss, vessel collision or sinking, and accidental release of hazardous and non-hazardous materials) from the Otway Basin 2DMC MSS are discussed and assessed. Control measures that will be used to reduce the impacts and risks of the activity to **ALARP** and an **Acceptable Level** are detailed in this EP. An assessment of the significance of any residual effects (following the implementation of control measures) is provided through an Environmental Risk Assessment process. The potential effects of seismic operations on not only the biological environment but also the socio-economic and cultural environments of the Operational Area are considered.

Receiving Environment

The Operational Area extends from the inshore to deep offshore waters. As such a wide range of habitat types are encompassed and a large number of fauna (i.e. plankton, invertebrates, fish, reptiles, cephalopods, cetaceans, pinnipeds and seabirds) are potentially present. While some species are site-attached and/or exhibit relatively small home-ranges, many others are highly mobile and/or migratory. Within the Operational Area there are two Key Ecological Features (**KEF**) of high productivity; the Bonney Upwelling and the West Tasmanian Canyons.

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The Bonney Upwelling is a regular seasonal event which brings cold nutrient-rich water to the surface. Biologically, the upwelling supports high productivity and high species diversity in comparison to surrounding waters. Increased phytoplankton abundance occurs as a result of the upwelling, which in turn attracts zooplankton grazers. Consequently, higher order predators such as fish, seabirds, pinnipeds and baleen whales are attracted to the area. In particular, the upwelling provides globally recognised foraging habitat for pygmy blue whales and supports commercially important fisheries. The West Tasmanian Canyons are located in the eastern region of the Operational Area; these are also areas high in productivity and diversity due to the upwelling of nutrient-rich water at the head of the canyons.

Information on benthic invertebrate communities within the Operational Area is limited. However, southern Australian waters are reported as having a variety of seabed habitats, supporting diverse infaunal and epifaunal communities.

Fish populations from the Operational Area are represented by demersal and pelagic species, with a number of larger migratory pelagic species seasonally visiting the area. Four bony fish species listed in the EPBC Act 'List of Threatened Fauna' may occur in the Operational Area; the Australian grayling (larvae and juveniles may occur in coastal waters), orange roughy (a deep-sea species targeted commercially), blue warehou (occur on the continental shelf and upper slope) and southern bluefin tuna (large pelagic migratory fish that aggregate in coastal waters in summer). Numerous sharks, rays and skates also occur in the Operational Area including the following species which all appear on the EPBC list of threatened fauna: white shark, the whale shark, the southern dogfish, the school shark, the shortfin mako and the porbeagle. The Operational Area overlaps with a Biologically Important Area (**BIA**) for white shark foraging habitat. Various octopus, squid and cuttlefish species are also likely to be present in the Operational Area; however, none appear on the EPBC Act 'List of Threatened Fauna'. Only one marine reptile species, the leatherback turtle, is regularly seen in southern Australian waters; however, no breeding beaches have been reported from this region.

Cetaceans are of particular interest during the planning stages of any seismic survey on account of the well-recognised potential for acoustic disturbance to these species. The EPBC Act Policy Statement 2.1, with which the Otway Basin 2DMC MSS will comply sets out different management procedures based on the likelihood of encountering whales during a survey. A thorough investigation of sightings and stranding data was conducted to assess which cetacean species were likely to be encountered in the Operational Area during the survey period. From this investigation it was concluded that the following species have a moderate to high likelihood of being present:

- Southern right whales (EPBC Act listing of endangered/migratory). Breed in coastal areas from May to October. The Operational Area overlaps with the southern right whale BIA which encompasses coastal areas used during migrations and the Warrnambool calving aggregation;
- Sei whales (EPBC Act listing of vulnerable/migratory). Forage in the Bonney Upwelling during summer and early autumn;
- Pygmy blue whales (EPBC Act listing of vulnerable/migratory). Forage for krill in the Bonney Upwelling from November to May (peak abundance in February). The Operational Area overlaps with the pygmy blue whale BIA which identifies critical foraging habitat for this species;
- Fin whales (EPBC Act listing of vulnerable/migratory). Forage in the Bonney Upwelling from November to May;

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- Humpback whales (EPBC Act listing of vulnerable/migratory). Migrate southwards through the Operational Area during November – December;
- Sperm whales (EPBC Act listing of migratory). Have been recorded from all Australian waters, particularly in deep waters off the continental shelf. The Operational Area overlaps with the sperm whale BIA which identifies foraging habitat for this species;
- Beaked whales. High number of stranding records of Gray's, strap-toothed and Cuvier's beaked whales in the South-east Marine Region suggest regionally significant populations of these species may be found in the vicinity of the Operational Area. Prefer deep waters beyond the shelf edge;
- Long-finned pilot whales. High numbers of stranding records for the Victoria coast suggest a regionally significant population;
- Risso's dolphin. High numbers have stranded within the South-east Marine Region suggesting that regionally significant populations may be present; and
- Common bottlenose dolphin. High numbers have stranded in the South-east Marine Region suggesting a regionally significant population. Summer breeding season.

Pinnipeds are less susceptible to acoustic damage from underwater noise; however, a BIA for Australian sea lions (EPBC Act listing of vulnerable) representing important foraging habitat overlaps with the northwest corner of the Operational Area.

A large number of seabird species have been identified as being potentially present within the Operational Area. Seventeen species have a BIA that overlaps with the Operational Area and of these, the following seven species are known to breed inshore of, and in close proximity to the Operational Area: Australasian gannet, black-faced cormorant, common-diving petrel, little penguin, short-tailed shearwater (migratory), shy albatross (vulnerable/migratory), and white-faced storm petrel. The offshore distribution of seabirds is patchy, with birds congregating in areas where food is abundant. For this reason, seabird aggregations are expected to be associated with areas of high primary productivity (e.g. the Bonney Upwelling and the West Tasmanian Canyons).

A number of conservation features and sensitive areas exist in the vicinity of the Operational Area. The Operational Area overlaps with three Australia Marine Parks and six others are located nearby. All but one of these marine parks is classified as 'IUCN Category VI', meaning that they are protected areas that allow for sustainable use of natural resources. The Murray Marine National Park, a large offshore marine park located 17.5 km west of the Operational Area, is however an 'IUCN Category II' park which has restrictions on fishing (commercial and recreational), tourism, mining (including seismic surveys), research and the placement of structures. Numerous State Marine Parks, State Marine Sanctuaries, State Marine Reserves, Conservation Parks, Abalone Fisheries Research Areas, Wetlands of International Importance, Nationally Important Wetlands, and Threatened Ecological Communities are located in coastal waters inshore of the Operational Area. Despite there being no direct spatial overlap between these protected areas and the Operational Area, they are included in the EP for completeness.

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Cultural elements of the receiving environment are also considered in the EP, where Victoria, South Australia and Tasmania all have a rich Aboriginal heritage. The coasts adjacent to the Operational Area are claimed as part of traditional lands by a number of groups, with Native Title Consent Determination Areas registered for the Ngarrindjeri and Others (South Australia); the First Nations of the South East (South Australia); the Gunditj Mirring (Victoria); and the Eastern Maar (Victoria). In Victoria, these claims include the sea for 3 NM from the high-water mark on the mainland and offshore islands. The Native Title claims are inshore of the Operational Area. In addition to this, there are no marine-based UNESCO World Heritage Sites, National Heritage Sites or Commonwealth Heritage Listed Places of direct relevance to the Operational Area.

The wider receiving environment also supports important socio-economic elements including coastal settlements, tourism, recreation and defence activities. In addition, the Operational Area overlaps with major shipping routes around southern Australia and existing oil and gas activities also occur in the Otway Basin. However, given the potential for direct overlap between commercial fishing and the Otway Basin 2DMC MSS, commercial fishing is perhaps the most relevant socio-economic component; hence, a brief description of fisheries in southern Australia is provided below.

The Otway Basin 2DMC MSS Operational Area encompasses a variety of commercial fisheries; both Commonwealth and State managed. Rock lobster is a highly valuable catch for all three states of the Operational Area. In South Australia, the 2015/16 fishing year annual catch was 1,592 t at an estimated value of $138 million, in Victoria, the annual catch was 288 t in 2015/16, at an estimated value of $24.5 million, and in Tasmania the annual 2015/16 catch was 1,138 t, with an estimated value of $93 million. Rock lobsters are harvested with steel-framed pots that are set overnight and retrieved at first light. Most of the lobster catch comes from inshore waters less than 100 m deep with the majority of fishing effort concentrated from October to January. Recent fishing effort within the South Australian Rock Lobster (Southern Zone) and Victorian Rock Lobster Fisheries has occurred within the Operational Area.

A Commonwealth managed small pelagic fishery operates in the Operational Area using mid-water trawls and purse seines to target Australian sardine, blue mackerel, jack mackerel and redbait. In the 2015/16 fishing year, Victorian fishers landed 1,524 t of sardines ($1.7 million) and South Australian fishers landed 41,103 t ($25.9 million). Catch and value statistics for the other three species were unavailable.

The Southern and Eastern Scalefish and Shark Fishery is a multi-sector, multi-gear and multi-species fishery, targeting a variety of fish, squid and shark stocks. Targeted species include blue grenadier, tiger flathead, silver warehou, gummy shark and pink ling. In the 2015/16 fishing season, this fishery reported a catch of 15,907 t with an estimated value of $73 million. Trawl effort in this fishery largely occurs along the 200 m depth contour in the Operational Area; however, Danish seine and scalefish hook vessels also operate under this fishery.

Most of the Australian catch of southern bluefin tuna is taken by purse seine within the Great Australian Bight from December to March. Although a small amount of fishing effort has occurred within the Operational Area, the closest main tuna fishing areas to the Operational Area are to the east of Kangaroo Island, over 100 km from the boundary of the Operational Area. This is a very valuable fishery with a total catch of 5,508 t in the 2015/2016 season with an estimated value of $35.9 – $37.2 million.

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The Southern Squid Jig Fishery occurs throughout the Operational Area, with the main 'local' port used by the jigging fleet being Portland (Victoria). Fishing effort and number of vessels participating in the fishery has declined, leading to a high level of latency in the fishery. The commercial catch for the 2015/16 fishing season was 385 t and valued at $1.0 million. This catch was taken by eight vessels across New South Wales, Victoria, South Australia and Tasmania, with a small amount of effort taken from within the Operational Area.

The giant crab fishery occurs along the shelf break, between 150 – 300 m deep off the east coast of Tasmania and from west coast Tasmania to South Australia. The reported catch for this species in South Australia during the 2015/16 fishing season was estimated to have a value of approximately $1.4 million over a fishing season that runs from October to April. Recorded catches in Tasmania for 2015/2016 were 25 t, with an estimated value of $2 million. In Victoria's Western Zone, the giant crab catch in 2015/16 was 9 t, with an estimated value of $280,000. Recent fishing effort for giant crab associated with the Victorian (Western Zone) fishery has occurred within the Operational Area.

The abalone fishery is one of the most valuable commercial fisheries in southern Australia; 3,394 t was collected during the 2015/16 fishing season, with an estimated value of $131.5 million. The fishery is diving-based in inshore areas less than 30 m water depth. Abalone harvested in Tasmania provides around 25% of the total annual global harvest; one of the largest wild abalone fisheries in the world. There has been no recent fishing effort in the Tasmanian or Victorian (Western Zone) abalone fisheries within the Operational Area, although recent effort has occurred in the boundaries of the Operational Area by South Australian abalone fishers.

The Commonwealth and State managed scallop fishery collected over 5,000 t of scallops during the 2015/16 fishing season, at an estimated value of $14.0 million. Scallops are typically collected using towed dredges; however, scallop dredges are prohibited in South Australia where scallops can only be collected by divers. Hence, in South Australia this fishery only operates in water depths <30 m. The default scallop fishing season is 1 April – 31 December. There has been no recent fishing effort within the Operational Area by any of the scallop fisheries.

There are several Commonwealth-managed fisheries that target large pelagic species throughout Australia's EEZ. Of relevance to the Operational Area are vessels that use longlines to target albacore tuna, yellowfin tuna, bigeye tuna, striped marlin and broadbill swordfish. A very small amount of fishing effort has occurred within the Operational Area by the Eastern Tuna and Billfish, and the Western Tuna and Billfish Fisheries.

In addition to the commercial fisheries mentioned above, marine aquaculture is common in South Australia and Tasmania. However, in South Australia, aquaculture is predominantly conducted in areas west of Kangaroo Island, well outside the Operational Area. In Tasmania, salmonid farming occurs in enclosed waters adjacent to the southeast corner of the Operational Area. Recreational fishing is also a major socio-economic component of the receiving environment, although the vast majority of recreational fishing occurs inshore of the Operational Area.

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Predicted Ecological Impacts

The EP considers all environmental impacts and risks from the proposed activity, along with an evaluation of these impacts and risks for all planned operations and potential unplanned events. The planned operations include the physical presence of the seismic vessel and towed equipment, acoustic disturbance to the marine environment, routine permissible waste discharges, atmospheric emissions and artificial light emissions. Potential unplanned events include the establishment of invasive marine species, streamer loss, vessel collision or sinking and its associated potential hydrocarbon spill, and the accidental release of hazardous and non-hazardous substances. A robust risk assessment methodology has been applied to each of these operations/events to assess impacts and risks on a consequence and likelihood basis; the end result being a residual risk outcome for relevant receptors that accounts for the implementation of a suite of proposed control measures to minimise risk where possible. Potential cumulative impacts have also been considered and assessed in the EP.

This risk assessment process confirmed that acoustic disturbance to the biological marine environment from seismic surveys is considered to be the most significant potential impact from the Otway Basin 2DMC MSS. Depending on the sound exposure level (**SEL**) and sensitivity threshold of each species, the effects of acoustic disturbance can be physiological (temporary or permanent threshold shift), behavioural, perceptual and/or indirect.

Project-specific Sound Transmission Loss Modelling (**STLM**) was undertaken to predict received SELs and the spread of noise emissions from the acoustic source during the Otway Basin 2DMC MSS. The STLM results indicated that at 1 km from the acoustic source the expected single shot SEL ranged from 164 dB 1 μPa^2 s in 50 m of water up to 170 dB 1 μPa^2 s in 4,800 m of water. The potential impacts on all faunal groups have been thoroughly reviewed through the EP with the following key findings:

- STLM results indicated that fish mortality or injury is possible from exposure to a single pulse of the acoustic source at full power at distances out to 250 m in the deepest water of the Operational Area, or 130 m in the shallowest waters. Exposure to multiple pulses from the moving source or doubling the noise dose with an infill line does not increase the risk of fish mortality or injury, since mortality effects are dominated by the peak impulsive effect of a single full power pulse;
- STLM results indicate that exposure to a single acoustic pulse could elicit permanent hearing damage to baleen whales within 50 m of the source. Cumulative exposure to multiple noise pulses could cause permanent hearing damage in baleen whales at distances out to around 1,200 m. Temporary hearing damage could occur if baleen whales were exposed to a single pulse at a distance of 80 – 130 m, or for whales remaining at one location for an extended time period within around 5 km of an active survey line, or around 7 km if an infill line is required. The higher frequency hearing range of other cetaceans mean that they are less susceptible to impacts and the STLM results indicate that there is no potential for either temporary or permanent hearing damage outside of 1 km from the active source for these high frequency hearing specialists; and
- STLM results indicated that exposure to a single pulse of the acoustic source could elicit mortality in zooplankton out to 4,500 m from the source, while fish eggs would experience mortality out to 250 m from the source. While these STLM results clearly demonstrate impacts on zooplankton and fish eggs, the high energy nature of the offshore marine environment in the Operational Area will help promote rapid recovery of zooplankton populations from dispersal and mixing.

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Where possible and as outlined above, acoustic sensitivity thresholds and STLM were used to determine the predicted impacts of acoustic disturbance from the Otway Basin 2D MC MSS. However, in the absence of such thresholds, and for potential impacts associated with other planned operations and unplanned events, published literature was used to predict potential effects. **Table 1** provides a full summary of results from the risk assessment process.

Stakeholder Engagement

An extensive stakeholder engagement programme has been conducted during the project planning phase for the Otway Basin 2DMC MSS. The intention of this programme was to engage with all parties considered as 'relevant persons' in accordance with the Environment Regulations so that they could raise any objections or claims of any environmental, social or economic nature. Stakeholders were identified on a spatial basis, whereby a 150 km buffer was placed around the Operational Area to define the potential scale of interest. This process allowed 'relevant persons' to be identified from within this area. However, in some instances parties beyond this distance were also engaged, as SLB preferred to include a 'capture all' approach for key stakeholder groups.

Engagement occurred with a wide variety of stakeholders including commercial and recreational fishers, State and Commonwealth industry bodies and associations, Marine Park and protected area authorities, tourism operators and numerous other interest groups. The engagement process involved the distribution of information sheets, face-to-face meetings and extensive email and telephone correspondence. During this process SLB has gained a deep understanding of the potential impacts (real and perceived) to interested parties.

This process has been particularly useful in relation to understanding risks to commercial fishers with high levels of engagement occurring with the South East Trawl Fishing Industry Association (**SETFIA**), Seafood Industry Victoria (**SIV**), and the Tasmanian Seafood Industry Council (**TSIC**) in particular. The key concerns raised by commercial fishers were 1) catch rates of target species may be adversely affected by the proposed operations, and 2) underwater noise would have detrimental effects on the larval stages of commercially fished species (primarily rock lobster and scallops). These concerns are thoroughly addressed in the EP through the inclusion of detailed discussions of scientific literature, STLM results and control measures. In a number of instances submissions from commercial fishers have been used to refine the survey design (in terms of both spatial and temporal extent) with the aim of reducing potential impacts where practicable.

A consultation strategy has been developed which defines key principles and policies that demonstrate SLB's genuine commitment to ongoing meaningful engagement with stakeholders throughout the duration of the Otway Basin 2DMC MSS. Throughout the stakeholder engagement process, SLB has taken pride in the honesty of their communications and the level of transparency conveyed regarding the proposed activity and associated impacts. The intention is for this nature of communication to continue throughout the survey and to culminate in a series of 'close-out' meetings after the survey is complete.

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Proposed Controls

SLB have committed to a large number of control measures to reduce potential impacts from the Otway Basin 2DMC MSS to **ALARP** and an **Acceptable Level**. Basic operational and contingency controls that will be implemented during the MSS include:

- The source capacity will be reduced to the minimum level possible whilst still enabling survey objectives to be met;
- Acoustic release will be limited to within the defined boundaries of the Operational Area;
- Minimum depth limitations will be implemented for activation of the acoustic source;
- Seismic operations will continue around the clock (as possible) to reduce the overall duration of the survey;
- The 5 km line spacing reduces the potential for 'acoustic intensification' in any one area;
- A 40 km spatial separation will be maintained between concurrent seismic surveys;
- Towed equipment will be retrieved when the seismic vessel is in transit (e.g. to and from port);
- A support vessel will be present around the survey vessel at all times;
- Compliance with relevant legislation and conventions with regard to maritime safety;
- Compliance with relevant legislation and conventions with regard to maritime discharges and pollution;
- Vessels will not utilise heavy fuel oil;
- An Emergency Response Plan for Hydrocarbon Spills has been prepared;
- Outwards facing lighting will be reduced to minimum levels on seismic and support vessels;
- A Ballast Water Management Plan will be implemented;
- A solid streamer fitted with 'streamer recovery devices' will be used;
- Automated Identification System (**AIS**) transponders will be fitted to survey vessels and the streamer tail buoy;
- A Notice to Mariners will be issued prior to commencement of the survey;
- The survey vessel and support vessels will avoid the Exclusion Zones of other marine users (i.e. oil and gas installations);
- Ongoing communication will be maintained with other marine users (commercial fishers, divers, oil and gas operators etc.); and
- 'Turtle guards' will be installed on the streamer tail buoy.

A number of controls have also been incorporated into the survey design following stakeholder feedback. In particular, two revisions were made to the survey design to reduce potential conflict with commercial fisheries:

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- The Operational Area was revised to reduce the spatial overlap with inshore waters. An initial revision to omit waters less than 50 m deep meant that the proposed Operational Area was reduced by 25,000 km^2 and spatial overlap with most rock lobster fishing grounds and abalone dive fisheries was eliminated. This revision also addressed potential impacts on ecological sensitivities in the coastal zone (e.g. the Bonney Upwelling System and those species dependant on it for foraging); and
- A second revision was subsequently made to the Operational Area, which resulted in a further reduction of 73,000 km^2 when all waters shallower than 1,000 m were omitted off the west coast of Tasmania.

These two revisions collectively reduced the Operational Area by approximately 100,000 km^2, meaning that 98% of the survey lines are in water depths greater than 200 m, and 91% of the Operational Area is in water depths greater than 1,000 m. Very little commercial fishing occurs in depths greater than 1,000 m. Therefore, spatial overlap with fisheries has been significantly reduced by these changes.

During the survey period, SLB will also issue '48-hour look-ahead notifications' to inform the fishing industry and other relevant marine users of the vessels predicted passage. These notifications will be updated every 24 hours. If any fishing gear is lost or damaged on account of seismic operations, SLB will compensate those fishers for the replacement value of the lost gear.

Contraction of the Operational Area to deeper offshore waters has also reduced the potential overlap with seasonal whale activity along the coast; namely feeding of blue whales in the Bonney Upwelling off South Australia in summer and southern right whale breeding activity in inshore waters. In addition, humpback whales migrate south along the east coast of Tasmanian and potentially through Bass Strait during November/December, and to avoid overlap with this migration, SLB intend to commence the Otway Basin 2DMC MSS in the northeast.

The Otway Basin 2DMC MSS will fully comply with the EPBC Act Policy Statement 2.1 in order to minimise the risk of acoustic disturbance to whales. The species assessment undertaken as part of the process of describing the receiving environment identified ten whale species with a 'moderate to high' likelihood of being encountered during the proposed operations. For all surveys where the likelihood of encountering whales is greater than 'low' the EPBC Policy Statement 2.1 requires additional management measures to be adopted. On this basis and in an effort to increase the protection afforded to whales, SLB have proposed a modification to the standard precautionary zones outlined in the EPBC Act Policy Statement 2.1; where SLB will extend the 500 m 'Shut-down Zone' out to 2 km to address the results of the STLM which predicted that cumulative exposure could cause PTS in baleen whales at distances out to 1,200 m.

Beyond this Shut-down Zone the 'Observation Zone' will be implemented out to 3+ km from the acoustic source. Two experienced Marine Mammal Observers (**MMO**s) will be present onboard the seismic vessel to monitor for marine mammals in the Observation Zone, and Passive Acoustic Monitoring (**PAM**) will be used around the clock to acoustically detect cetaceans, which will be monitored by two additional experienced PAM observers. The use of pre-start-up observations, soft starts, delayed starts and stop work procedures are standard requirements of the EPBC Act Policy Statement 2.1and will be implemented during the survey; however, SLB has also committed to 'no energy' line turns, run-ins and run-outs in an effort to further reduce the spatial footprint of the survey and night-time and low visibility procedures will also be implemented.

In addition to these measures, SLB's survey design also provides a degree of mitigation against disturbance to marine mammals, namely:

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- The Otway Basin 2DMC MSS Operational Area is located in Open Ocean and not in any confined water body or spatially discrete migratory corridor; and
- The 5 km spacing between survey lines will ensure the survey vessel will not focus in any specific area for a long period of time.

Within the defined operational window of October 2019 to June 2020, two periods have been identified when the biological significance of potential impacts to whales in the inshore areas where the tie lines will be acquired will be lowest. These two periods depend on when the survey commences; so the tie lines will either be acquired at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey (i.e. 1 March-30 April 2020). Acquiring the inshore lines during these periods will minimise the potential overlap between seismic operations and:

- The end of the southern right whale breeding season in October;
- The start of the southern right whale breeding season in May/June;
- The arrival of pygmy blue whales to the Bonney Upwelling foraging area towards the end of December;
- The peak of pygmy blue whale feeding activity in January and February;
- The northward humpback migration in April/May.

Gill *et al*. (2011) documented that blue whale foraging typically occurs in the west of the upwelling system (in the vicinity of Kangaroo Island and Eyre Peninsula) early in the upwelling season (November-December), before spreading eastward between Cape Jaffa and Cape Otway.

Due to the Operational Area overlapping with a BIA for blue whales and southern right whales, and the recognised biological significance of these areas, SLB will implement a number of control measures that will be adopted when operating within the BIAs. These BIA control measures will be used in conjunction with the Standard and Additional Control Measures required under the EPBC Act Policy Statement 2.1 and outlined above when the survey vessel is operating within the BIAs, and include:

- Application of a 4 km buffer along the offshore boundary of the blue whale and southern right whale BIAs;
- Extension of the 2 km Shut-down Zone to 4 km horizontal radius from the acoustic source;
- The presence of two MMOS on the bridge of the survey vessel during daylight hours while the acoustic source is active within the BIA and buffer zone;
- The addition of an experience MMO on the support vessel to provide a secondary platform for marine mammal observing during daylight hours while the acoustic source is active in the BIAs and buffer zone;
- Application of adaptive management measures for unexpected observations; and
- Discussions will be held with the Department of the Environment and Energy (**DoEE**) for any additional management measures that may be required in the event that whale sightings are higher than anticipated and adaptive measures are being implemented repeatedly during the survey.

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Additional control measures have been proposed for implementation during tie line acquisition as SLB recognises that the potential to encounter whale's increases as the Operational Area approaches the coast and whale densities in these areas are likely to be significantly higher than elsewhere in the Operational Area. In particular the Operational Area overlaps with parts of the Bonney Upwelling Zone, a BIA for pygmy blue whales, and the BIA for southern right whales along the inshore boundary, where the tie lines are located.

The additional tie line control measures will be implemented in conjunction with the above control measures and include:

- Acquisition will only occur during day light hours and in good visibility;
- The extended 4 km Shut-down Zone will be in place; and
- Acquisition of the tie lines will be undertaken either at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey (i.e. 1 March-30 April 2020) when the least number of whales are expected to be in the area.

Further Adaptive Management Measures will also be implemented by SLB for the duration of the Otway Basin 2DMC MSS and include:

- Relocation of the survey vessel to another survey line at least 10 km away (i.e. two survey lines) in the event that high numbers of whale detections result in three or more shut-downs within a 24-hour period;
- Immediate shut-down of the acoustic source if a southern right whale mother and calf pair is observed during the MSS. Start-up and soft-start procedures will not commence until the whales have disappeared from observable distance for at least one hour, or approximately 8 km away; and
- Discussions will be held with the DoEE if whale sightings are higher than anticipated to determine whether any additional management measures are required.

Environmental Risk Assessment Summary

A robust risk assessment methodology has been applied to assess impacts and risks associated with the proposed Otway Basin 2DMC MSS. This methodology uses consequence and likelihood criteria to assess each planned activity and all conceivable unplanned events. The risk assessment culminates in a residual risk outcome being assigned to each relevant environmental receptor following the consideration of how the proposed control measures will serve to minimise impacts and risk to **ALARP** and an **Acceptable Level**. The results of the risk assessment process are summarised in **Table 1**.

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Table 1 Environmental Risk Assessment Results for Planned Operations and Unplanned Events

	Receptor	Likelihood	Consequence	Residual Risk
Planned Operations	*Physical Presence of Seismic Vessel and Towed Equipment*			
	Potential Impacts on Marine Reptiles	Unlikely	Minor	Low
	Potential Impacts on Cetaceans	Likely	Minor	Low
	Potential Impacts on Pinnipeds	Likely	Minor	Low
	Potential Impacts on Commercial Fishing	Likely	Moderate	Moderate
	Potential Impacts on Commercial Shipping	Likely	Minor	Low
	Potential Impacts on Oil & Gas Activities	Remote	Severe	Low
	Potential Impacts on Tourism & Recreation	Possible	Minor	Low
	Acoustic Disturbance to the Marine Environment			
	Physiological Impacts on Zooplankton	Likely	Minor	Low
	Physiological Impacts on Scallop Larvae	Possible	Minor	Low
	Physiological Impacts on Rock Lobster Larvae	Likely	Minor	Low
	Physiological Impacts on Benthic Invertebrates	Unlikely	Minor	Low
	Physiological Impacts on Fish	Likely	Minor	Low
	Physiological Impacts on Cephalopods	Unlikely	Minor	Low
	Physiological Impacts on Marine Reptiles	Rare	Moderate	Low
	Physiological Impacts on Whales	Rare	Moderate	Low
	Physiological Impacts on Small Dolphins & Pinnipeds	Rare	Catastrophic	Moderate
	Physiological Impacts on Elasmobranchs	Rare	Minor	Low
	Physiological Impacts on Seabirds	Rare	Minor	Low
	Behavioural Impacts on Benthic Invertebrates	Unlikely	Minor	Low
	Behavioural Impacts on Fish	Likely	Minor	Low
	Behavioural Impacts on Cephalopods	Unlikely	Minor	Low
	Behavioural Impacts on Marine Reptiles	Rare	Moderate	Low
	Behavioural Impacts on Cetaceans	Likely	Moderate	Moderate
	Behavioural Impacts on Pinnipeds	Likely	Minor	Low
	Behavioural Impacts on Elasmobranchs	Unlikely	Minor	Low
	Behavioural Impacts on Seabirds	Possible	Minor	Low
	Perceptual Impacts on Fish	Likely	Minor	Low
	Perceptual Impacts on Cetaceans	Certain	Minor	Moderate
	Potential Impacts on Australian Marine Parks	Likely	Minor	Low
	Potential Impacts on State Marine Parks, Marine National Parks, Marine Sanctuaries, Marine Reserves, and Fisheries Research Areas	Rare	Minor	Low
	Potential Impacts on Onshore Protected Areas, Wetlands of National Importance, and Wetlands of International Importance	Remote	Negligible	Negligible

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	Potential Impacts on Biologically Important Areas	Likely	Minor	Low
	Potential Impacts on Threatened Ecological Communities	Rare	Minor	Low
	Potential Impacts on Key Ecological Features	Unlikely	Minor	Low
	Potential Impacts on World and National Heritage Sites	Rare	Negligible	Negligible
	Potential Impacts on Catch Rate of Commercial Crustacean Fisheries	Possible	Minor	Low
	Potential Impacts on Catch Rate of Commercial Mollusc Fisheries	Unlikely	Minor	Low
	Potential Impacts on Catch Rate of Commercial Fish Fisheries	Possible	Minor	Low
	Potential Impacts on Southern Squid Jig Fishery	Certain	Minor	Low
	Potential Impacts on Southern Bluefin Tuna Fishery	Possible	Minor	Low
	Potential Impacts on Commercial and Recreational Dive Operations	Unlikely	Minor	Low
	Routine Permissible Waste Discharges			
	Potential Impacts on all Receptors	Unlikely	Negligible	Negligible
	Atmospheric Emissions			
	Potential Impacts on Human Health	Likely	Negligible	Negligible
	Artificial Light Emissions			
	Potential Impacts on Marine Mammals	Unlikely	Minor	Low
	Potential Impacts on Seabirds	Unlikely	Minor	Low
	Potential Impacts on Marine Reptiles	Rare	Negligible	Negligible
Unplanned Events	*Invasive Marine Species*			
	Potential Impacts on Environmental Receptors	Rare	Severe	Moderate
	Potential Impacts on Stakeholders and Other Marine Users	Rare	Severe	Moderate
	Streamer Loss			
	Potential Impacts on all Receptors	Remote	Minor	Low
	Vessel Collision or Sinking			
	Potential Impacts on Physical Environment	Rare	Minor	Low
	Potential Impacts on Biological Environment	Rare	Minor	Low
	Potential Impacts on Commercial Fishing	Remote	Severe	Low
	Potential Impacts on Marine Aquaculture	Rare	Moderate	Low
	Potential Impacts on Commercial Shipping	Rare	Minor	Low
	Potential Impacts on Tourism and Recreation	Rare	Minor	Low
	Hydrocarbon Response			
	Potential Impacts on Environmental Receptors	Rare	Minor	Low
	Accidental Release of Hazardous or Non-Hazardous Materials			
	Potential Impacts on Environmental Receptors	Unlikely	Minor	Low

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The predicted risks and impacts of the Otway Basin 2DMC MSS are thoroughly assessed in this EP and are considered to be **Negligible** to **Moderate**. All effects can be sufficiently managed by the control measures proposed in this EP. Hence, in light of the survey design revisions and the extensive suite of proposed controls, the overall conclusion from the environmental risk assessment is that the impacts from the Otway Basin 2DMC MSS have been reduced to **ALARP** and **Acceptable Levels** and the survey will fully comply with all relevant legislation and industry best practice.

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Table 2 Regulation 13 Requirements

Regulation 13	How this Requirement is Met
(1) The Environment Plan must contain a comprehensive description of the activity including the following:	
(a) the location or locations of the activity;	The proposed Otway Basin 2DMC MSS is located within Otway Basin off the coasts of South Australia, Victoria and Tasmania as detailed within **Section 3.2** and seen within **Figure 4**.
(b) general details of the construction and layout of any facility	This EP is not for the construction or establishment of any facility and the exact details of the seismic vessel are not yet known as a seismic vessel is yet to be contracted. However, the details of vessels similar to what would be used for the Otway Basin 2DMC MSS are included within **Section 3.4.4** and **3.4.5**.
(c) an outline of the operational details of the activity (for example, seismic surveys, exploration drilling or production) and proposed timetables	A detailed description of the operational details of this proposal are included within **Section 3.4**, and includes discussions on the acoustic source configuration, streamer configuration, sail lines and turns, and details on the survey vessel and support and chase vessels similar to what would to be utilised for the Otway Basin 2DMC MSS. **Section 3.3** discusses the proposed timing and duration of the proposed Otway Basin 2DMS MSS.
(d) any additional information relevant to consideration of environmental impacts and risks of the activity	**Section 3** contains the full description of proposed project and includes all information considered relevant to enable the consideration of the environmental impacts and risks of the activity.
(2) The Environment Plan must:	
(a) describe the existing environment that may be affected by the activity	A full detailed description of the environment is included within **Section 5** which has been broken down into five sub-sections detailing the physical environment, biological environment, coastal environment (marine protected and sensitive areas), cultural and heritage values and the socio-economic environment. This assessment has been based on the Operational Area provided within **Figure 4**, and also includes areas of importance in the surrounding environment based on the extent of potential impacts and risks associated with the proposal.
(b) include details of the particular relevant values and sensitivities (if any) of that environment	The values and sensitivities of the environment within, and surrounding, the Operational Area are detailed throughout **Section 5**.

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Regulation 13	How this Requirement is Met
(3) Without limiting paragraph (2)(b), particular relevant values and sensitivities may include any of the following:	
(a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act	An assessment of the heritage values within the Operational Area has been conducted and detailed within **Section 5.4.2**. No World Heritage properties were identified within, or surrounding, the Operational Area.
(b) the national heritage values of a National Heritage place within the meaning of that Act	As outlined in relation to Regulation 13(3)(a) above, an assessment of the heritage values within the Operational Area was undertaken during the development of this EP (**Section 5.4**). No National Heritage places were identified within the Operational Area.
(c) the ecological character of a declared Ramsar wetland within the meaning of that Act	Three Ramsar wetlands have been identified within the environment surrounding the Operational Area, and two further afield. A description of the ecological character of these wetlands is included within **Section 5.3.5**.
(d) the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act	**Section 5.2** contains a detailed assessment of the biological environment, including an assessment on any threatened species or threatened ecological communities likely to be found within and surrounding the Operational Area.
(e) the presence of a listed migratory species within the meaning of that Act	As per the above, an assessment on the potential migratory species that traverse the Operational Area has been undertaken during the development of this EP. A description of any identified species is contained within **Section 5.2**.
(f) any values and sensitivities that exist in, or in relation to, part or all of: (i) a Commonwealth marine area within the meaning of that Act; or (ii) Commonwealth land within the meaning of that Act	There are a variety of values and sensitivities within the Commonwealth marine area within and surrounding the Operational Area. A detailed description of known values and sensitivities is found throughout **Section 5.3**, and includes bioregions, onshore protected areas, Australian marine parks, state marine parks, wetlands (both nationally and internationally important), threatened ecological communities, key ecological features, biologically important areas and the Australian whale sanctuary.

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Regulation 13	How this Requirement is Met
(4) The Environment Plan must:	
(a) describe the requirements, including legislative requirements, that apply to the activity and are relevant to the environmental management of the activity (b) demonstrate how those requirements will be met	**Section 2** of the EP contains a detailed description of the requirements on SLB to undertake the proposed activity, including methods of meeting those requirements. These requirements include the Offshore Petroleum and Greenhouse Gas Storage Act and its associated Environment Regulations, along with the Environment Protection and Biodiversity Conservation Act and the associated EPBC Act Policy Statement 2.1– Interaction between Offshore Seismic Exploration and Whales and other relevant management plans. In addition to these core pieces of legislation, a number of other requirements need to be met by SLB in undertaking the proposed survey; all of which are detailed within **Section 2.3**.
(5) The environment must include:	
(a) details of the environmental impacts and risks for the activity (b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk (c) details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an Acceptable Level	An Environmental Risk Assessment (**ERA**) has been undertaken to determine the potential impacts and risks associated with the activity on the environment and existing interests. The method for this ERA has been outlined within **Section 6**. This ERA has been developed utilising the joint Australian & New Zealand International Standard Risk Management – Guidelines (AS/NZS ISO 31000:2018). The potential impacts on the environment and existing interests from those activities planned as part of the Otway Basin 2DMC MSS have been detailed within **Section 7**, and the potential risks to the environment and existing interests from unplanned events are contained within **Section 8**. Any potential cumulative effects from the Otway Basin 2DMC MSS are detailed within **Section 9**. As part of the assessment of the impacts and risks from this proposal, a description of the control measures to be implemented has been included. With the implementation of these measures, the impacts and risks from the activity are considered to be reduced to **ALARP**, and to an **Acceptable Level**.
(6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from:	
(a) all operations of the activity	As outlined above, the environmental impacts from the proposed operations have detailed within **Section 7** of this EP and includes all control measures that have been developed by SLB to reduce these impacts to **ALARP**, and to an **Acceptable Level**.

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Regulation 13	How this Requirement is Met
(b) potential emergency conditions, whether resulting from accident or any other reason	An assessment of the risk from unplanned activities, including the introduction of invasive marine species, streamer loss, vessel collision or sinking (and its associated hydrocarbon spill) and accidental release of hazardous and non-hazardous materials is outlined throughout **Section 8**.
(7) The Environment Plan must:	
(a) set environmental performance standards for the control measures identified under paragraph (5)(c)	As part of the ERA process undertaken for this activity found within **Sections 7** and **8**, SLB has developed control measures that will be used to reduce the impacts and risks of the activity to **ALARP** and an **Acceptable Level**. During the development of these control measures, environmental performance standards, environmental performance outcomes and measurement criteria were established to ensure those control measures are implemented and maintained in a manner that reduces the impact and risk of the activity to **ALARP** and an **Acceptable Level**. The specific control measures, environmental performance standards, environmental performance outcomes and measurement criteria are detailed against each activity associated with this proposal throughout **Sections 7** and **8**.
(b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured	
(c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met	

Table 3 Regulation 14 Requirements

Regulation 14	How this Requirement is Met
(1) The environment plan must contain an implementation strategy for the activity in accordance with this regulation.	An implementation strategy has been developed for the Otway Basin 2DMC MSS and is included within **Section 10** of the EP.
(2) The implementation strategy must:	
(a) state when the titleholder will report to the Regulator in relation to the titleholder's environmental performance for the activity	The reporting requirements of the EP are outlined within **Section 10.6**, including an environmental performance report which will be submitted to NOPSEMA within two months following the completion of the survey.
(b) provide that the interval between reports will not be more than 1 year	

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<table>
<tr><th>Regulation 14</th><th>How this Requirement is Met</th></tr>
<tr><td colspan="2">(3) The implementation strategy must contain a description of the environmental management system for the activity, including specific measures to be used to ensure that, for the duration of the activity:</td></tr>
<tr><td>(a) the environmental impacts and risks of the activity continue to be identified and reduced to a level that is as low as reasonably practicable</td><td rowspan="3">The SLB environmental management system to be used throughout the Otway Basin 2DMC MSS is detailed within Section 10.1. The overall environmental management system includes various aspects to it which are detailed throughout Section 10.
The environmental inductions undertaken prior to commencement will include awareness and compliance aspects of the approved EP including the key sensitivities and impacts/risks associated with the Otway Basin 2DMC MSS to ensure all staff members are aware of these aspects and their continual need to be identified and reduce to ALARP and an Acceptable Level.
In addition to the above, monitoring of control measures, environmental performance outcomes and standards will be undertaken as per Section 10.4 to ensure that control measures are operating in a way that effectively reduces impacts/risks to ALARP and an Acceptable Level and that environmental performance outcomes and standards are being met.</td></tr>
<tr><td>(b) control measures detailed in the environment plan are effective in reducing the environmental impacts and risks of the activity to as low as reasonably practicable and an Acceptable Level</td></tr>
<tr><td>(c) environmental performance outcomes and standards set out in the environment plan are being met</td></tr>
<tr><td>(4) The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan, including during emergencies or potential emergencies</td><td>Table 104 within Section 10.2 contains a clear definition of the roles and responsibilities of all staff involved with the Otway Basin 2DMC MSS. In addition to this, Figure 79 provides an organisational chart outlining the chain of command within SLB.</td></tr>
<tr><td>(5) The implementation strategy must include 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 the environment plan, including during emergencies or potential emergencies, and has the appropriate competencies and training</td><td>An outline of the training, competencies and awareness is included within Section 10.3 of the EP. This section describes the environmental induction that all SLB employees and contractors will be required to attend prior to the commencement of the activity which includes awareness and compliance aspects of the approved EP.
Additional requirements under the EPBC Act Policy Statement 2.1 for MMOs to have proven experience in whale observation, distance estimation and reporting is also discussed within Section 10.3.2.</td></tr>
</table>

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Regulation 14	How this Requirement is Met
(6) The implementation strategy must provide for sufficient monitoring, recording, audit, management of non-conformance and review of the titleholder's environmental performance and the implementation strategy to ensure that the environmental performance outcomes and standards in the environment plan are being met	The environmental performance of the Otway Basin 2DMC MSS will be undertaken in accordance with **Section 10.4**. This section outlines the methods in which SLB will ensure there is sufficient monitoring and recording (**Section 10.4.1**) and its associated record management (**Section 10.4.2**), auditing (**Section 10.4.3**), and the management of any non-conformances (**Section 10.4.4**). These factors are all utilised in the review of the EP (discussed within **Sections 10.4.5**) to ensure that the environmental performance standards and outcomes are being met and for the environmental performance reporting which is outlined within **Section 10.6.2**.
(7) The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met	**Section 10.4.1** of this EP discusses the monitoring and recording which will be undertaken during the Otway Basin 2DMC MSS which includes daily reports and weekly inspections. These will quantitatively record a variety of aspects relating to each of the planned and unplanned activities (**Table 105**).
(8) The implementation strategy must contain an oil pollution emergency plan and provide for the updating of the plan	SLB have developed an oil pollution emergency plan to meet the requirements of Regulation 14(8AA) as outlined in the following rows and contained within **Section 10.9**.
(8AA) The oil pollution emergency plan must include adequate arrangements for responding to and monitoring oil pollution, including the following:	
(a) the control measures necessary for timely response to an emergency that results or may result in oil pollution	A series of control measures have been developed in order to ensure timely responses to emergencies that result, or may result, in oil pollution which are included within **Table 90** in **Section 8.3.4**. In addition to this, control measures have been developed to ensure that any response to an emergency does not result in further environmental impacts (**Section 8.4.2**).
(b) the arrangements and capability that will be in place, for the duration of the activity, to ensure timely implementation of the control measures, including arrangements for ongoing maintenance of response capability	The hydrocarbon spill response arrangements associated with the Otway Basin 2DMC MSS are discussed within **Section 10.9.5**. These arrangements include on-site equipment for the prevention/minimisation of loss of oil to the sea, and the notification and reporting requirements should a spill make it to the sea.

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Regulation 14	How this Requirement is Met
(c) the arrangements and capability that will be in place for monitoring the effectiveness of the control measures and ensuring that the environmental performance standards for the control measures are met	To ensure the control measures and environment performance standards for the risks associated with vessel collision (and the subsequent hydrocarbon spill) are being met, measurement criteria was developed in accordance with these control measures within **Section 8.3.4**, and for those control measures relating to hydrocarbon spill response detailed in **Section 8.4.2**.
(d) the arrangements and capability in place for monitoring oil pollution to inform response activities	The monitoring arrangements for the Otway Basin 2DMC MSS are detailed within **Section 10.9.6**, and include Type I (Operational) and Type II (Scientific) monitoring as further detailed below in relation to Regulation 14(8D).
(8A) The implementation strategy must include arrangements for testing the response arrangements in the oil pollution emergency plan that are appropriate to the response arrangements and to the nature and scale of the risk of oil pollution for the activity	As outlined within **Section 10.9.5.6** a series of drills and exercises will be undertaken to ensure crew are confident in using the onboard spill equipment and implementing the incident response procedures. Further details of these exercises are discussed below in relation to Regulation 14(8B).
(8B) The arrangements for testing the response arrangements must Include:	
(a) a statement of the objectives of testing	The arrangements for testing the response arrangements are detailed within **Table 108** in **Section 10.9.5.6** which includes undertaking three-monthly drills and exercise to increase efficiency in the event of an emergency and allow revisions (through the Management of Change process detailed within **Section 10.4.6**) of the Oil Pollution Emergency Plan should issues arise from these exercises.
(b) a proposed schedule of tests	
(c) mechanisms to examine the effectiveness of response arrangements against the objectives of testing	
(d) mechanisms to address recommendations arising from tests	
(8C) The proposed schedule of tests must provide for the following:	
(a) testing the response arrangements when they are introduced	A summary of the testing requirements are detailed within **Table 108** in **Section 10.9.5.6** which includes the schedules of tests required, including drills conducted within three months prior to commencement of the activity and at least every three months during the activity.
(b) testing the response arrangements when they are significantly amended	

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Regulation 14	How this Requirement is Met
(c) testing the response arrangements not later than 12 months after the most recent test	Should any changes be required as a result of this testing schedule, SLB will undertake a Management of Change process as outlined within **Section 10.4.6**.
(d) if a new location for the activity is added to the environment plan after the response arrangements have been tested, and before the next test is conducted—testing the response arrangements in relation to the new location as soon as practicable after it is added to the plan	
(e) if a facility becomes operational after the response arrangements have been tested and before the next test is conducted—testing the response arrangements in relation to the facility when it becomes operational	
(8D) The implementation strategy must provide for monitoring of impacts to the environment from oil pollution and response activities that	
(a) is appropriate to the nature and scale of the risk of environmental impacts for the activity	The monitoring of hydrocarbon spill impacts is detailed throughout **Section 10.9.6** and is split into Type I (Operational Monitoring) and Type II (Scientific Monitoring). In consultation with the Control Agency, and dependant on the nature and scale of the hydrocarbon spill will determine the monitoring response required.
(b) is sufficient to inform any remediation activities	
(8E) The implementation strategy must include information demonstrating that the response arrangements in the oil pollution emergency plan are consistent with the national system for oil pollution preparedness and response	The Oil Pollution Emergency Plan has been developed in alignment with the National Plan, including the utilisation of the incident classification for hydrocarbons spills. Keeping this consistent with the National Plan will provide direction on the potential consequences and impact of the incident and guidance for preparedness, incident notifications and response actions as outlined within **Section 10.9.5**.
(9) The implementation strategy must provide for appropriate consultation with:	
(a) relevant authorities of the Commonwealth, a State or Territory	SLB has undertaken comprehensive consultation during the development of this EP (**Appendix B**, **C**, **D** & **F**) and are committed with ongoing consultation with relevant authorities of the Commonwealth, State and all other relevant interested persons and organisations. The ongoing stakeholder engagement strategy is outlined in detail within **Section 4.5.8**.
(b) other relevant interested persons or organisations	

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Regulation 14	How this Requirement is Met
(10) The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity	The implementation strategy for the Otway Basin 2DMC MSS has been developed in accordance with the OPGGS Act, the Environment Regulations (as outlined throughout this table) and all relevant environmental legislation.

Table 4 Regulation 15 Requirements

Regulation 15	How this Requirement is Met
(1) The environment plan must include the following details for the titleholder:	
(a) name (b) business address (c) telephone number (if any) (d) fax number (if any) (e) email address (if any) (f) if the titleholder is a body corporate that has an ACN (within the meaning of the *Corporations Act 2001*) - ACN	All relevant details of the titleholder (Schlumberger Australia Pty Limited) have been included within **Table 6** of **Section 1.1**.
(2) The environment plan must also include the following details for the titleholder's nominated liaison person	
(a) name (b) business address (c) telephone number (if any) (d) fax number (if any) (e) email address (if any)	Similar to the above, the relevant details for the nominated liaison person have been included within **Table 7** of **Section 1.1**.

EXECUTIVE SUMMARY

Regulation 15	How this Requirement is Met
(3) The environment plan must include arrangements for notifying the Regulator of a change in the titleholder, a change in the titleholder's nominated liaison person or a change in the contact details for either the titleholder or the liaison person	The method for notifying the regulator of a change in the titleholder, the nominated person or the contact details for either are discussed within **Section 1.1**.

Table 5 Regulation 16 Requirements

Regulation 16	How this Requirement is Met
The environment plan must contain the following:	
(a) a statement of the titleholder's corporate environmental policy	A copy of SLBs corporate Environmental Policy is included in **Figure 1** within **Section 1.2**.
(b) a report on all consultations between the titleholder and any relevant person, for regulation 11A, that contains: (i) a summary of each response made by a relevant person (ii) an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates (iii) a statement of the titleholder's response, or proposed response, if any, to each objection or claim (iv) a copy of the full text of any response by a relevant person	Extensive consultations with relevant people have been undertaken during the development of this EP; a description of this process is included within **Section 4**. In addition to this discussion, **Appendix F** contains an assessment of all the consultation undertaken with relevant persons, an assessment of the merits, objections and claims, a statement of the response by SLB and cross referencing to where these have been addressed within the EP. The full correspondence between the relevant person and SLB is also provided within **Appendix C**.
(c) details of all reportable incidents in relation to the proposed activity	SLB will notify NOPSEMA of any reportable incidents as soon as possible, but no later than two hours after the occurrence of the incident as detailed within **Section 10.6.4**.

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ABBREVIATIONS AND DEFINITIONS

2D	2-dimensional
3D	3-dimensional
AAM	Active Acoustic Monitoring
ACAP	Agreement on the Conservation of Albatrosses and Petrels
ADF	Australian Defence Force
AFMA	Australian Fisheries Management Authority
AHO	Australian Hydrographic Office
AIS	Automated Identification System
ALARP	As Low As Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
ARPA	Automatic Radar Plotting Aids
AS/NZS ISO 31000:2018	Australian & New Zealand International Standard Risk Management – Guidelines 31000:2018
ASBTIA	Australian Southern Bluefin Tuna Industry Association
AUV	Autonomous Underwater Vehicle
BIA	Biologically Important Areas
BOM	Bureau of Meteorology
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CGG	CGG Services (Australia) Pty Limited
CMS	Convention on Migratory Species
COLREGS	International Regulations for Preventing Collisions at Sea 1972
CPUE	Catch per Unit Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTS	Commonwealth Trawl Sector
dB	Decibels
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DoEE	Department of the Environment and Energy
DPIPWE	Department of Primary Industries, Parks, Water and Environment
DPTI	Department of Planning, Transport and Infrastructure

CONTENTS

EEZ	Exclusive Economic Zone
Environment Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
EP	Environment Plan
EPA Tasmania	Environmental Protection Authority Tasmania
EPA	Environmental Protection Authority
EPBC Act Policy Statement 2.1	EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ERA	Environmental Risk Assessment
ESD	Ecologically Sustainable Development
GABIA	Great Australian Bight Fishing Industry Association
HFO	Heavy-Fuel-Oil
IAGC	International Associated of Geophysical Contractors
IAPP Certificate	International Air Pollution Prevention Certificate
IMO	International Maritime Organisation
IMS	Invasive Marine Species
IOPP Certificate	International Oil Pollution Prevention Certificate
irMA	Intrinsic Ranging by Modulated Acoustics
ISPP Certificate	International Sewage Pollution Prevention Certificate
ISPP Certificate	International Sewage Pollution Prevention Certificate
IUCN	International Union for Conservation of Nature
JRCC	Joint Rescue Coordination Centre
KEF	Key Ecological Features
London Protocol	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972
MARPOL	International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978
MCS	Maximum Credible Scenario
MFA	Marine Fishing Areas
MGO	Marine Gas Oil
MMO	Marine Mammal Observer
MMSI	Maritime Mobile Service Identity
MoC	Management of Change

CONTENTS

MSDS	Material Safety Data Sheets
MSS	Marine Seismic Survey
National Plan	Australian National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances
NEBA	Net Environmental Benefit Analysis
NES	National Environmental Significance
NM	Nautical Mile
NMFS	U.S. National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
OCS	Offshore Constitutional Settlement
ODS	Ozone Depleting Substance
OPEP	Oil Pollution Emergency Plan
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006
ORCV	Ocean Racing Club of Victoria
Otway Basin 2DMC MSS	Otway Basin 2D Multiclient Marine Seismic Survey
PAM	Passive Acoustic Monitoring
PGS	PGS Australia Pty Limited
PIRSA	Department of Primary Industries and Regions, South Australia
Pk SPL	Peak Sound Pressure level
Pk-Pk SPL	Peak to Peak Sound Pressure Level
POLREP	Pollution report
PSPPS Act	Protection of the Sea (Prevention of Pollution from Ships) Act 1983
PSZ	Petroleum Safety Zones
PTS	Permanent Threshold Shift
QHSE Policy	Quality, Health, Safety and Environment Policy
RADAR	Radio Detection and Ranging
Ramsar Convention	The Convention on Wetlands of International Importance
RMS SPL	Root-Mean-Square Sound Pressure Level
RMS	Root Mean Square
SARDI	South Australian Research and Development Institute

CONTENTS

SARLA	South Australian Rock Lobster Association
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SESSF	Southern and Eastern Scalefish and Shark Fishery
SETFIA	South East Trawl Fishing Industry Association
SGSHS	Gillnet and Shark Hook Sector
SHS	Scalefish Hook Sector
SIA	Seafood Industry Australia
SITREP	Situation Report
SIV	Seafood Industry Victoria
SLB	Schlumberger Australia Pty Limited
SOLAS	International Convention of the Safety of Life at Sea
SOP	Standard Operating Procedures
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
SRL	Southern Rock Lobster Limited
STCW Convention	International Convention of Standards of Training, Certification and Watch Keeping for Seafarers
STLM	Sound Transmission Loss Modelling
TACC	Total Allowable Commercial Catch
TAFI	Tasmanian Aquaculture and Fisheries Institute
TEC	Threatened Ecological Community
TRLFA	Tasmanian Rock Lobster Association
TSIC	Tasmanian Seafood Industry Council
TTS	Temporary Threshold Shift
UNCLOS	United Nations Convention on the Law of the Sea 1982
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VFA	Victorian Fisheries Authority

1 Introduction

Schlumberger Australia Pty Limited (**SLB**) is proposing to acquire the Otway Basin 2D Multiclient Marine Seismic Survey (**Otway Basin 2DMC MSS**) from October 2019; with an estimated survey duration of 100 days, a conservative completion date of June 2020 is assumed. SLB has prepared this Environment Plan (**EP**) to ensure the Otway Basin 2DMC MSS is planned and undertaken in accordance with SLB's Quality, Health, Safety and Environment Policy (**QHSE Policy**), which is discussed further in **Section 1.2**, along with the regulatory requirements of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (**OPGGS Act**) and the associated *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (**Environment Regulations**).

This EP has been developed in accordance with the requirements of the Environment Regulations, and details the processes involved in assessing the potential risks and impacts to the different receptors within the receiving environment and stakeholders that utilise the area. Included within this assessment are the controls, mitigation measures and operational procedures proposed to be implemented in order to reduce the potential adverse environmental impacts from the planned operational activities, and risks from unplanned emergency events, to As Low As Reasonably Practicable (**ALARP**) and to **Acceptable Levels**. In addition, environmental performance standards have been developed to measure the performance of the controls, mitigation measures and operational measures that will be implemented throughout the Otway Basin 2DMC MSS.

Section 2 of this document describes the legislative framework and requirements in accordance with which this EP has been prepared.

Section 3 provides a detailed description of the Otway Basin 2DMC MSS.

Section 4 describes the stakeholder engagement programme which has been undertaken by SLB.

Section 5 describes the existing environment in relation to the location of the Otway Basin 2DMC MSS Operational Area, including a description of the physical and biological environments, the coastal environment and marine conservation, cultural values, and the socio-economic environment.

Section 6 details the environmental impact and risk assessment methodology undertaken in the development of this EP.

Section 7 provides a detailed assessment of environmental impacts from planned activities, including the control measures that will be implemented to reduce these impacts to **ALARP** and an **Acceptable Level**.

Section 8 provides an assessment of the potential environmental risks associated with unplanned activities, and an assessment of the control measures required to reduce these risks to **ALARP** and an **Acceptable Level**.

Section 9 provides an assessment of potential cumulative effects associated with the Otway Basin 2DMC MSS.

Section 10 describes the implementation strategy for the Otway Basin 2DMC MSS, which includes the environmental management system.

Section 11 provides an overall summary of the EP.

Section 12 summarises the references cited throughout the EP.

1.1 Titleholder and Nominated Liaison Person

SLB is the Titleholder for this activity. SLB is the world's leading supplier of technology, integrated project management and information solutions to customers working in the oil and gas industry worldwide. Employing over 100,000 people, representing over 140 nationalities and working in more than 85 countries, SLB provides the industry's widest range of products and services from exploration through to production. WesternGeco, a business segment of SLB, provides advanced seismic acquisition and data processing services and has extensive experience in conducting seismic surveys internationally and in Australia. As WesternGeco is a business segment of SLB, it will be referred to as SLB throughout this EP.

Regulation 15(1) of the Environment Regulations require specific details of the titleholder and liaison person, each of which are detailed within **Table 6** and **Table 7**, respectively.

Table 6 Titleholder Details

Environment Regulation Requirements	Description
Name	Schlumberger Australia Pty Limited
Business address	Level 5, 256 St Georges Terrace, Perth, Western Australia 6000
Telephone number	+61 8 6208 3572
Fax number	+61 8 9420 4600
Email address	environment@slb.com
Australian Company Number	002 459 225

Table 7 Liaison Person Details

Environment Regulation Requirements	Description
Name	Kunal Mishra
Business address	Level 5, 256 St Georges Terrace, Perth, Western Australia 6000
Telephone number	+61 8 6208 3572
Fax number	+61 8 9420 4600
Email address	environment@slb.com

As per Regulation 15(3) of the Environment Regulations, the SLB Liaison Person (**Table 7**) or the SLB Project Manager (**Table 108**) will notify NOPSEMA both verbally and in writing as soon as practicable and prior to a change in the titleholder or the liaison person, or a change in the contact details for either the titleholder or liaison person, occurring.

1.2 SLB Environmental Policy

SLB has a corporate QHSE Policy which provides a public statement of SLB's commitment to protecting the environment during all operations, including the proposed Otway Basin 2DMC MSS. Environment Regulation 16(a) requires a statement of the titleholder's corporate environmental policy; therefore, SLB's corporate QHSE Policy is provided within **Figure 1**.

Figure 1 Schlumberger's Corporate QHSE Policy

Schlumberger

Quality, Health, Safety, and Environmental (QHSE) Policy

The long-term business success of Schlumberger depends on our ability to continually improve the quality of our services and products while protecting people and the environment. Emphasis must be placed on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. This commitment is in the best interests of our customers, our employees and contractors, our stockholders and the communities in which we live and work.

Schlumberger requires the active commitment to and accountability for, QHSE from all employees and contractors. Line management has a leadership role in the communication and implementation of, and ensuring compliance with, QHSE policies and standards. We are committed to:

- Protect, and strive for improvement of, the health, safety and security of our people at all times;
- Eliminate Quality non-conformances and HSE accidents;
- Meet specified customer requirements and ensure continuous customer satisfaction;
- Set Quality & HSE performance objectives, measure results, assess and continually improve processes, services and product quality, through the use of an effective management system;
- Plan for, respond to and recover from any emergency, crisis and business disruption;
- Minimize our impact on the environment through pollution prevention, reduction of natural resource consumption and emissions, and the reduction and recycling of waste;
- Apply our technical skills to all HSE aspects in the design and engineering of our services and products;
- Communicate openly with stakeholders and ensure an understanding of our QHSE policies, standards, programs and performance. Reward outstanding QHSE performance;
- Improve our performance on issues relevant to our stakeholders that are of global concern and on which we can have an impact, and share with them our knowledge of successful QHSE programs and initiatives.

This Policy shall be regularly reviewed to ensure ongoing suitability. The commitments listed are in addition to our basic obligation to comply with Schlumberger standards, as well as all applicable laws and regulations where we operate. This is critical to our business success because it allows us to systematically minimize all losses and adds value for all our stakeholders.

Paal Kibsgaard
Chief Executive Officer, Schlumberger Limited

2 Legislative Framework and Requirements

Petroleum and greenhouse gas storage activities, including marine seismic surveys, in 'offshore areas' – defined as those waters between the outer limit of coastal water (3 nautical miles (**NM**)) and the outer limit of the Continental Shelf (at least 200 NM) - are required to be assessed and authorised under the OPGGS Act and the associated Environment Regulations.

The following sections detail the requirements of the Environment Regulations, along with all legal and other environmental management requirements that are relevant to the proposed Otway Basin 2DMC MSS. **Table 2** provides a summary of the Environmental Regulations, in particular, Regulation 13 and provides a road map to the relevant sections of this EP to where each of the requirements within the Environment Regulations has been adhered to.

2.1 Offshore Petroleum and Greenhouse Gas Storage Act 2006

The OPGGS Act commenced in March 2006 with the objective of providing an effective regulatory framework for petroleum exploration and recovery, and the injection and storage of greenhouse gas substances in Australia's offshore areas.

The OPGGS Act confers powers to the National Offshore Petroleum Safety and Environmental Management Authority (**NOPSEMA**) to regulate the health and safety, structural integrity and environmental management of petroleum exploration and development activities within Australia's offshore areas.

A system regulating petroleum and greenhouse gas activities is established under the OPGGS Act. This includes activities associated with the exploration for and recovery of petroleum, construction and operation of infrastructure facilities relating to petroleum or greenhouse gas substances, construction and operation of pipelines for conveying petroleum or greenhouse gas substances, exploration for potential greenhouse gas storage formations, and injection and storage of greenhouse gas substances (DoEE, 2014).

The OPGGS Act is supported by regulations covering matters such as safety, diving, petroleum resource management and environmental management (see **Section 2.1.1**).

In addition to establishing the regulatory regime for environmental management authorisation, the OPGGS Act has other relevant powers, including:

- Requiring that an activity in an offshore area must be undertaken in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seabed, any lawfully established activities of another person and the enjoyment of native title rights and interests;
- Requiring operations to be carried out in accordance with good oilfield practices;
- Requiring titleholders, in the event of an escape of petroleum, to eliminate or control the escape, clean up the escaped petroleum and remediate any resulting damage to the environment, and carry out environmental monitoring of the impact of the escape on the environment;
- Providing for NOPSEMA to give written directions to titleholders covering all aspects of petroleum exploration and production;
- Providing for remedial directions by NOPSEMA with regard to the restoration of the environment; and
- Requiring a titleholder to maintain in good condition and repair all structures and equipment that are used in connection with the operations authorised by the permit, lease, licence or authority.

2.1.1 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

The Environment Regulations have been developed under the OPGGS Act and provide an objective-based regime for the management of environmental performance for Australian offshore petroleum exploration and production and greenhouse gas storage activities in areas of Commonwealth jurisdiction.

The objectives of the Environment Regulations are to ensure any activity is carried out:

- In a manner consistent with the principles of Ecologically Sustainable Development (**ESD**) (**Section 2.2**);
- In a manner in which the environmental impacts and risks of the activity will be reduced to **ALARP.** To ensure the impacts and risks from the proposed activities are reduced to ALARP, a hierarchy of controls have been utilised which follows a tiered system of 'eliminate-substitute-reduce-mitigate' and these are defined within **Section 6.6**; and
- In a manner in which the impacts and risks will be of an **Acceptable Level**. The criteria used to determine whether the residual risk of an activity following the implementation of the control measures is at an **Acceptable Level** is provided within **Section 6.7**.

Table 2, **Table 3**, **Table 4** and **Table 5** define the information required for inclusion within an EP under Regulations 13, 14, 15 and 16 of the Environment Regulations, respectively, along with how these requirements are achieved within this EP.

2.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (**EPBC Act**) is the Australian Government's central piece of environmental legislation which provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places as matters of National Environmental Significance (**NES**). There are nine matters of NES to which the EPBC Act applies (outlined within Sections 12 to 24 of the EPBC Act), which are:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (RAMSAR Sites);
- Listed threatened species and ecological communities;
- Listed migratory species;
- Nuclear actions;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park; and
- Protection of water resources from coal seam gas development and large coal mining development.

The NES listed above are discussed in detail within **Section 5** where relevant to the proposed Otway Basin 2DMC MSS.

In relation to the listed threatened species and ecological communities, the EPBC Act has established a list of categories, including: extinct, extinct in the wild, critically endangered, endangered, vulnerable and conservation dependant. **Section 5.2** includes a discussion on the biological environment found in and around the Operational Area, which includes some species that are listed as threatened. Definitions for the relevant categories found in the Otway Basin 2DMC MSS Operational Area are as follows:

A native species is eligible to be included in the ***endangered*** *category at a particular time if, at that time:*

(a) It is not critically endangered; and

(b) It is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.

A native species is eligible to be included in the ***vulnerable*** *category at a particular time if, at that time:*

(a) It is not critically endangered or endangered; and

(b) It is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

A native species is eligible to be included in the ***conservation dependent*** *category at a particular time if, at that time:*

(a) The species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or

(b) The following subparagraphs are satisfied:

(i) The species is a species of fish;

(ii) The species is the focus of a plan or management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised;

(iii) The plan of management is in force under a law of the Commonwealth or of a State or Territory;

(iv) Cessation of the plan of management would adversely affect the conservation status of the species.

In addition to the matters listed above, the EP must describe matters protected under Part 3 of the EPBC Act and assess any impacts and risks to these. As outlined within **Section 2.1.1**, one objective of the Environment Regulations is to ensure that the activity is carried out in a manner consistent with the principles of ESD, which is set out in Section 3A of the EPBC Act as:

a. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
b. If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;

c. The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;

d. The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and

e. Improved valuation, pricing and incentive mechanisms should be promoted.

The EPBC Act has been utilised throughout the development of this EP, particularly in relation to the existing environment (**Section 5**) and within the assessment of the impacts and risks from the proposal (**Section 6**).

2.2.1 EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales

Under the EPBC Act, a number of whale species are listed as threatened and/or migratory species (see **Section 5.2.6**) and are subsequently protected under the EPBC Act as matters of NES. In order to manage the interaction between offshore seismic exploration and whales, the EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales (**EPBC Act Policy Statement 2.1**) was developed. The aim of the EPBC Act Policy Statement 2.1 is to:

- Provide practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations;
- Provide a framework that minimises the risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important habitat areas or during critical behaviours; and
- Provide guidance to both proponents of seismic surveys and operators conducting seismic surveys about their legal responsibilities under the EPBC Act.

2.2.1.1 Potential Impacts to be Considered

Section 4 of the EPBC Act Policy Statement 2.1 discusses the potential impacts to be considered when planning a seismic survey, which has been utilised in the preparation of this EP. An important aspect to consider when assessing the likelihood of potential impacts on whales is determining whether the survey will have a 'low likelihood' or a 'moderate to high likelihood' of encountering whales. These are defined within the EPBC Act Policy Statement 2.1 as:

- Low likelihood – spatially and temporally outside aggregation areas, migratory pathways and areas considered to provide biologically important habitat; and
- Moderate to high likelihood – spatially and/or temporally proximate to aggregation areas, migratory pathways and/or areas considered to provide biologically important habitat.

In addition to the above, identifying whether a proposed survey will occur within a biologically important habitat of a whale species is necessary because displacement from these areas may have a greater impact than elsewhere. An assessment into the likelihood of encountering whale species has been undertaken and included within **Section 5.2.6**, along with the identification of any areas which are biologically important habitats for those whale species.

2.2.1.2 Legislative Responsibilities

There are two obligations that need to be considered under the EPBC Act when developing a seismic survey: referrals and permits. These are defined as follows:

- Referrals - if a seismic survey has or is likely to have a significant impact on a matter of NES or the 'environment' (including threatened and migratory species) then that action should be referred to the Australian Government Environment Minister under the EPBC Act. The Minister may then determine the referral to be either a 'controlled action' in which the action is subject to the assessment and approval processes under the EPBC Act, or not a controlled action where further approval is not required if the action is undertaken in accordance with the referral, or in a particular way specific in the decision notice.

  As part of the development of this EP, a number of control measures has been utilised in assessing the impact of the proposed Otway Basin 2DMC MSS (contained throughout **Section 7** for planned activities, and **Section 8** for unplanned activities). Based on these control measures, overall it is considered that the proposed Otway Basin 2DMC MSS activities will not have a significant impact on a matter of NES or on the 'environment' in general, as outlined within **Sections 7** and **8**.

- Permits – an action that will kill, injure, take or interfere with a whale or dolphin within the Australian Whale Sanctuary (described within **Section 5.3.10**) is an offence under the EPBC Act, unless the proposed action has been referred to the Environment Minister and approved, or a permit has been granted. Generally, a seismic survey will not interfere with whales if it is undertaken in an area and time where the likelihood of encountering whales is low and appropriate measures are implemented.

  As outlined above, the likelihood of encountering whales during the proposed Otway Basin 2DMC MSS is discussed within **Section 5.2.6** and the control measures to be implemented are contained within **Sections 7** and **8**. Based on these sections, it is considered that the proposed Otway Basin 2DMC MSS activities will not kill, injure, take or interfere with a whale or dolphin within the Australian Whale Sanctuary.

2.2.1.3 Management Measures for Vessels Conducting Seismic Surveys in Australian Waters

The EPBC Act Policy Statement 2.1 provides a discussion on the management measures for vessels and organisations looking to conduct seismic surveys within Australian waters. These measures are divided into two primary areas, precautionary zones and management procedures which are discussed in the following sections.

2.2.1.3.1 Precautionary Zones

Section 6.1 of the EPBC Act Policy Statement 2.1 defines three zones (observation, low-power and shut-down) which are to be used during seismic surveys, based on the likely sound levels surrounding the seismic sound source. There are two levels of precautionary zones, dependant on the sound exposure level each seismic emission makes which is to be demonstrated through sound modelling or empirical measurements.

If the received sound exposure level will not likely exceed 160 dB re 1 μPa^2s for 95% of seismic shots at 1 km range, the following precautionary zones are recommended under the EPBC Act Policy Statement 2.1:

- Observation zone: 3^+ km horizontal radius from the acoustic source;
- Low-power zone: 1 km horizontal radius from the acoustic source; and
- Shut-down zone: 500 m horizontal radius from the acoustic source.

For all other proposed seismic surveys, the EPBC Act Policy Statement 2.1 recommends the following zones:

- Observation zone: 3+ km horizontal radius from the acoustic source;
- Low-power zone: 2 km horizontal radius from the acoustic source; and
- Shut-down zone: 500 m horizontal radius from the acoustic source.

A graphical representation of the three recommended zones is indicated within **Figure 2**.

Figure 2 EPBC Act Policy Statement 2.1 - Recommended Precautionary Zones

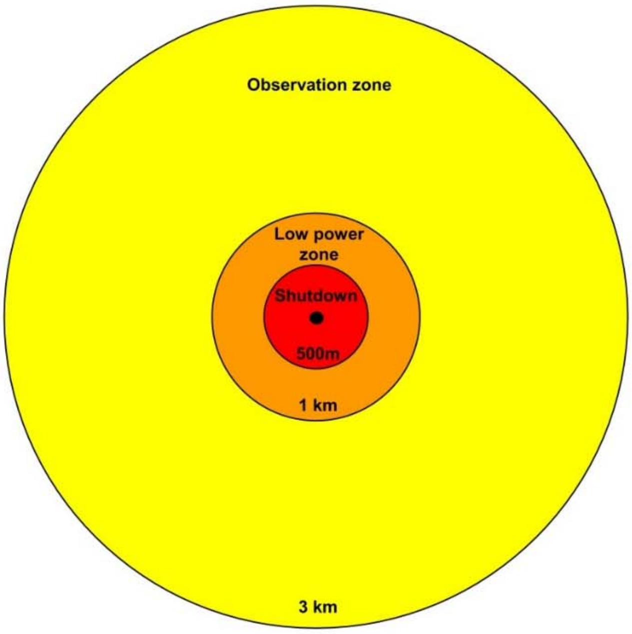


Diagram 1: Precaution zones surrounding the acoustic source for surveys that meet the criteria for a **1km low power zone**.

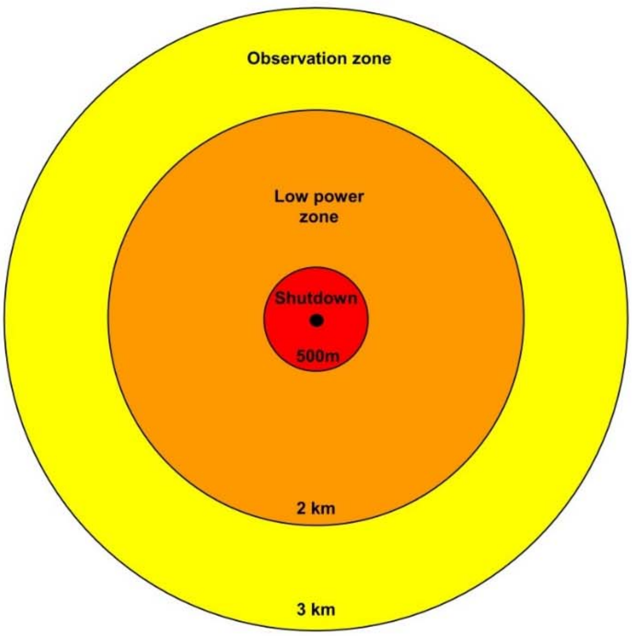


Diagram 2: Precaution zones surrounding the acoustic source for all other surveys (**2km low power zone**)

Source: EPBC Act Policy Statement 2.1 (DoEWHA, 2008)

Each of the three zones has differing requirements, as follows:

- Observation zone – whales and their movements should be monitored to determine whether they are approaching or entering the 'Low-power Zone';
- Low-power zone – when a whale is sighted within, or is about to enter, this zone, the acoustic source should immediately be powered down to the lowest possible setting; and
- Shut-down zone – when a whale is sighted within, or is about to enter, this zone, the acoustic source must immediately be shut-down completely.

SLB has undertaken Sound Transmission Loss Modelling (**STLM**) (**Section 7.2.1.3**) which has shown that at 1 km, the expected single shot Sound Exposure Level (**SEL**) is 164 dB 1 μPa^2 s in 50 m of water and 170 dB 1 μPa^2 s in 4,800 m of water (**Table 49**).

The STLM results confirm that the SELs are expected to be greater than 160 dB re 1 $\mu Pa^2 s$ for 95% of seismic shots at 1 km, so SLB will implement the more stringent precautionary zone requirements of the EPBC Act Policy Statement 2.1 (**Figure 2**).

As an additional mitigation measure, SLB is proposing a modification to the precautionary zones recommended by the EPBC Act Policy Statement 2.1, whereby there will be no Low- power Zone. Instead, SLB is proposing that the 500 m Shut-down Zone is extended out to 2 km in order to include the recommended Low-power Zone. The Observation Zone of 3+ km will still be implemented in accordance with the requirements above. Further discussion on this approach is contained within **Section 7.2.5**.

2.2.1.3.2 Management Procedures

In addition to the precautionary zones discussed above, the EPBC Act Policy Statement 2.1 includes a number of management procedures which should be followed by all seismic vessels conducting surveys in Australian waters irrespective of location and time of year. These management procedures are split into 'Standard Management Procedures' and 'Additional Management Procedures' under Section 6.2 of the EPBC Act Policy Statement 2.1.

The Standard Management Procedures include:

- Pre-survey planning – ideally, no seismic surveys will be planned to be conducted when whales are likely to be breeding, calving, resting or feeding; if a seismic survey is proposed to occur during this period, careful consideration of the survey and associated mitigation measures will need to be undertaken;
- Trained crew – sufficiently trained crew, including people with proven experience in whale observation, distance estimation and reporting, are required to undertake relevant requirements during the survey operations;
- During survey – all seismic survey vessels operating in Australian waters are required to follow basic procedures during surveys irrespective of location and time of the year, including:
  - Pre-start-up visual observations;
  - Soft start;
  - Start-up delay;
  - Operations;
  - Power-down and stop work; and

- Compliance and sighting reports – a record of procedures employed during operations is required, including information on any whales (or other species) sighted during the survey. This information may be useful for future operations.

When a seismic survey is proposed to operate in areas where the likelihood of encountering whales is moderate to high (discussed in **Section 2.2.1.1**) then additional management procedures are required to ensure that impacts and interference are avoided and/or minimised. These additional management procedures include:

- Marine Mammal Observer (**MMO**) – MMOs should be trained and experienced in whale identification and behaviour, distance estimation, be capable of making accurate identifications and observations of whales in Australian waters, and can assist other observers on the seismic vessel;
- Night-time/poor visibility – appropriate management measures to detect (or predict) whale presence should be included to reduce the likelihood of encounters, including limiting initiation of soft start procedures, daylight spotter vessel or aircraft and pre-survey research;
- Spotter vessel(s) and aircraft – a spotter vessel/aircraft could be used to assist in detecting the presence of whales, including during night-time/poor visibility operations;
- Increase precaution zones and buffer zones – in some locations and circumstances an increased distance for the instigation of power-down procedures (discussed above) is advisable;
- Passive Acoustic Monitoring – deployment of PAM to detect whales in real-time may provide an additional method of detecting whales during surveys, and particularly during night-time/poor visibility operations; and
- Adaptive management – adaptive management procedures should be considered to manage the potential increased likelihood of encountering whales; for example, ceasing night-time operations if there are three consecutive days on which operators experience three or more whale-instigated shut-down/power down situations.

An assessment of the likelihood of encountering whales has been undertaken within **Section 5.2.6**, which has concluded that there is a moderate to high likelihood of encountering whales during the proposed Otway Basin 2DMC MSS. Therefore, additional management procedures will be required, and these are discussed in detailed within **Section 7.2**.

2.2.2 Environment Protection and Biodiversity Conservation Regulations 2000

The EPBC Regulations, 2000 implement the provisions of the EPBC Act, and provide additional measures to control a range of activities, including the use of vehicles and vessels, littering, commercial activities, research, and commercial and recreational fishing. In particular, Part 8 of these regulations relates to interacting with cetaceans and whale watching. The relevant provisions of Part 8 have been considered when determining the impacts and risks associated with the proposed Otway Basin 2DMC MSS (**Section 7**).

2.2.3 EPBC Act Management Plans

When a native species or ecological community is listed as threatened under the Commonwealth EPBC Act, conservation advice is developed to assist with its recovery. Conservation advice provides guidance on the immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of a newly listed species or ecological community.

The Minister for the Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and Threatened Ecological Communities (**TEC**) listed under the EPBC Act. Recovery plans define the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or ecological community.

A summary of the EPBC Act Conservation Management Plans, Recovery Plans and Conservation Advice that relate to the Operational Area are described within **Table 8**, with detailed descriptions of the species which may be found within the Otway Basin 2DMC MSS Operational Area being included within **Section 5.2**. In addition, any relevant measures contained within the conservation advice and recovery plans have been considered as part of the assessment of impacts and risks that may occur as a result of the Otway Basin 2DMC MSS (**Section 7.2.2**).

Table 8 EPBC Act Conservation Management Plans, Recovery Plans and Conservation Advice relevant to the Otway Basin 2DMC MSS

Species	Relevant Plan/Conservation Advice	Key threats within Plan/Advice of relevance to MSS	Plan/Advice actions relevant to this EP
Australian grayling	National Recovery Plan for the Australian Grayling *Prototroctes maraena*	No specific key threats or management actions of relevance to Otway Basin 2DMC MSS identified in Recovery Plan.	
White shark	2013 Recovery Plan for the White Shark (*Carcharodon carcharias*)	No specific key threats or management actions of relevance to Otway Basin 2DMC MSS identified in Recovery Plan.	
Whale shark	Conservation Advice adopted 1 October 2015	Boat strike	Minimise transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations (Note these areas are not expected within Operational Area).
Leatherback turtle	2017 Recovery Plan for Marine Turtles in Australia; and Conservation Advice approved 17 December 2008	Marine debris – Entanglement and Ingestion	Support the implementation of the EPBC Act Threat Abatement Plan for the impacts of marine debris on vertebrate marine life.
		Light pollution	No management actions of relevance to Otway Basin 2DMC MSS due to lack of habitat critical to marine turtles and turtle nesting beaches in the vicinity of the Operational Area.
		Vessel disturbance	No management actions specific to vessel disturbance identified in Recovery Plan.
		Noise disturbance	No management actions specific to vessel disturbance identified in Recovery Plan.
Loggerhead turtle	2017 Recovery Plan for Marine Turtles in Australia	See above for threats.	See above for relevant actions.

Species	Relevant Plan/Conservation Advice	Key threats within Plan/Advice of relevance to MSS	Plan/Advice actions relevant to this EP
Southern right whale	2011 – 2021 Conservation Management Plan for the Southern Right Whale	Noise Interference – Seismic and shipping	Improve the understanding of what impact anthropogenic noise may have on southern right whale populations by: • Assessing anthropogenic noise in key calving areas; • Assessing responses of southern right whales to anthropogenic noise; and • If necessary, developing further mitigation measures for noise impacts
		Vessel disturbance – Vessel collisions	No management actions specific to vessel collision of relevance to Otway Basin 2DMC MSS in Management Plan.
		Entanglement - Marine debris	No management actions specific to entanglement in marine debris identified in Management Plan.
Sei whale	Conservation Advice approved 1 October 2015	Anthropogenic noise and acoustic disturbance	Once the spatial and temporal distribution (including Biologically Important Areas (**BIA**)) of sei whales is further defined an assessment of the impacts of increasing anthropogenic noise should be undertaken on sei whales; and If required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.
		Vessel strike	Ensure all vessel strike incidents are reported in the National Vessel Strike Database.
Blue whale	2015 – 2025 Conservation Management Plan for the Blue Whale	Noise interference - seismic and shipping	Assess the effect of anthropogenic noise on blue whale behaviour; 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; and EPBC Act Policy Statement 2.1. – Interaction between offshore seismic exploration and whales is applied to all seismic surveys.

Species	Relevant Plan/Conservation Advice	Key threats within Plan/Advice of relevance to MSS	Plan/Advice actions relevant to this EP
		Vessel disturbance – vessel collisions	Ensure all vessel strike incidents are reported in the National Ship Strike Database; and 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.
		Marine debris	No management actions specific to marine debris have been identified within the blue whale Conservation Management Plan.
Fin whale	Conservation Advice approved 1 October 2015	Anthropogenic noise and acoustic disturbance	Once the spatial and temporal distribution (including BIAs) of fin whales if further defined, an assessment of the impacts of increasing anthropogenic noise should be undertaken on fin whales; and If required, additional management measures should be developed and implemented to ensure the ongoing recovery of fin whales.
		Vessel strike	Ensure all vessel strike incidents are reported in the National Vessel Strike Database.

Species	Relevant Plan/Conservation Advice	Key threats within Plan/Advice of relevance to MSS	Plan/Advice actions relevant to this EP
Humpback whale	Conservation Advice approved 1 October 2015	Noise interference	All seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1 – Interactions 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; For actions involving acoustic impacts (e.g. 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); Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified a noise management plan should be developed. This can include: • The use of Shut-down and Caution Zones; • Pre and post activity observations • The use of MMOs and/or PAM; and • Implementation of an adaptive management program following verification of the noise levels produced from the action (i.e. if the noise levels created exceeded original expectations).
		Vessel disturbance and strike	Ensure all vessel strike incidents are reported in the National Vessel Strike Database; and 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.
Australian sea lion		Entanglement in marine debris	Assess the impacts of marine debris on Australian sea lion populations; and Develop and implement measures to mitigate the impacts of marine debris on Australian sea lion populations.

Species	Relevant Plan/Conservation Advice	Key threats within Plan/Advice of relevance to MSS	Plan/Advice actions relevant to this EP
	2013 Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) and supporting Issues Paper for the Australian Sea Lion (*Neophoca cinerea*)	Human disturbance Oil spills	Develop management actions to mitigate impact of vessel strike, pollution and oil spills on Australian sea lion populations.
		Noise	No management actions specific to noise have been identified within the Australian sea lion Recovery Plan.
Sub-Antarctic fur seal	Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan 2004 - 2009	Pollution (including marine debris)	No management actions specific to pollution have been identified.
Southern elephant seal	Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan 2004 – 2009; and Conservation Advice adopted 7 December 2016	See above.	See above.
Albatrosses and giant petrels	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011 - 2016	Marine pollution	No management actions of relevance to Otway Basin 2DMC MSS have been identified.
Blue petrel	Conservation Advice approved on 1 October 2015	No specific key threats or management actions of relevance to Otway Basin 2DMC MSS identified in Conservation Advice.	
Soft-plumaged petrel	Conservation Advice approved on 1 October 2015	No specific key threats or management actions of relevance to Otway Basin 2DMC MSS identified in Conservation Advice.	

2.3 Other Relevant Legislative Requirements

Regulation 13(4) of the Environment Regulations requires a description of the relevant legislative requirements that apply to the activity and are relevant to the environment management of the activity. A number of legislative instruments exist which are relevant to the proposed Otway Basin 2DMC MSS; these are outlined below along with a discussion on how each of these requirements will be achieved. The relevant legislation that applies to the Otway Basin 2DMC MSS were determined based on SLBs previous operational experience conducting seismic operations in Australian waters, along with review of NOPSEMAs guidance notes, and SLRs experience in completing environmental impact assessments for MSS activities.

2.3.1 Relevant Commonwealth and State Legislation

The key pieces of Commonwealth legislation relevant to the environmental management of the Otway Basin 2DMC MSS is outlined within **Table 9**.

Table 9 Key Commonwealth Legislation Relevant to the Otway Basin 2DMC MSS

Legislation	Applicability
Australian Maritime Safety Authority Act 1990	This Act established the Australian Maritime Safety Authority (**AMSA**), which has the responsibility of protecting the marine environment from pollution from ships, and other environment damage resulting from shipping activities. These responsibilities include being the lead agency when responding to hydrocarbon spills within the marine environment under the Australian National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances (known as the **National Plan**). Given the Otway Basin 2DMC MSS will take place in the marine environment, there is always a remote risk of pollution or other incidents as a result of the operations. The potential risks from an unplanned activity occurring in association with the Otway Basin 2DMC MSS is assessed within **Section 8**. This assessment also provides the measures that will be implemented throughout the survey to reduce these risks to **ALARP** and an **Acceptable Level**; for example, having the National Plan incorporated within SLBs Oil Pollution Emergency Plan (**Section 10.9**).
Environment Protection (Sea Dumping) Act 1981	The Environment Protection (Sea Dumping) Act 1981 is administered by the Australian Government Department of the Environment and Energy (**DoEE**) and is aimed at protecting the waters surrounding Australia's coastlines from wastes and pollution dumped at sea. In addition, this Act fulfils Australia's international obligations under the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972, and 1996 Protocol (the **London Protocol**). The aim of this Act is to minimise pollution threats by: • Prohibiting ocean disposal of waste considered too harmful to be released into the marine environment; and • Regulating permitted waste disposal to ensure environmental impacts are minimised. Since the proposed Otway Basin 2DMC MSS will involve the use of a survey vessel within Australian waters, the management and operation of the vessel will be subject to this Act. Although no waste or other matter (other than routine vessel discharges e.g. appropriately treated sewage) is proposed to be discharged within Australian waters as part of this EP, there is always a remote chance of an accident occurring where such waste or equipment could be lost overboard. **Section 8.4** outlines the potential risks and associated impacts if an accidental discharge occurs, along with the measures that SLB will implement to reduce the risk to **ALARP** and within **Acceptable Levels**.

Legislation	Applicability
Navigation Act 2012	This act covers international ship and seafarer safety, shipping aspects of protecting the marine environment and the actions of seafarers in Australian waters. The Act gives effect to the relevant aspects of the International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 (**MARPOL**), the United Nations Convention on the Law of the Sea 1982 (**UNCLOS**) and the International Regulations for Preventing Collisions at Sea 1972 (**COLREGS**), among other international treaties, details of which are outlined below: • MARPOL is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The Annexes of MARPOL that Australia is a party to are given effect to by current legislation, including the Environment Protection (Sea Dumping) Act 1981, the Australian Maritime Safety Authority Act 1990 and the Navigation Act 2012; • UNCLOS lays down a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources; and • COLREGS set out the navigational rules to be followed by ships and vessels at sea to prevent collisions. These Regulations will be important in maintaining safe operating procedures to ensure collisions don't occur during the survey. In addition to the above international treaties, several Marine Orders are enacted under the Navigation Act 2012 which relate to offshore petroleum activities, including: • Marine Order Part 21: Safety of navigation and emergency procedures; • Marine Order Part 27: Radio equipment; • Marine Order Part 28: Operations standards and procedures; • Marine Order Part 30: Prevention of collisions; • Marine Order Part 31: Vessel surveys and certification; • Marine Order Part 32: Cargo handling equipment; and • Marine Order Part 59: Offshore support vessel operations. Since the survey vessel proposed to be used for the Otway Basin 2DMC MSS will be operating within Australian waters, the management and operation of the vessel will be subject to this Act. The relevant aspects of this Act and subsequent Marine Orders, along with the international treaties that provide control measures to avoid potential risks associated with this activity are discussed within **Section 8.3**.
Offshore Minerals Act 1994	The Offshore Minerals Act 1994 establishes a regulatory regime for the exploration and production of minerals with Commonwealth waters (i.e. beyond 3 NM of the territorial sea baseline) including the establishment of a licencing scheme for minerals. The exploration and production of minerals within waters inside the 3 NM limit is managed by the relevant State or the Northern Territory. The relevant permits near the Operational Area are described within **Section 5.5.4**.

<table>
<tr><th>Legislation</th><th>Applicability</th></tr>
<tr><td>Protection of the Sea (Prevention of Pollution from Ships) Act 1983</td><td>MARPOL includes regulations aimed at preventing both accidental pollution and pollution from routine vessel operations. Australia implements MARPOL through the Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (PSPPS Act) and the Navigation Act 2012 (discussed above).
The PSPPS Act (and the Navigation Act), along with the following Commonwealth legislation gives effect to MARPOL:
• Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations;
• Marine Order 91 (Marine Pollution Prevention – Oil) 2014;
• Marine Order 93 (Marine Pollution Prevention – Noxious Liquid Substances) 2014;
• Marine Order 94 (Marine Pollution Prevention – Packaged Harmful Substances) 2014;
• Marine Order 95 (Marine Pollution Prevention – Garbage) 2013;
• Marine Order 96 (Marine Pollution Prevention – Sewage) 2013; and
• Marine Order 97 (Marine Pollution Prevention – Air Pollution) 2013.
The PSPPS Act, and the associated legislation listed above have been considered as part of the impact and risk assessment detailed within Section 7.3.</td></tr>
<tr><td>Protection of the Sea (Harmful Anti-fouling Systems) Act 2006</td><td>This Act was developed as part of Australia's commitment to MARPOL and the International Convention on the Control of Harmful Anti-fouling Systems on Ships and regulates the use of anti-fouling compounds and systems in Australian waters.
The vessel to be used for the Otway Basin 2DMC MSS will have an anti-fouling management regime in place that is consistent with this Act.</td></tr>
<tr><td>Historic Shipwrecks Act 1976</td><td>This Act protects historic wrecks and associated relics that are more than 75 years old and within Commonwealth waters. This act aims to ensure that historic shipwrecks are protected for their heritage values and maintained for recreational, scientific and educational purposes.
Some shipwrecks lie within protected or no-entry zones which can include an area up to 800 m radius around a wreck site, which are implemented if circumstances place the wreck at particular risk of interference. There are no protected or no-entry zones located within the Operational Area. An assessment of shipwrecks has been undertaken within Section 5.4.2.2.</td></tr>
<tr><td>Biosecurity Act 2015</td><td>The Biosecurity Act 2015 details how Australia manages biosecurity threats to plants, animals and human health. Section 4 of this Act describes the objectives, which are:
(a) To provide for managing the following:
(i) Biosecurity risks;
(ii) The risk of contagion of a listed human disease or any other infectious human disease;
(iii) The risk of human diseases or any other infectious human diseases entering Australian territory or a part of Australian territory, or emerging, establishing themselves or spreading in Australian territory or a part of Australian territory;
(iv) Risks related to ballast water;
(v) Biosecurity emergencies and human biosecurity emergencies;
(b) To give effect to Australia's international rights and obligations, including under the International Health Regulations, the SPS Agreement, the Ballast Water Convention, the United Nations Convention on the Law of the Sea and the Biodiversity Convention.
There are a number of relevant legislative documents that have been prepared to deal with the issue of biosecurity (discussed below); all of which have been considered as part of the preparation of this EP, specifically in relation to the assessment of environmental risks associated with invasive marine species (Section 8.1).</td></tr>
</table>

Legislation	Applicability
Ozone Protection & Synthetic Greenhouse Gas Management Act 1989	The Ozone Protection & Synthetic Greenhouse Gas Management Act 1989 regulates the manufacture, importation and use of ozone depleting substances which are typically used in fire-fighting equipment and refrigerants. The use of these substances is discussed within **Section 7.4** which stipulates that no ozone depleting substance will be deliberately released.
National Environment Protection Council Act 1994	The National Environment Protection Council is established under the National Environment Protection Council Act and has two primary functions: to make National Environment Protection Measures; and to assess and report on the implementation and effectiveness of these measures in participating jurisdictions. One such measure is the National Pollutant Inventory which was developed to maintain and improve the ambient air quality, and ambient marine, estuarine and fresh water quality which minimising the environmental impacts associated with hazardous waste and improving the sustainable use of resources. The management of pollution relevant to this proposal is described within **Section 7.3** and **7.4**.
Protection of the Sea (Powers of Intervention) Act 1981	The Protection of the Sea (Powers of Intervention) Act authorises the Commonwealth (through AMSA) to take the appropriate measures to intervene in shipping operations to protect the sea from pollution by oil and other noxious substances discharged from ships, and for related purposes. The authority of AMSA is recognised in the proposed Otway Basin 2DMC MSS, with methods to mitigate discharges discussed within **Section 7.3**.
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This Act establishes a liability and compensation regime to apply in cases of pollution damage following the escape of bunker oil from a ship that is not an oil tanker. This Act prescribes that ship owners are strictly liable for pollution damage resulting from the escape or discharge of bunker oil from their ships; resulting in the obligation on ships over 1,000 gross tonnage to carry insurance certificates when leaving/entering Australian ports. The survey vessels undertaking the MSS will hold the necessary insurance certificates.
Protection of the Sea (Shipping Levy) Act 1981	The Protection of the Sea (Shipping Levy) Act provides for any vessel of 24 metres or more in length carrying 10 tonne or more of oil on board at any time during a calendar quarter to pay the protection of the sea levy. This levy assists AMSA to respond to any environmental incidents. The vessels associated with this MSS will adhere to the protection of the sea levy.
National Greenhouse and Energy Reporting Act 2007	The National Greenhouse and Energy Reporting Act established the National Greenhouse and Energy Reporting scheme which is a single national framework for reporting and disseminating company information about greenhouse gas emissions, energy production, energy consultation and other information specified under the legislation. Any requirements to report greenhouse gas emissions from the proposal will be met.
Australian Heritage Council Act 2003	The Australian Heritage Council Act established the Australian Heritage Council as an independent expert advisory body on heritage matters. The main responsibilities of the Australian Heritage Council relate to assessing places for the National Heritage List and the Commonwealth Heritage List. An assessment of the heritage values associated with the Operational Area is outlined within **Section 5.4.2**.

Although the Otway Basin 2DMC MSS is located within Commonwealth waters (between 3 and 200 NM from the territorial baseline), and hence falls under the Commonwealth legislation, an assessment of the relevant State legislation has been undertaken. This is due to the fact that the survey vessel will utilise State waters for re-fuelling and supplies, emitted sound levels may spread into State waters, along with very unlikely event of a hydrocarbon spill occurring and entering State waters, State legislation would be triggered. Therefore, an assessment of the key State legislation is outlined within **Table 10**.

Table 10 Key State Legislation Relevant to the Otway Basin 2DMC MSS

Legislation	Applicability
	Victoria
Marine and Coastal Act 2018	The Marine and Coastal Act 2018 provides a simple, integrated and coordinated approach to planning and managing the marine and coastal environment. This is done by enabling the protection of the coastline and the ability to address the long-term challenges of climate change, population growth and ageing coastal structures; along with ensuring that partners work together to achieve the best outcomes for Victoria's marine and coastal environment. This Act is complemented by Victoria's Marine and Coastal Reforms Final Transition Plan which identifies a programme of policy reforms and on-the-ground actions to transition to the new system over the coming years. An assessment of the coastal environment has been undertaken within **Section 5.3** which outlines the various aspects of importance in the Victorian coastal area, with potential impacts on this area being discussed within **Section 7**.
Environment Protection Act 2017 and the Environment Protection Act 1970	The Environment Protection Act 1970, and the updated Environment Protection Act 2017, is the key Victorian legislation that applies to noise emissions and the air, water and land in Victoria, the territorial sea along the Victorian coast and to discharges of waste to the Murray River. This Act created the Environment Protection Authority Victoria which has a legislated objective to protect human health and the environment by reducing the harmful effects of pollution and waste. A number of regulations under these Acts regulate the management arrangements for ballast water. The ship masters of the survey vessels will abide by all requirements in relation to ballast water management, which is discussed within **Section 8.1** relating to the spread of invasive marine species.
Heritage Act 2017	The Heritage Act is administered by Heritage Victoria and is the key cultural heritage legislation. This Act identifies and protects heritage places and objects that are of significance to Victoria, including shipwrecks and artefacts. All shipwrecks and shipwreck relics in Victorian waters that are at least 75 years old are protected by the establishment of protected zones and the prohibition of certain activities in relation to historic shipwrecks. **Section 5.4.2** provides an assessment of the maritime heritage.
Emergency Management Act 2013	The Emergency Management Act 2013 established Emergency Management Victoria and operates concurrently with the Emergency Management Act 1986 which will ultimately be repealed. This Act established the State Crisis and Resilience Council which is responsible for providing emergency management policy and strategy advice to the Victoria Government; along with the Inspector-General for Emergency Management whose functions include developing and maintaining a monitoring and assurance framework along with the State Emergency Response Plan and the State Emergency Recovery Plan.
Marine Safety Act 2010	The Marine Safety Act and its associated Marine Safety Regulations provide for safe marine operations in Victoria. The Act and Regulations set out a range of requirements including safety duties for persons and parties responsible for marine safety. This Act reflects the requirements of various international conventions which will be met during the Otway Basin 2DMC MSS (as described in **Section 8.3**).
Flora and Fauna Guarantee Act 1988	The Flora and Fauna Guarantee Act is the key piece of legislation in Victoria which in terms of the conservation of threatened species and communities and for the management of potentially threatening processes. Its aim is to conserve all of Victoria's native plants and animals by establishing a range of mechanisms, including (among others) listing threatened species, communities and threats to native species.

Legislation	Applicability
Pollution of Waters by Oil and Noxious Substances Act 1986	The Pollution of Waters by Oil and Noxious Substances Act's purpose is to protect the sea and other waters from pollution by oil and noxious substances and implements the International Convention for the Prevention of Pollution from Ships 1973. The potential impacts from routine permissible waste discharges is assessed within **Section 7.3**.
National Parks Act 1975	The National Parks Act, along with the National Parks Regulations 2013 provide for the preservation and protection of the natural and cultural heritage values of the parks, including marine national parks and coastal parks. An assessment of the marine protected and sensitive areas in the coastal environment is described within **Section 5.3**.
Wildlife Act 1975	The Wildlife Act's purpose is to establish procedures in order to promote the protection and conservation of wildlife; the prevention of taxa of wildlife from becoming extinct along with the sustainable use and access to wildlife. Under this Act the Wildlife (Marine Mammals) Regulations 2009 provides minimum distances to whales and seals/seal colonies, along with restrictions of noise within certain zones. These Regulations are due to expire during the timing window of the Otway Basin 2DMC MSS (November 2019) with revised Regulations being developed. A detailed assessment of the potential impacts on wildlife is discussed throughout **Section 7**.
South Australia	
Marine Parks Act 2007	The Marine Parks Act has the aim of protecting and conserving marine biodiversity and habitats by providing for the establishment and management of marine parks in South Australian waters. The Regulations under this Act prohibit certain activities within the certain marine park zones, with exemptions for some activities, such as for persons acting in the course of an emergency. An assessment of the marine protected and sensitive areas in the coastal environment is described within **Section 5.3**.
Emergency Management Act 2004	The Emergency Management Act establishes a framework for the management of emergencies in South Australia and provides for the establishment of among others, the State Emergency Management Plan which comprises strategies for the prevention of emergencies in the State. This Act has been taken into account in the development of this EP.
Protection of Marine Waters (Prevention of Pollution by Ships) Act 1987	This Act provides for the protection of the sea and State waters from pollution by ships from oil and noxious substances. This Act provides penalties for discharges of oil or of an oily mixture if it occurs within State waters, unless it is exempt for a variety of reasons outlined n Part 2 of the Act. The survey vessels to be used during the Otway Basin 2DMC MSS will meet the requirements of this Act when transiting into State waters, such as during supply runs or for refuelling.
Coast Protection Act 1972	The Coast Protection Act provides for the conservation and protection of the beaches and coast of South Australia. A Coast Protection Board was formed in 2017 with the proclamation of the Act with, among other things, the protection of the coast from pollution and misuse. Any potential impacts from the Otway Basin 2DMC MSS would be in relation to the unlikely event of a hydrocarbon spill which is assessed within **Section 8.3**.
National Parks and Wildlife Act 1972	The National Parks and Wildlife Act is the principle legislation in South Australia in respect to the establishment and management of protected areas. The closest reserve to the Operational Area is the Lower South East which is inshore of northern extent of the Operational Area. Potential impacts on the area inshore of the Operational Area are discussed within **Section 8.3**.
Tasmania	
Pollution of Waters by Oil and Noxious Substances Act 1987	This Act deals specifically with discharges of oil and other pollutants from ships and gives effect in Tasmania to the International Convention for the Prevention of Pollution from Ships 1973. The potential impacts from routine permissible waste discharges is assessed within **Section 7.3**

Legislation	Applicability
Environmental Management and Pollution Control Act 1994	This Act is the primary environment protection and pollution control legislation in Tasmania with the fundamental basis being the prevention, reduction and remediation of environmental harm. The potential impacts from routine permissible waste discharges is assessed within **Section 7.3**.
Emergency Management Act 2006	The Emergency Management Act outlines the prevention, preparedness, and response and recovery procedures in order to protect life, property and the environment in a declared State emergency. The potential risks of an emergency occurring during the Otway Basin 2DMC MSS is discussed within **Section 8.3**.

2.3.2 Relevant Guidelines, Standards and Codes

South-East Commonwealth Marine Reserves Network Management Plan 2013 – 2023

This management plan came into effect on 1 July 2013 and is utilised for the conservation and management of the South-East Marine Park Network (formerly known as the Commonwealth Marine Reserves Network). The plan outlines management strategies for research, monitoring, assessment, permitting, compliance, community participation, indigenous involvement and environmental management.

Section 5.3 outlines the coastal environment and marine conservation areas in the vicinity of the Otway Basin 2DMC MSS Operational Area, including the identification of the relevant Marine Parks which are then assessed within **Section 7.2.2.4**.

United Nations Convention on Biological Diversity

Australia is a party to the United Nations Convention on Biological Diversity which has three main objectives which requires the conservation of biological diversity, the sustainable use of the components of biological diversity and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources (CBD, 2018).

This Convention covers a range of topics and requirements which are subsequently implemented in Australia via different means, including Australia's Biodiversity Conservation Strategy 2010-2030 which is the guiding framework for the conservation of Australia's national biodiversity to 2030. An assessment of the biological environment is outlined within **Section 5.2**, with any potential impacts from the Otway Basin 2DMC MSS being assessed throughout **Sections 7** and **8**.

Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971

This convention is commonly known as the Ramsar Convention (due to it being signed in the Iranian town of Ramsar in 1971). The Ramsar Convention's broad aims are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. This has broadened over time to cover all aspects of wetland conservation and wise use (broadly defined as maintaining the ecological character of a wetland), recognising that wetland ecosystems are important for both biodiversity conservation and the well-being of human communities (DoEE, 2018).

The EPBC Act recognises all wetlands listed under the Ramsar Convention as matters of NES which means approvals are required for actions that will have or are likely to have a significant impact on the ecological character of a Ramsar listed wetland. An assessment of the wetlands in near the Operational Area is outlined within **Section 5.3.5**, with an assessment of the potential impacts from the Otway Basin 2DMC MSS on those wetlands discussed within **Section 7.2.2.4**.

Convention on the Conservation of Migratory Species of Wild Animals

The Convention on the Conservation of Migratory Species of Wild Animals (known as the Bonn Convention) provides a global platform for the conservation and sustainable use of migratory animals and their habitats. The Bonn Convention was entered into force in 1983, with Australia being a party to the Convention since September 1991. The Bonn Convention includes obligations for parties to it, including:

- Acknowledging the importance of conserving migratory species;
- Promote, cooperate and support research relating to migratory species;
- For endangered species, endeavour to take measures to conserve the species and its habitat, prevent the adverse effects of activities that impede or prevent migration, prevent or minimise factors that endanger the species where possible, and make the taking of the species prohibited (subject to limited exceptions); and
- For species that are defined as having an 'unfavourable conservation status', endeavour to conclude agreements which would benefit and prioritise those species (Parliament of Australia, 2018).

The species of relevance from the Bonn Convention and the associated obligations are addressed under the EPBC Act. An assessment of those migratory species relevant to the Otway Basin 2DMC MSS are outlined throughout **Section 5.2**.

International Convention for the Regulation of Whaling

The International Convention for the Regulation of Whaling is the International Whaling Commission's founding document and was signed in 1946. Obligations under this convention include the complete protection of certain species, and the establishment of whale sanctuaries. All of the Commonwealth waters of Australia are assigned as the Australian Whale Sanctuary (**Section 5.3.10**).

National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna:
The overarching goal of this strategy document is to "*provide guidance on understanding and reducing the risk of vessel collisions and the impacts they may result*". This document highlights the importance of keeping vessels away from whales, slowing vessel speed and avoidance manoeuvres to reduce impacts on marine megafauna; all of which have been incorporated within the development of this EP (see **Section 7**).

Agreement on the Conservation of Albatrosses and Petrels

This agreement seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to their populations. This agreement came into force in February 2004 and has 13 member countries (as at June 2015), including Australia (ACAP, 2018). The purpose of the Agreement is the conservation of highly migratory and threatened seabirds by protecting critical habitat, controlling non-native species by developing Conservation Guidelines on biosecurity and quarantine for breeding sites and eradication of introduced mammals from islands, introducing best-practice advice for mitigating incidental catch of seabirds in fisheries, and supporting research into the effective conservation of albatrosses and petrels (ACAP, 2018). **Section 5.2.8** provides an assessment on the seabirds potentially present within the Operational Area, including albatrosses and petrels.

United Nations Declaration on the Rights of Indigenous Peoples

The United Nations Declaration on the Rights of Indigenous Peoples was adopted by the General Assembly on 13 September 2007, with the Australian Government announcing its support on 3 April 2009. This Declaration establishes a universal framework of minimum standards for the survival, dignity and well-being of the indigenous peoples of the world and elaborates on the human rights standards and fundamental freedoms as they apply to the specific situation of indigenous peoples (United Nations, 2018). **Section 5.4.1** provides an assessment of the aboriginal heritage associated with the Operational Area to provide an understanding of potential impacts on that heritage from the Otway Basin 2DMC MSS.

International Standards of Training, Certification and Watch-keeping for Seafarers, 1978

International Convention of Standards of Training, Certification and Watch Keeping for Seafarers (**STCW Convention**), 1978, sets the mandatory minimum standards of training, certification and watchkeeping for masters, officers and watch personnel on seagoing merchant ships registered under the flag of a country party to the convention. As the survey and support vessels proposed to be used for the Otway Basin 2DMC MSS will be operating within Australian waters, the masters, officers and watch personnel of the vessels will be subject to this convention. Aspects of the survey and support vessel operations that relate to this convention are discussed within **Sections 7** and **8**.

Australian Ballast Water Management Requirements 2017

These requirements include legislative obligations under the Biosecurity Act 2015, and the International Convention for the Control and Management of Ships' Ballast Water and Sediments regarding the management of ballast water and ballast tank sediment when operating within Australian waters. These requirements, along with the Biosecurity Act discussed above, have been provided for in relation to the assessment of environmental risks associated with invasive marine species (**Section 8.1**).

National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009

This guidance document has been developed to provide useful tools for operations within the petroleum production and exploration industry to minimise the growth of biofouling on vessels, infrastructure and submersible equipment to reduce the risk of spreading marine pests around the Australian coastline. This guidance document has been utilised in determining the **Acceptable Levels** of risks associated with the Otway Basin 2DMC MSS, and the environmental performance outcomes and standards (**Section 8.1**).

International Maritime Organisation (IMO) Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species 2011

These guidelines provide a consistent approach globally to the management of biofouling (the accumulation of various aquatic organisms on ships' hulls) and are aimed at reducing the transfer of invasive aquatic species by ships. These guidelines have been utilised as part of the development of this EP, particularly in relation to the assessment of the potential risks associated with invasive marine species (**Section 8.1**).

Code of Environmental Practice 2008 – Australian Petroleum Production and Exploration Association (APPEA)

This Code provides guidance on ensuring that exploration and production operations are conducted using effective management in order to be sustainable within the Australian environment. This includes the need to avoid or minimise and manage impacts to the environment, focusing on four basic recommendations:

- Assess the risk 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 **ALARP** and to an **Acceptable Level** by using the best available technology and management practises;
- 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.

These recommendations, which effectively mirror the requirements within the Environment Regulations, have been considered in the development of this EP (**Sections 7** and **8**, respectively).

International Association of Oil and Gas Producers Environmental Management in Oil and Gas Exploration and Production 1997:

This document provides an overview of the oil and gas exploration and production processes, and examines the potential impacts from these activities, including the approaches to achieving high environmental performance in all parts of the world. The recommendations within this document have been considered during the development of this EP, particularly when determining the environmental impacts and risk associated with the proposed Otway Basin 2DMC MSS (**Sections 7** and **8**, respectively).

Environment Protection (Sea Dumping) Act 1981

The Environment Protection (Sea Dumping) Act 1981 is administered by the DoEE and is aimed at protecting the waters surrounding Australia's coastlines from wastes and pollution dumped at sea. In addition, this Act fulfils Australia's international obligations under the London Protocol. The aim of this Act is to minimise pollution threats by:

- Prohibiting ocean disposal of waste considered too harmful to be released into the marine environment; and
- Regulating permitted waste disposal to ensure environmental impacts are minimised.

Since the proposed Otway Basin 2DMC MSS will involve the use of a survey vessel within Australian waters, the management and operation of the vessel will be subject to this Act. Although no waste or other matter (other than routine vessel discharges e.g. appropriately treated sewage) is proposed to be discharged within Australian waters as part of this EP, there is always a remote chance of an accident occurring where such waste or equipment could be lost overboard. **Section 8.4** outlines the potential risks and associated impacts if an accidental discharge occurs, along with the measures that SLB will implement to reduce the risk to **ALARP** and within **Acceptable Levels**.

2.3.3 Relevant NOPSEMA Guidance Documents

Various guidance documents prepared by NOPSEMA have been utilised through the development of this EP to ensure that it meets all the requirements of the Environment Regulations and the expectations of NOPSEMA. These documents include:

- Guidance Notes:
  - Environment Plan Content Requirements (N-04750-GN1344, Draft for Comment, March 2019);
  - Responding to Public Comment on Environment Plans (N-04750-GN1847, Draft for Comment, March 2019);
  - Petroleum Activities and Australian Marine Parks (N-04750-GN 1785, Rev 0, 16/07/2018);
  - Oil Pollution Risk Management (GN1488, Rev 2, February 2018);
  - Notification and Reporting of Environmental Incidents (N-03000 – GN0926, Rev 4, 28 February 2014;
- Guidelines:
  - Making Submissions to NOPSEMA (N-04000-GL0225, Draft for Comment, Revision No 18, March 2019);
  - Environment Plan Decision Making (GL1721, Rev 5, June 2018);
  - Financial Assurance for Petroleum Titles (N-04750-GL1381, Revision No 6, September 2017);
  - Making Submissions to NOPSEMA (N-04000-GL0225, Revision No 16, 05 May 2017);
  - Environment Plan Summaries (N-04750-GL1566, Revision No 1, 13 July 2016);
- Policy:
  - Environment Plan Assessment (N-4750-PL1347, Revision 7, 15 April 2019);
- Forms:
  - Environment Plan Summary Statement (N-04750-FM1848, Draft for Comment, March 2019);
  - Titleholder Report on Public Comment (N-04750-FM1896, Draft for Comment, March 2019);
- Information Papers:
  - Consultation Requirements under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (N-04750-IP1411, Revision No 2, December 2014);
  - Operational and Scientific Monitoring Programs (N-04700-IP1349, March 2016); and
- Acoustic Impact Evaluation and Management (N-04750-IP1765, Revision No 1, September 2018).

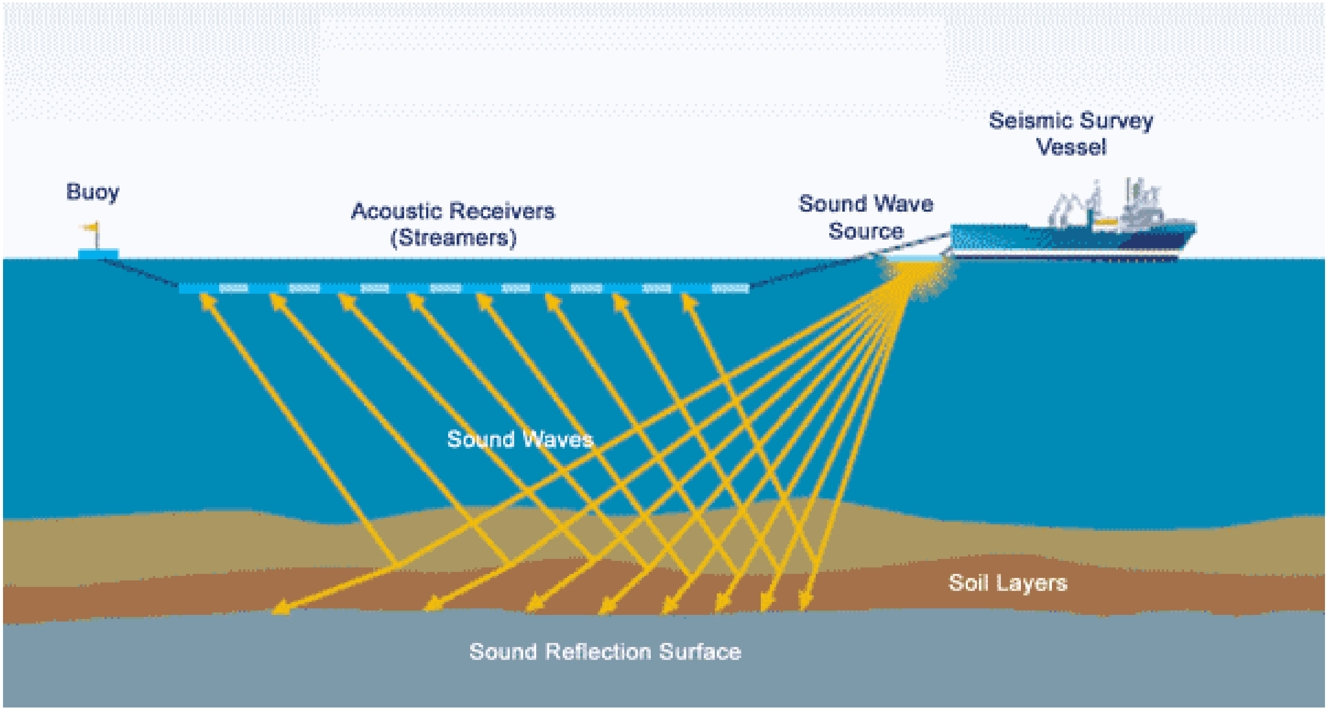
Some of the documentation listed above which were utilised during the preparation of this EP are labelled as Draft for Comment. This is due to the fact that amendments to the Environment Regulations were made to increase the transparency of offshore oil and gas EPs while this EP was being drafted. This increased transparency now requires any EPs submitted after 25 April 2019 to be published prior to regulatory assessment, and a 30-day public comment period being applied for all EPs for seismic surveys and exploratory drilling.

3 Project Description

3.1 Survey Overview

Marine seismic surveys (**MSS**) fall into two main categories of varying complexity: 2-dimensional (**2D**) and 3-dimensional (**3D**) surveys. A 2D survey is a fairly basic survey method which involves a single seismic source and a single streamer towed behind the seismic vessel (**Figure 3**).

Figure 3 Schematic of 2D Marine Seismic Survey



Source: www.fishsafe.eu

Seismic surveys in the marine environment use data acquired through the use of a controlled seismic source mechanically generating a sound wave that is transmitted downwards towards and into the seabed. The sound wave source uses compressed air to create a pulse of acoustic energy. The pulse of acoustic energy travels through the water column and into the seabed where energy is reflected at different speeds and intensities depending on the sediment type and/or density of the various sedimentary layers. The reflected acoustic signals are detected by an array of sensitive hydrophones located in the streamer which is towed behind the seismic vessel. These sound signals are then analysed and processed into visual images of the subsurface structure of the seabed using powerful on-board computers and software.

This EP has been prepared in support of the proposed Otway Basin 2DMC MSS by SLB. The objective of this MSS is to identify and assist in the appraisal of potential recoverable hydrocarbon reserves in the Otway Basin. The following sections outline specific details of the proposed seismic survey.

3.2 Survey Location

The proposed Otway Basin 2DMC MSS is located outside Coastal Waters, mostly within the Exclusive Economic Zone (**EEZ**) (between 12 and 200 NM from shore), with parts of the Operational Area within the Territorial Sea that are more than 3 NM from shore[1] (**Figure 4**). International waters (i.e. waters beyond the 200 NM EEZ limit) are more than 165 km from the Operational Area. The Operational Area is located off the coasts of South Australia, Victoria and Tasmania.

The Operational Area is located 190 km southeast of Kingscote South Australia, 18 km south of Portland Victoria and 241 km northwest of Strahan Tasmania, with water depths ranging from 50 to 5,600 m. The Operational Area is approximately 93,000 km^2, with approximately 95% being in waters > 200 m deep. However, the proposed seismic survey will not actually encompass the entire Operational Area, which indicates the maximum extent of the survey, including a 15 km buffer around the proposed survey lines in most cases.

Approximately 109 2D survey lines are proposed to be acquired for the Otway Basin 2DMC MSS which will total up to 14,000 lineal km. Of these proposed survey lines, 2% will be in waters less than 200 m, or up on the shelf, whilst 98% will be in waters greater than 200 m, or beyond the shelf edge. This can be further quantified, whereby approximately 91% of the survey lines will be in water depths greater than 1,000 m (**Figure 61**).

Most of the survey lines will run in a northeast-southwest orientation (**Figure 4**), while two long lines will span the survey lines and will have a northwest-southeast orientation (**Figure 4**) and the survey lines will be 5 km apart in most cases.

The coordinates of the Operational Area are provided in **Table 11**.

[1] 'Shore' in this definition is defined as the 'Territorial Sea Baseline', which in this case corresponds with the low water line along the coast, including the coasts of islands.

Figure 4 Location of Otway Basin 2DMC MSS Operational Area and Survey Lines

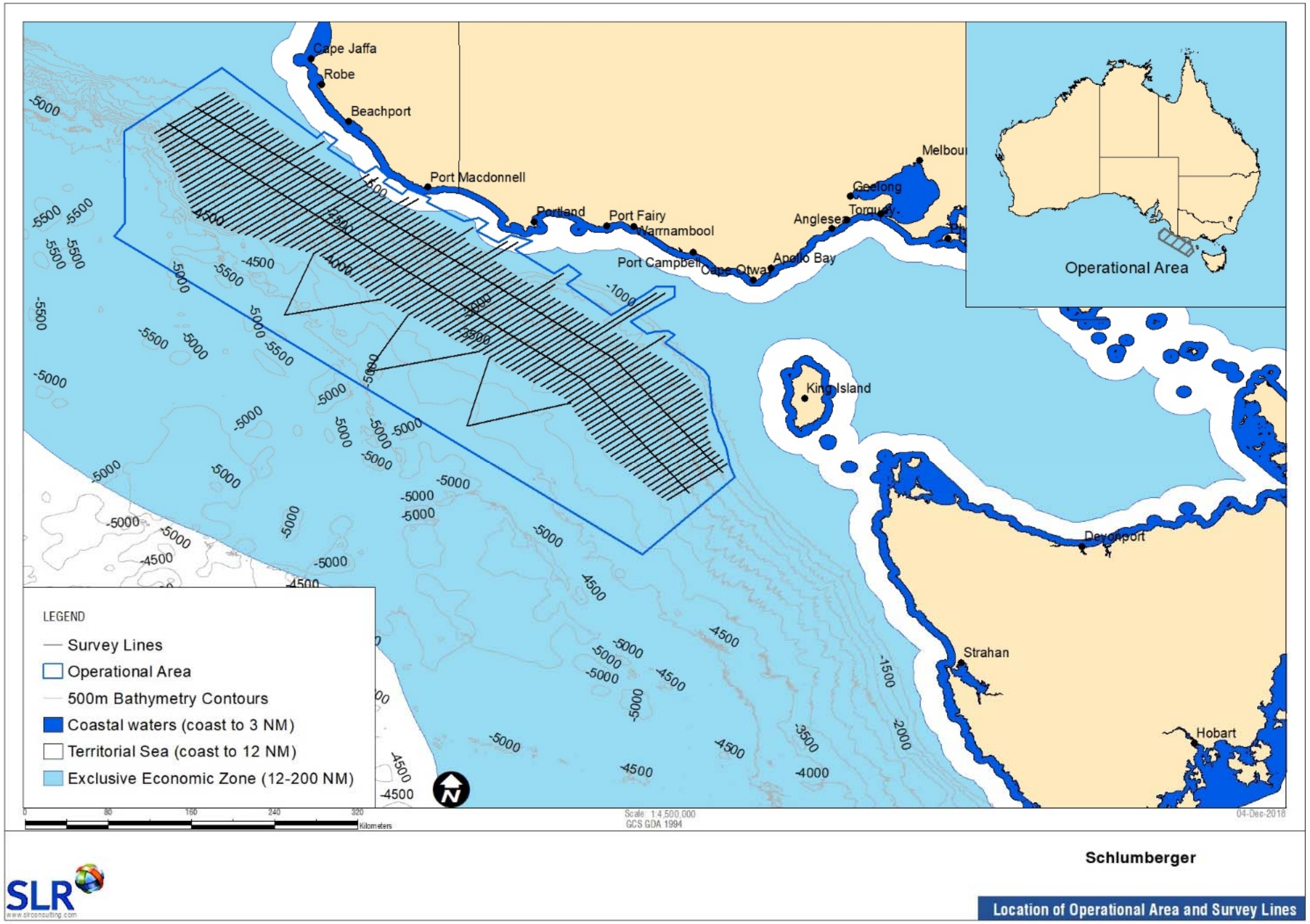


Table 11 Coordinates of the Otway Basin 2DMC MSS Operational Area

S No	Longitude	Latitude	S No	Longitude	Latitude
1	139.80	-37.58	27	142.83	-38.92
2	139.92	-37.65	28	139.80	-37.58
3	139.83	-37.72	29	142.83	-39.00
4	140.15	-37.93	30	142.67	-39.09
5	140.25	-37.87	31	142.45	-39.21
6	140.36	-37.97	32	142.59	-39.32
7	140.31	-38.01	33	142.67	-39.30
8	140.47	-38.11	34	142.78	-39.30
9	140.53	-38.07	35	142.83	-39.33
10	140.72	-38.15	36	142.75	-39.40
11	140.68	-38.18	37	143.08	-39.63
12	141.01	-38.35	38	143.13	-39.69
13	141.14	-38.32	39	143.16	-40.00
14	141.22	-38.36	40	143.19	-40.07
15	141.12	-38.43	41	143.21	-40.15
16	141.31	-38.53	42	143.23	-40.19
17	141.42	-38.47	43	143.29	-40.32
18	141.60	-38.52	44	143.31	-40.46
19	141.45	-38.59	45	143.36	-40.57
20	141.79	-38.80	46	142.55	-41.23
21	141.91	-38.72	47	137.98	-38.48
22	142.02	-38.80	48	138.08	-38.37
23	141.90	-38.89	49	138.07	-37.57
24	142.28	-39.16	50	138.91	-37.02
25	142.58	-38.98	51	139.74	-37.63
26	142.68	-38.92	52	139.80	-37.58

Note: Coordinate projection is in WGS84.

3.3 Timing and Duration

To account for worst-case scenarios, this EP has been developed to incorporate all sensitivities, seasonality and receptors that could be influenced by the Otway Basin 2DMC MSS commencing in October 2019 and extending until June 2020. However, even though a large timeframe has been included in the assessment of this EP, the acquisition of seismic data will not take place for the entirety of this period. The timing of this survey will be dependent on weather conditions and any other external factors such as vessel availability; however, the seasonality component has been considered to take these factors into account whilst assessing for the worst-case scenario.

Seismic data acquisition for the Otway Basin 2DMC MSS is estimated to take 100 days in total and includes allowances for unsuitable weather, and operational or marine fauna mitigation downtime. During periods of seismic data acquisition, the survey vessel will operate 24 hours per day, seven days per week.

Through the development of this EP various sensitivities have been identified which has resulted in changes to the proposed timing of certain aspects of the Otway Basin 2DMC MSS. Due to the sensitivities identified around the Bonney Upwelling (**Section 5.3.8.1**), SLB propose to undertake the acquisition of the tie lines in the shallower parts of the Operational Area during daylight hours only. Depending on the commencement of the Otway Basin 2DMC MSS within the operational window (October 2019-June 2020), the acquisition of the tie lines will take place either at the start of the survey (i.e. 15 October 2019 – 31 December 2019), or at the end of the survey (i.e. 1 March-30 April 2020), for the reasons outlined in **Section 7.2.2.1.8**.

3.4 Otway Basin 2DMC MSS Programme

3.4.1 Acoustic Source Configuration

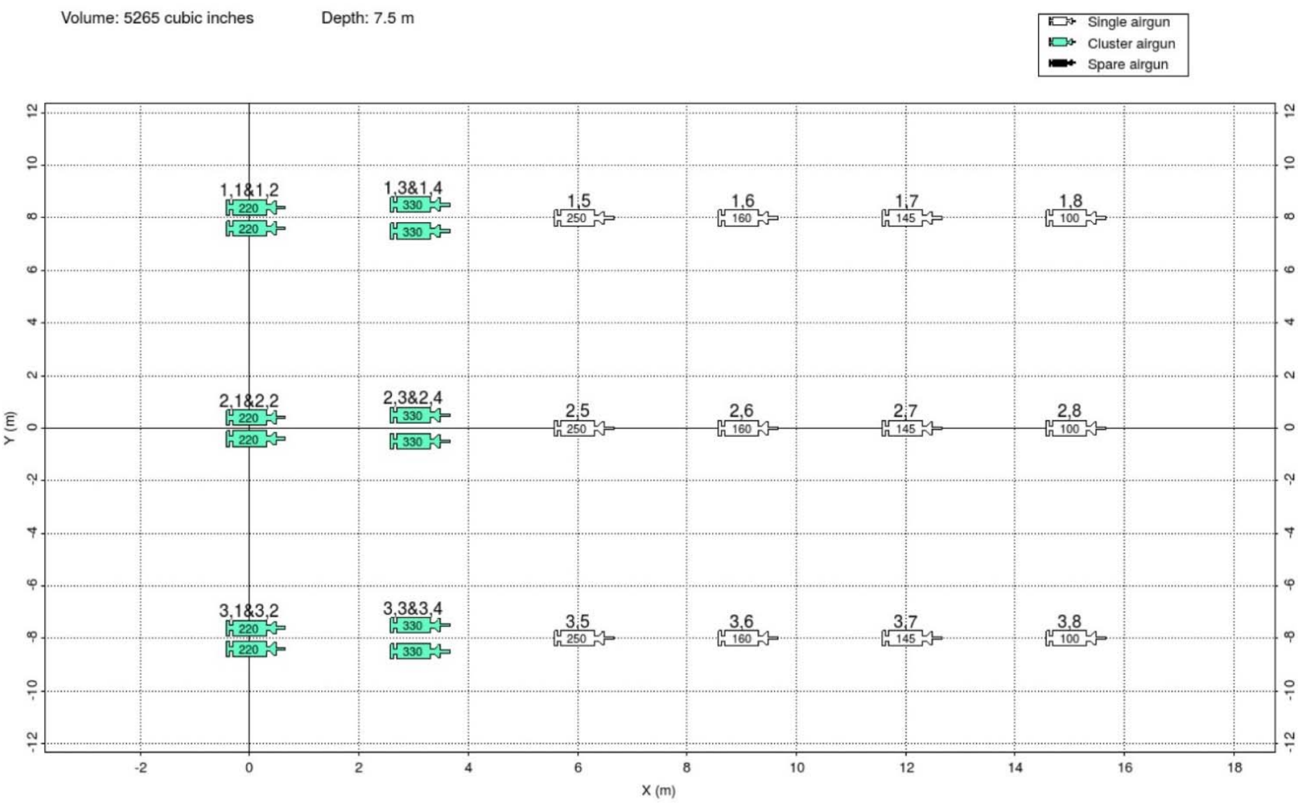
The proposed Otway Basin 2DMC MSS will comprise a single seismic survey vessel towing one seismic streamer up to 11 km long at a speed of approximately 4 – 5 knots. The seismic recording and energy source specifications are provided in **Table 12**, while **Figure 5** indicates the source array proposed for the Otway Basin 2DMC MSS.

Table 12 Seismic Recording and Energy Source Specifications, Otway Basin 2DMC MSS

Recording System Specifications	
Manufacturer	WesternGeco
Type	TRIACQ V
Streamer length	Up to 11,000 m
Number of channels	800
Group interval	12.5 m
Record length	12 sec with continuous recording
Auxiliary channels	18 NFH, 18 Notional, 2 FFS
Channels per acquisition line section	32 in 3.125m interval
Preamplifier gain	0 dB (no gain)
Sample rate	2 ms
Lo-cut filter type	1.5 or 3 Hz 8dB /octave
Hi-cut filter	200 Hz @ 476 dB/octave
System start from T0	0 ms
Total system delay	0 ms
Fold	200
Streamer depth	10 – 30 m (nominal linear slant)
SP interval	25 m
Array volume	5,265 in^3
Array depth	7.5 m
Nominal pressure	2,000 psi
Energy Source	
Array configuration	Single source 2D
Type	Point Source (Bolt Technologies LL Sources)
No. sub-arrays	3
Sub-array configuration	Each sub-array contains 8 individual sources
Air source type	Bolt 1500 LL Bolt 1900 LLXT
Volume	5,265 in^3
Source depth	7.5 m
Towing separation	8 m
COS to CFG offset	125 m
Nominal working pressure	2,000 psi

Note: The proposed recording system is subject to availability and an alternative recording system may be selected for the survey with equivalent technical specifications.

Figure 5 Seismic Source Array Proposed for the Otway Basin 2DMC MSS



The acoustic source will have an effective volume of up to 5,265 in^3 and will comprise three sub-arrays with eight acoustic sources per sub-array. The acoustic source array will be towed approximately 210 m behind the survey vessel on an umbilical line at a depth of 7.5 m below the sea surface.

The acoustic source comprises two high pressure chambers; an upper control chamber and a discharge chamber. High pressure air (~2,000 psi) from compressors on-board the seismic vessel is continuously fed to the source, forcing a piston downwards and filling the chambers with high-pressure air while the piston remains in the closed position.

The acoustic source is activated by sending an electrical pulse to a valve which opens, and the piston is forced upwards, allowing the high-pressure air in the lower chamber to discharge to the surrounding water. The discharged air forms a spherical bubble, which oscillates according to the operating pressure, the depth of operation, the water temperature and the discharge volume, forming a pressure wave. Following this discharge, the piston is forced back down to its original position by the high-pressure air in the control chamber, allowing the sequence to be repeated. The compressors are capable of re-charging the acoustic source rapidly and continuously enabling the source arrays to be fired every few seconds. The proposed firing interval for the Otway Basin 2DMC MSS is every 25 m, which translates to the release of the acoustic source every 12 seconds.

The required size of the acoustic source volumes is determined by a number of factors such as the objectives of the survey, complexity of seabed geology and the water depths of the Operational Area and are designed to provide sufficient seismic energy to 'illuminate' the geological objective of the survey (OGP, 2011). SLB considered three different source volumes to determine the most appropriate size to minimise impacts while achieving the survey objectives for the Otway Basin 2DMC MSS. The preferred source size for illumination was a larger array with a volume of 6,280 in^3. A smaller array with a volume of 3,147 in^3 was found to be insufficient to achieve the goals of the survey and reach the deep tartes that SLB is trying to assess in the deep waters. The selected intermediate size was found to be sufficient while minimizing impacts. The source is attached to a hanger by chains of a fixed length and the hanger is attached by ropes to a surface buoy for flotation. SLB have previously acquired a 2D seismic survey in the Pegasus Basin in New Zealand, with similar water depths using the 6,280 in^3 source so are familiar with the source size and outputs from this larger source but still decided to reduce the source for the Otway Basin 2DMC MSS in order to reduce potential disturbance effects to **ALARP** and an **Acceptable Level**.

Acoustic arrays are designed to direct most of the sound energy vertically downwards, although some residual energy dissipates horizontally into the surrounding water. The amplitude of sound waves generally declines with lateral distance from the acoustic source, and the weakening of the signal with distance (attenuation) is frequency dependent, with stronger attenuation at higher frequencies. The decay of sound in the sea is dependent on the local conditions such as water temperature, water depth, seabed characteristics and depth at which the acoustic signal is generated.

Acoustic arrays used by the oil and gas industry are designed to emit most of their energy at low frequencies, typically 20 – 50 Hz with declining energy at frequencies above 200 Hz (Popper *et al.*, 2014). Array source levels can range from ~241 – 265 dB peak-to-peak at one metre when measured relative to a reference pressure of one micro-Pascal (re 1 µPa $m_{p\text{-}p}$) (Richardson *et al.*, 1995). The overall source level amplitude of a system depends on how many elements are in each array and interaction between elements.

Peak-to-peak pressure is the primary output from the acoustic source (measured by pressure units of bar/m) caused by the expanding high pressure at release, which is measured at a stated reference point (usually 1 m from the source). Using standardised measuring protocols (peak-to-peak) and a reference point enables a comparison of the pressure produced by different acoustic sources. While the units for source level pressure are often reported in bar/m these values have little biological/environmental meaning and sound levels in the water emanating from an acoustic source involved with a seismic survey are more often presented as decibels (**dB**), calculated from peak-to-peak pressure measurements.

During source signature modelling the following source sound pressure levels were determined for this project to represent the array as a whole:

- Peak sound pressure level (**Pk SPL**) – 81.4 bar (258.5 dB re 1 µPa @ 1 m);
- Peak to Peak sound pressure level (**Pk-Pk SPL**) – 166.0 (9398/-8.79) bar (264.0 dB re 1 µPa @ 1 m);
- Root-mean-square sound pressure level (**RMS SPL**) – 254.6 dB re 1 µPa @ 1 m with 90% of the pulse of energy occurring over a duration of 15 milliseconds; and
- SEL of 236.4 re 1 $\mu Pa^2.s$ @ 1 m.

These values were derived from the source signature modelling to enable the conversions between the different parameters (i.e. SEL vs Pk SPL/Pk-Pk SPL) to be determined, which are then used to estimate the zones of impact from single pulses which are used to assess for effects (**Section 7.2.2**). This source signature simulation was conducted using Gundalf Designer software package (2018) performed by SLR Consulting (**Appendix A**).

3.4.2 Streamer Configuration

When the acoustic source is activated, the hydrophones in the streamer detect the low-level sound waves that are reflected back up from the geological structures below the seabed. The hydrophones convert the reflected pressure signals into electrical signals that are digitised and transmitted along the streamer to the recording system on-board the seismic vessel. The streamer used during the Otway Basin 2DMC MSS will be up to 11 km long so that it can adequately record the necessary information where the target zones are deep below the seabed. Both the seismic source and the streamer are towed beneath the surface (**Figure 3**).

Towing a streamer underwater reduces the potential for acoustic interference from the sea surface. The deeper the streamer is towed, the lower the background surface noise; however, this can also result in a narrower bandwidth of received data. Typical streamer operating depths range from 4 – 5 m for shallow high-resolution surveys in relatively good weather but can be 8 – 12 m for deeper penetration below the seabed and lower frequency targets in more open waters. Streamer depth is controlled from the seismic vessel utilising units called ‘birds’, which provide an accuracy of +/-1 m for the required operating depth (OGP, 2011). Electronically controlled ‘wings’ on the birds pivot in response to changes in pressure (depth) as detected by a pressure transducer inside each bird, automatically pivoting the wings up or down if the streamer pulls too deep or shallow (OGP, 2011).

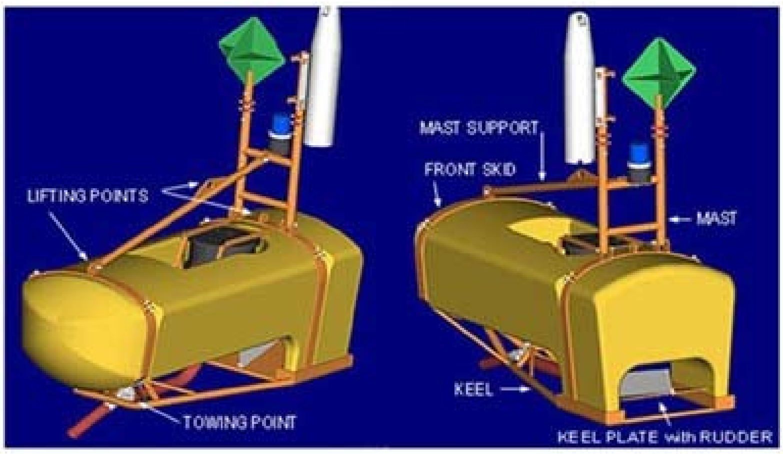
3.4.2.1 Tail Buoy

The tail buoy (**Figure 6**) is a large hydrodynamically-shaped buoy that is towed at the rear end of the streamer where it serves several functions:

- Keeping the streamer straight;
- Keeping the rear of the streamer up/afloat;
- Providing a visual reference for the end of the streamer for the vessel and survey crew (which allows the crew to determine that correct coverage is being met); and
- Holding a flag, radar reflector and flashing light and an Automated Identification System (**AIS**) transponder to allow other vessels to locate the rear of the streamer.

The tail buoy for the Otway Basin 2DMC MSS will have a radar reflector and flashing light. The tail buoy will also have marine fauna deflectors on the front, in particular to ensure marine turtles are not damaged or trapped within the tail buoy.

Figure 6 Example of a Seismic Streamer Tail Buoy, with Light and Radar Reflector



3.4.3 Sail Lines, Line Turns and Infill Lines

The proposed Otway Basin 2DMC MSS is composed of a grid of long survey lines along which high resolution 2D seismic data will be acquired. The layout of the lines (the line plan) is designed to allow suitable coverage of areas of interest within the Operational Area, with the greatest efficiency.

The Otway Basin 2DMC MSS will include up to a total of 14,000 lineal km of 2D seismic data acquisition, where the survey lines in most cases will be spaced at 5 km intervals (**Figure 4**).

Prior to commencing the survey or after a break in the source being active, a soft start will be undertaken which consists of gradually increasing the source's power, starting with the lowest capacity acoustic source, over a period of at least 20 minutes and no more than 40 minutes. The operational source capacity will not be exceeded during the soft start period.

At the beginning and end of each survey line, the seismic vessel will undertake a 'run-in' and a 'run-out', respectively. Each run-in and run-out is typically half the distance of the active streamer length and enables the seismic vessel to turn up to 180 degrees and realign itself (and the streamer) in the direction of the next survey line. The turn is fully completed beyond the end of the survey lines and ensures that the seismic source and the streamer are pre-positioned to commence data acquisition at the beginning of each survey line. Seismic data will not be acquired during the turns, with the seismic source held in stand-by mode until the start of the next survey line is reached.

After a break in the source being active due to the presence of a marine mammal inside the precautionary 2 km Shut-down Zone, a delay of at least five hours (minimum) would occur before resuming data acquisition at the same location (an infill line). This delay includes the minimum 30-minute observation time required to be sure the animal has left the Shut-down Zone, in addition to time required to reposition the source and streamer prior to the start-up procedures (i.e. pre-observation and soft-starts) prior to restarting data acquisition along the infill line.

However, depending on where the survey vessel is on the particular line, the sail line may be completed, and the infill activities left to either the end or later in the survey as opposed to the standby time required to avoid cumulative effects arising from infill lines.

The survey vessel has limited ability to manoeuvre whilst towing the streamer and acoustic array, and a large turning circle is required to turn from one survey line into the next, especially given the proposed 5 km spacing of the survey lines.

The EPBC Act Policy Statement 2.1 (Standard Mitigation Measures – Part A) requires that during line turns the acoustic source should be powered down to its lowest energy output setting. Following industry best practice and legislative requirements, SLB will not activate the acoustic source during line turns but will maintain pressure so that the acoustic source is ready to commence data acquisition as soon as the vessel is aligned on the next survey line.

During data acquisition, the survey vessel will travel at approximately 4 – 5 knots (7 – 9 km/h), and with survey line lengths of approximately 90 km, the survey of each line will take approximately 11 hours (assuming no delays, shut-downs or deviations are required). There are two longer lines which cross most of the survey lines running in a northwest-southeast direction, which are approximate 535 km long, and these will take 59 hours to acquire (assuming no delays, shut-downs or deviations required). In addition, there are six deep lines in the southern extent of the Operational Area, which form a "saw tooth' off the main survey line plan. Each of these lines is approximately 72 km in length and is expected to take 8 hours to acquire.

The acoustic source will only be active within the Otway Basin 2DMC MSS Operational Area as shown in **Figure 4** and bound by the coordinates provided in **Table 11**.

3.4.4 Survey Vessel

The selection of the most appropriate seismic survey vessel to undertake the Otway Basin 2DMC MSS has not yet been finalised so the specific vessel details cannot be provided at this stage. However, for the purpose of this application and the risk assessment throughout this EP, specifications of a typical 2D MSS vessel that will be similar to what SLB will contract to acquire the Otway Basin 2DMC MSS is provided in **Table 13**. Likewise, the support vessel provider has not been contracted so those details cannot be provided, but the specifications of a typical support vessel that is capable of operating in the Otway Basin is also provided in **Table 13** and discussed further in **Section 3.4.5**.

Table 13 Typical Seismic Survey Vessel and Support/Chase Vessel Specifications

Specification	Seismic Survey Vessel	Support/Chase Vessel
Length	93.3 m	48 m
Width	23.5 m	13.2 m
Draught (max)	7.4 m	5.2 m
Operational speed	4 – 5 knots	5 – 10 knots
Double hull	No	No
Accommodation	Up to 63 persons	Up to 14 persons
Fuel type	Marine Gas Oil (**MGO**)	MGO
Fuel capacity (total)	1,679 m^3 (95% full)	630 m^3
Largest fuel tank	572 m^3	133 m^3
Fuel consumption	28 m^3/day	4 m^3/day
Incineration	65 L sludge/hr	N/A
Treated sewage	15 m^3/day max	1.1 m^3/day max
Bilge water	2.5 m^3/hr	0.5 m^3/hr

Refuelling of the seismic survey and support vessels will be undertaken in port.

3.4.5 Support Vessel

During the survey there will be at least one support vessel accompanying the seismic vessel at all times. The role of the support vessel is to manage any possible interactions between the seismic vessel, the seismic array (acoustic source and streamer) and other vessels or activities occurring in the area. The engagement process and advanced notification has and will be implemented to ensure all users of the area are aware of the survey. Effective communication of the survey's location and proposed activities will continue throughout the Otway Basin 2DMC MSS to help to reduce potential conflict between the survey and other marine users.

The support vessel will be positioned at a safe distance from the seismic vessel and towed seismic array and will maintain 24-hour watch using visual and electronic means for other vessels or activities which might be approaching or in the path of the seismic vessel. The support vessel may also re-supply the seismic vessel during the Otway Basin 2DMC MSS; however, it is likely a smaller vessel will fill this role providing fresh stores every 2 – 3 weeks.

In addition to the support vessel, helicopters may be utilised to transport equipment, supplies and crew to and from the seismic survey vessel during the Otway Basin 2DMC MSS; and also provide emergency medical evacuation, if required. However, the main preference will be to undertake crew changes in port when bunkering occurs.

At the time of submission of this EP, the specific support vessel has not been contracted. However, the support vessel will be smaller than the seismic vessel, be of suitable class for safely operating in the offshore environment within the Operational Area, be crewed by competent persons, have all required operational procedures and systems in-place, and carry all required communication and safety equipment. SLB will undertake a vessel audit before commencement of the Otway Basin 2DMC MSS.

3.4.6 Refuelling Operations & Crew Changes

All crew changes and bunkering for the seismic vessel and support vessel will be undertaken in port. The specific port has not yet been determined, as it will depend on which particular part of the Operational Area the vessels are working. SLB will audit all ports throughout South Australia, Victoria and Tasmania to assess which ports are suitable for berthing the survey vessel, have the provision for providing enough MGO and can provide the supplies and any maintenance requirements that are needed. During crew changes and bunkering the vessels will take on fresh provisions for the next swing offshore.

These provisions will not last the duration of each swing, so a vessel will visit the survey vessel every 2 – 3 weeks to deliver fresh provisions given they would perish and not last the duration if all fresh supplies were taken at once.

Bunkering in port reduces the potential risk of any MGO spill during ship to ship transfer as it will be undertaken in a controlled environment within the Port, under the Port Authority’s management plans, procedures and response plans.

Crew change, and bunkering operations will take place every five weeks.

3.4.7 Marine Mammal Control Measures & Adaptive Management Measures

The Otway Basin 2DMC MSS Operational Area has water depths that range from 50 m at the shallowest to nearly 5,000 m at the deepest and includes the state waters of South Australia, Victoria, Tasmania and the Commonwealth waters of Australia. There are a range of environmental and commercial sensitivities within the Operational Area (described throughout **Section 5**) that have been considered and assessed as part of this EP and incorporated into the control measures (where relevant) to reduce the potential impacts from the Otway Basin 2DMC MSS to **ALARP** and an **Acceptable Level**.

In relation to whales, the key sensitivities within the Operational Area relate to the presence of the Bonney Upwelling Zone, the blue whale BIA and the southern right whale BIA. The control measures that will be implemented during the Otway Basin 2DMC MSS to minimise impacts on whales from acoustic and physical disturbance have taken into consideration the sensitivities within these areas. In addition, to reduce potential impacts from MSS activities to **ALARP**, the control measures have taken into consideration the requirements of the EPBC Act Policy Statement 2.1, and the Conservation Management Plans for blue whales and southern right whales.

Three sets of control measures have been developed for the Otway Basin 2DMC MSS, where the mitigation increases as the seismic vessel approaches the coastline. These measures include:

- Standard and Additional Control Measures (**Section 3.4.7.1**);
- Blue Whale and Southern Right Whale Biologically Important Area Control Measures (**Section 3.4.7.2**); and
- Bonney Upwelling and Tie Line Control Measures (Section **3.4.7.2.1**).

The control measures that were developed in relation to the BIAs and the Bonney Upwelling have an associated map to identify the part of the Operational Area to which the control measures apply. The different zones of mitigation will be clearly displayed on the bridge of the seismic and support vessel to enable the MMOs and PAM Operators to confirm exactly where they are in relation to the relevant mitigation zone and control measures applicable. The lead MMO on the support vessel will be responsible for designating which control measure applies if there is any discrepancy; however, if there is any uncertainty the most conservative control measure will be applied.

SLB took a conservative approach when developing the control measures to provide additional protection to whales. The mitigation zones selected for shut-down procedures were far more conservative than what was required by the regulations, as confirmed by STLM and was applied across a far wider area than they needed to avoid any confusion among the observers if different mitigation zones were implemented based on bathymetry.

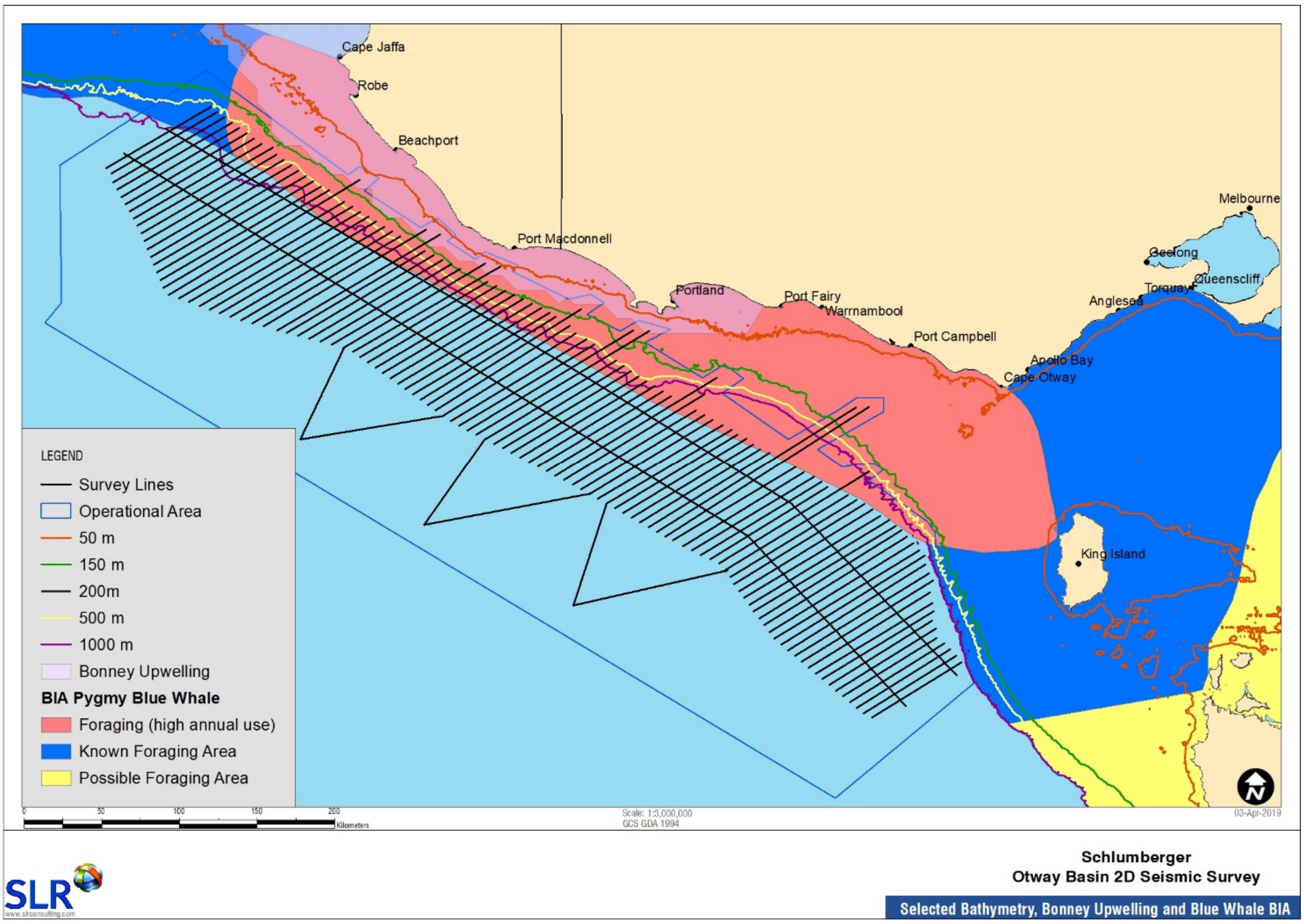
Temporal avoidance of whales has been incorporated into the suite of control measures following extensive investigation and literature searches on the presence and movement of blue whales, southern right whales and the commencement of the Bonney Upwelling. The timing of whales both leaving southern Australian waters after the calving season (i.e. southern right whales) and arriving in the area to feed at the start of the upwelling season (i.e. blue whales) has been considered when selecting the commencement date of the Otway Basin 2DMSS, and in particular the period in which the tie lines are going to be acquired.

The EPBC Act Policy Statement 2.1 stipulates that if a survey is either spatially or temporally on the edge of an area that is considered to provide biologically important habitat, then the proponent may consider implementing adaptive management procedures to manage the potential increased likelihood of encountering whales.

The Otway Basin 2DMC MSS Operational Area spatially overlaps the blue whale BIA, southern right whale BIA and the Bonney Upwelling Zone (**Figure 7**). As described above, SLB has developed an extensive suite of control measures for the Otway Basin 2DMC MSS which will be implemented over three different zones within the Operational Area.

To further supplement these control measures, SLB has developed a set of adaptive management measures on the occurrence that more whales are encountered than expected during the Otway Basin 2DMC MSS or juvenile and adult southern right whales are observed in the Operational Area. The adaptive management measures that will be implemented for whales during the Otway Basin 2DMC MSS are detailed in **Section 3.4.7.4**.

Figure 7 Operational Area Overlap with Blue Whale and Southern Right Whale BIAs and Bonney Upwelling



3.4.7.1 Standard and Additional Control Measures

SLB will implement a set of standard control measures that are in accordance with the EPBC Act Policy Statement 2.1 for the duration of the Otway Basin 2DMC MSS. In addition to these standard control measures, SLB have developed a suite of additional control measures to be implemented on account of having a 'moderate to high likelihood' of encountering whales within the Otway Basin 2DMC MSS Operational Area. These additional control measures were developed for implementation to further minimise any possible impacts to whales.

The standard and additional control measures will be applied throughout the Otway Basin 2DMC MSS Operational Area; however, when the seismic vessel moves into the BIAs and Bonney Upwelling Zone the level of mitigation increases (i.e. increased Shut-down Zone and day time operations only) which is detailed in **Sections 3.4.7.2** and **3.4.7.2.1** respectively.

The standard and additional control measures that will be implemented during the Otway Basin 2DMC MSS include:

- Monitoring of a 3+ km Observation Zone for whales (**Table 67**);
- Implementation of Pre-Start-up Visual Observations (**Table 67**);
- Implementation of a Soft Start procedure (**Table 67**);
- Implementation of a Delayed Start-up procedure (**Table 67**);
- An extended Shut-down Zone: 2 km horizontal radius from the acoustic source (**Table 67**);
- Implementation of a Stop Work procedure upon whales entering the Shut-down Zone (**Table 67**);
- Two experienced MMOs (as defined in **Section 10.3.2**) will be onboard the seismic vessel at all times;
- Continuous daylight observations for whales by experienced MMOs;
- A PAM system will operate continuously whilst the acoustic source is active, and will be programmed to ensure sensitivity within a frequency range of 10 Hz to 200 kHz to detect low frequency vocalisations of baleen whales;
- Two experienced PAM Operators (as defined in **Section 10.3.2**) will be onboard the seismic vessel at all times;
- The PAM system will be utilised 24 hours per day whilst the acoustic source is active to acoustically detect the presence of whales upon which shut-down procedures of the acoustic source can be implemented;
- At all times when the acoustic source is in the water, at least one experienced MMO (during daylight hours) and at least one experienced PAM Operator will maintain 'watch' (visually and acoustically) for whales;
- A full replacement PAM system will be onboard the seismic vessel, so if there is any issues or malfunctions with the PAM system, and the PAM Operators cannot repair it, the PAM system can be swapped out with the replacement PAM system;
- The acoustic source will not be activated or active outside of the Otway Basin 2DMC MSS Operational Area (**Figure 4**);
- The acoustic source volume of 5,265 in^3, which was used in the STLM will not be exceeded at any time during the Otway Basin 2DMC MSS;
- Implementation of Night Time and Low Visibility procedures;
- Whale sightings will be reported to the DoEE within two months of survey completion (**Table 67**);
- If whale sightings are higher than anticipated, and adaptive management measures (**Section 3.4.7.4**) are being implemented repeatedly during the survey (i.e. more than three shut-downs in a 24-hour period) then a discussion will be held with the DoEE for any additional management measures required; and

- The Otway Basin 2DMC MSS will be operated under 24-hour operations to minimise survey duration where possible and to ensure that any avoidance or displacement will be temporary and will cease as soon as possible.

3.4.7.2 Blue Whale and Southern Right Whale Biologically Important Area – Control Measures

The Otway Basin 2DMC MSS Operational Area overlaps with the BIAs for the blue whale and the southern right whale. The Conservation Management Plans for blue whales and southern right whales respectively state:

- 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 (Commonwealth of Australia, 2015); and
- Seismic surveys should be undertaken outside of BIAs at biologically important times, i.e. seismic surveys should not take place in the vicinity of southern right whale calving areas during the southern right whale calving period (Commonwealth of Australia, 2012).

The control measures that will be implemented for the duration of the Otway Basin 2DMC MSS were developed in accordance with these key Conservation Management Plan principles.

Behavioural disturbance to whales is considered to occur when underwater noise levels reach 160 dB re 1 µPa (NMFS, 2013). The threshold distances for behavioural disturbance to whales, specific to the Otway Basin 2DMC MSS and acoustic source configuration was determined by STLM across eight different water depths within the Operational Area ranging from 50 m to 4,800 m (**Table 62**).

These disturbance thresholds were utilised to determine the mitigation zone within the blue whale and southern right whale BIAs to avoid any injuries, displacement or behavioural disturbance in accordance with the Conservation Management Plans.

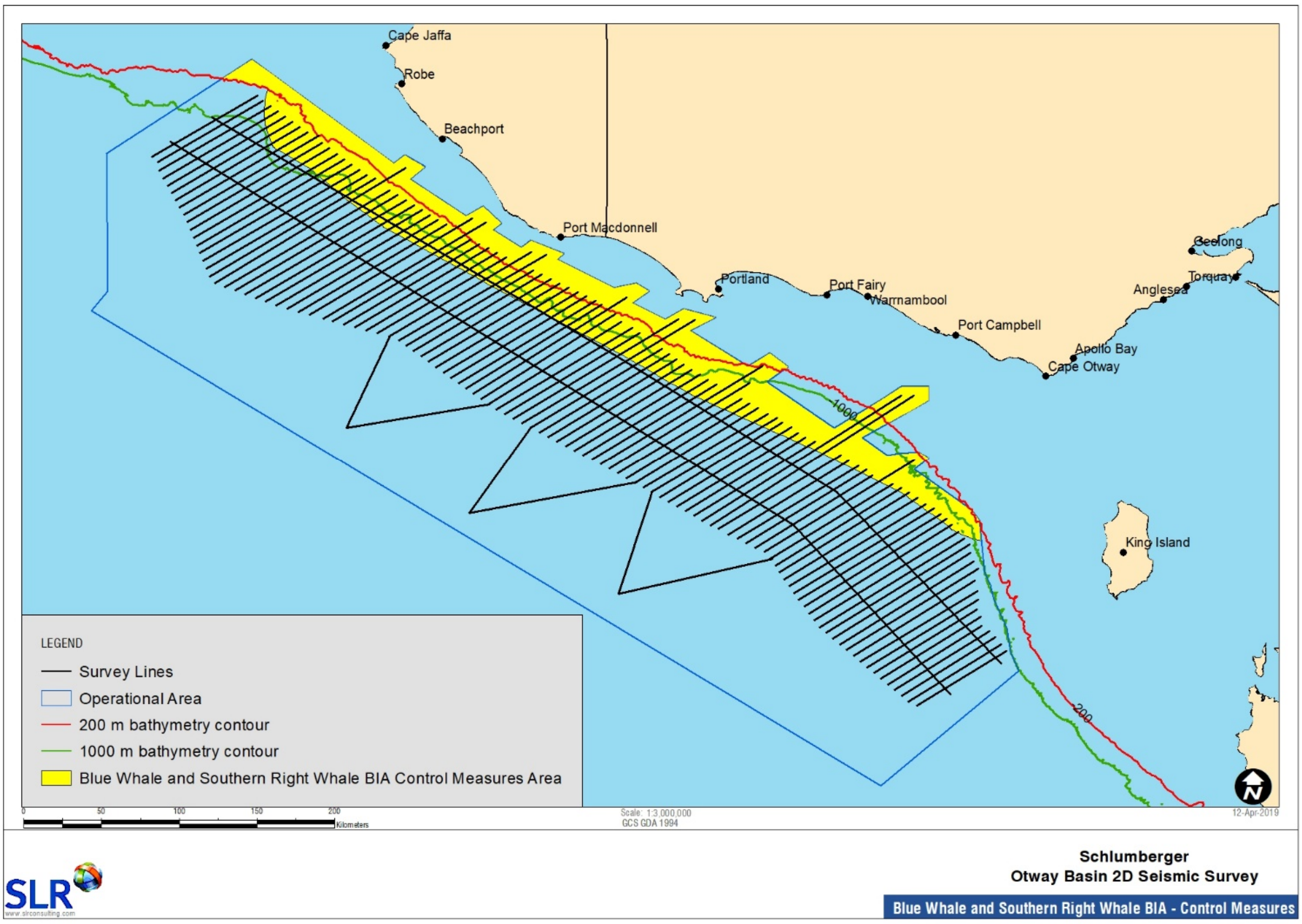
The offshore extent of the blue whale BIA has a water depth of approximately 1,000 m. The behavioural disturbance thresholds in **Table 62**, utilising 1,600 m water depth equates to a behavioural disturbance threshold distance of 4 km. The shallowest part of the Operational Area is 50 m with a behavioural disturbance threshold of 2.5 km.

However, rather than implementing different mitigation zones based on bathymetric contours, SLB will implement a 4 km behavioural disturbance threshold throughout the blue whale BIA and southern right whale BIA. This approach affords even more conservatism in the inshore waters, where 1.5 km of additional contingency is incorporated into the mitigation zone based on STLM calculations and behavioural disturbance thresholds.

This approach aligns with SLB's conservative approach throughout the development of the EP where there has been considerable effort to minimise conflict with stakeholders and avoid impacts to the marine environment, whilst still trying to achieve primary survey objectives.

As a result, for MSS activities within the blue whale BIA and southern right whale BIA, SLB have taken a conservative approach and increased the 2 km Shut-down Zone out to 4 km to reflect the 4 km behavioural disturbance threshold. SLB will also apply a 4 km buffer on the offshore extent of the BIAs. The area within which the additional control measures will be implemented within the blue whale and southern right whale BIA is shown in **Figure 8**.

Figure 8 Blue Whale and Southern Right Whale BIA Control Measure Area



An additional experienced MMO will be placed on the support vessel to assist in the observation of whales within the BIAs and BIA buffer. An operational plan for the support vessel MMO is further detailed within the Implementation Strategy **Section 10.5**. This operational plan defines the role of the support vessel in terms of where it will be placed in relation to the seismic vessel whilst acquiring in the BIA and the communication procedures for any observations and potential mitigation actions as a result of a whale entering into a mitigation zone.

For a number of the survey lines, only a small section of the lines encroaches into the BIAs, ranging from ~6 – 18 km (**Figure 8**). It is not practical to take the additional MMO on and off the support vessel for these lines, so they will stay on the support vessel for most of the Otway Basin 2DMC MSS, providing additional coverage for whale observations and monitoring of the Shut-down Zone.

The control measures that will be implemented for the acquisition of the Otway Basin 2DMC MSS within the blue whale and southern right whale BIAs and the 4 km buffer are summarised below and are in general accordance with the requirements of the blue whale and southern right whale Conservation Management Plans.

The Standard and Additional Control Measures (**Section 3.4.7.1**) will still apply in the blue whale and southern right whale BIAs; however, the specific control measures that will be implemented for the blue whale and southern right whale BIAs and the 4 km buffer (**Figure 8**) that are additional to those control measures provided in **Section 3.4.7.1**, will include:

- An Extended Shut-down Zone: 4 km horizontal radius from the acoustic source;
- Two experienced MMOs (as defined in **Section 10.3.2**) will be on the bridge of the survey vessel during daylight hours while the source is active in the BIAs and the 4 km buffer (**Figure 8**) to maximise visual coverage and increase potential for observing any whale(s) that may enter the 4 km Shut-down Zone;
- An additional experienced MMO will be present on the support vessel to provide additional observations from a second platform during daylight hours for whales in the wider vicinity of the seismic vessel while the acoustic source is active in the BIAs and the 4 km buffer (**Figure 8**). This will maximise visual coverage of the 4 km Shut-down Zone, and increase potential for observations of whale(s) entering the 4 km Shut-down Zone, particularly in adverse weather conditions;
- The additional MMO on the support vessel and the operations of the support vessel will be undertaken in accordance with the Support Vessel MMO Operational Plan (**Section 10.5**);
- Adaptive management measures will be in place for this area for observations that are unexpected (**Section 3.4.7.4**); and
- If whale sightings are higher than anticipated, and adaptive management measures (**Section 3.4.7.4**) are being implemented repeatedly during the survey (i.e. more than three shut-downs in a 24-hour period) then a discussion will be held with the DoEE for any additional management measures required.

3.4.7.2.1 Extended Shut-down Zone Implementation

The Extended Shut-down Zone of 4 km proposed under the blue whale and southern right whale BIA control measure (which is also proposed to be undertaken as part of the Bonney Upwelling and Tie Lines discussed in **Section 3.4.7.2.1**) is considered to be appropriate and technically feasible for implementation during the Otway Basin 2DMC MSS. This is supported by the following reasons:

- The height of the MMO viewing position on the bridge (i.e. bridge deck) of a typical 2D seismic vessel is 19.2 m. In addition, the height of the observer also needs to be taken into consideration, which has conservatively been assumed at 1.6 m. Using mathematical calculations to determine the distance of the horizon, based on the observer's height above sea level, it is calculated to be 16.3 km (assuming good visibility and weather conditions);
- SLB have undertaken two recent MSSs in New Zealand in the Taranaki and Pegasus Basins and it was found that MMOs were able to observe, and identify, blue whales out to 6.2 km from the seismic vessel a number of times as recorded in the MMO weekly and final reports and submitted to the regulators. These observations were from a 3D MSS vessel (*Amazon Warrior*) which had a bridge deck above the water line of 20.4 m. Taking the same conservative 1.6 m MMO height it provides a horizon distance of 16.8 km, again assuming good visibility and weather conditions, which is comparable to a 2D vessel likely to be contracted for the Otway Basin 2DMC MSS. The Taranaki and Pegasus Basins are similar to the Otway Basin in that they are exposed to the Southern Ocean, resulting in strong winds and large swells which can make sea and visibility conditions adverse;
- An additional MMO will be onboard the support vessel, acting as an additional viewing platform and will operate in accordance with the Support Vessel MMO Management Plan (**Section 10.5**). This additional MMO will provide further coverage of the 4 km Extended Shut-down Zone in front of the seismic vessel and increase efficiency of observations within the Shut-down Zone;

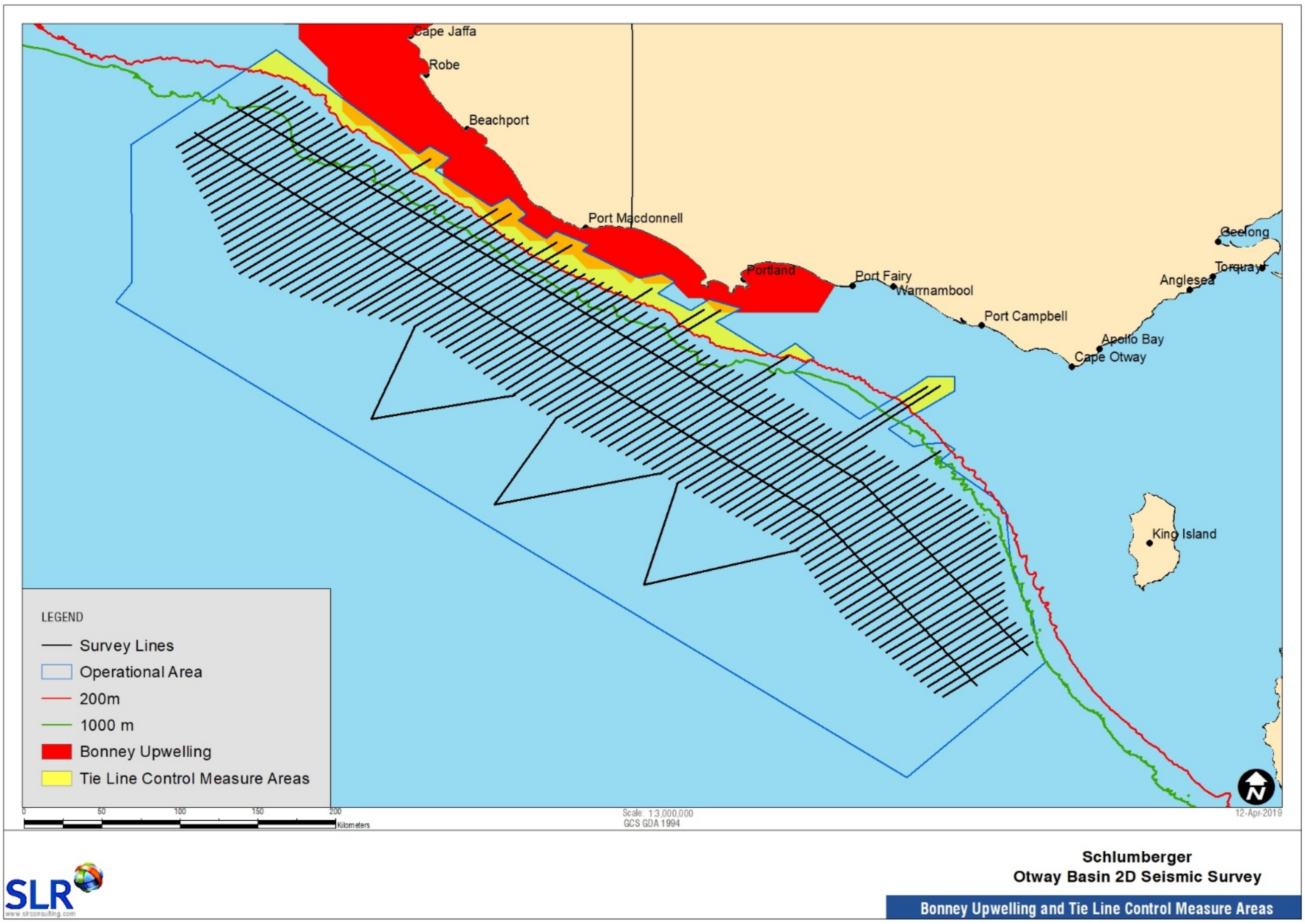
- The period in which the 4 km Extended Shut-down Zone will be in place on the inshore part of the survey lines which encroach into the BIA is estimated to be in the order of two to four hours. This short duration will reduce any MMO fatigue, as they will not have to be searching this extended zone for 12-hour periods at a time; and
- The ability of the MMOs to observe the blue whales and southern right whales prior to entering the 4 km Shut-down Zone is aided by the large size of these cetaceans.

3.4.7.3 Bonney Upwelling and Tie Line – Control Measures

SLB acknowledges that the potential to encounter whales increases as the Otway Basin 2DMC MSS Operational Area approaches the coastline as whale densities in these shallower waters are likely to be significantly higher than elsewhere in the Operational Area. As detailed above, the Operational Area overlaps with parts of the Bonney Upwelling Zone, a BIA for pygmy blue whales, and a BIA for southern right whales along the inshore boundary (**Figure 7**).

Within the survey design of the Otway Basin 2DMC MSS there are 13 tie lines along the inshore section of the Operational Area, which extend in to previously drilled wells with the intention to correlate the Otway Basin 2DMC MSS data with logged, down-bore data from the previously drilled wells. Six tie lines in the northwest of the Operational Area overlap with the Bonney Upwelling Zone (**Section 7.2.2.4**), where the overlap ranges in length from 4 – 9 km (**Figure 9**).

Figure 9 Bonney Upwelling and Tie Line Control Measure Area



Within the defined operational window of October 2019 to June 2020, there are two periods which have been identified when the biological significance of potential impacts from the Otway Basin 2DMC MSS to whales in the inshore tie line areas will be lowest (i.e. October-December and March-April).

Depending on when the Otway Basin 2DMC MSS commences, tie line acquisition will take place at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey (i.e. 1 March-30 April 2020) with the intention to minimise disturbance, and potential overlap between whales and seismic operations. These two periods for acquisition of the tie lines have been selected following extensive literature reviews, and is summarised for the following reasons:

1. The end of the southern right whale breeding season in October;
2. The arrival of pygmy blue whales to the Bonney Upwelling foraging area towards the end of December;
3. The peak of pygmy blue whale feeding activity in January and February;
4. The beginning of the southern right whale breeding season in May/June; and
5. The northward humpback migration in April/May.

Gill *et al*. (2011) documented that blue whale foraging typically occurs in the west of the upwelling system (in the vicinity of Kangaroo Island and Eyre Peninsula) early in the upwelling season (November – December), before spreading eastward between Cape Jaffa and Cape Otway.

Hence, tie line acquisition will occur at the start of the survey (i.e. 15 October 2019 and 31 December 2019) or if the survey starts later due to vessel availability, tie line acquisition will occur at the end of the survey (i.e. 1 March-30 April 2020). This proposed timing of the tie line acquisition does overlap with the southward migration of humpback whales (November/December); however, tagging studies indicate that the majority of humpbacks move south along the east coast of Tasmania (Andrews-Goff *et al*., 2018) well away from the tie line locations.

Other baleen whale species (sei and fin whales) also utilise the Bonney Upwelling for foraging, so these species will also presumably benefit from tie line acquisition control measures in addition to all the other control measures above that will be implemented throughout the Otway Basin 2DMC MSS.

It is considered that the full suite of Standard and Additional Control Measures (**Section 3.4.7.1**), and Blue Whale and Southern Right Whale Control Measures (**Section 3.4.7.2**) will have significant benefits to minimising impacts to whales to **ALARP** and **Acceptable Level** during SLBs MSS activities. This has been fully risk assessed throughout this EP as well. However, there is one more level of mitigation proposed as the vessel heads to the shallowest part of the Operational Area whilst the tie lines are being acquired.

These control measures are also in keeping with the management requirements of the Conservation Management Plans for blue whales and southern right whales, and the STLM calculations for behavioural disturbance has determined that in the shallower waters there is an additional 1.5 km of protection to the mitigation zone proposed for the Shut-down Zone. The additional control measures that will be implemented for the tie lines in the Bonney Upwelling Zone while the vessel is within the area indicated in **Figure 9** are:

- Tie line acquisition will only occur during day light hours;
- The 4 km Shut-down Zone will be in place;
- Timing of tie line acquisition will be undertaken at the start of the survey (i.e. 15 October 2019 and 31 December 2019) when the least number of whales are expected to be in the area; and/or
- Timing of tie line acquisition will be undertaken at the end of the survey (i.e. 1 March 2020 and 30 April 2020) when the least number of whales are expected to be in the area.

3.4.7.4 Adaptive Management Measures

Blue whales are typically solitary species; however, aggregations of multiple whales do form at breeding and foraging areas. A threshold of three blue whale initiated shut-downs will be utilised to provide an indication of foraging, and therefore the presence of high prey/krill densities and an active upwelling system.

The threshold of three whale-initiated shut-downs will be applied to all species, not just blue whales, although southern right whales are known to form groups of up to 12 individuals. It does need to be clarified though that the three whale density threshold will be implemented for three mitigation actions not three individuals being sighted. If more than three shut-downs occur, it would be considered that the density of whales in the area is considered to be high and would require the implementation of the adaptive management measures below (i.e. relocation of the survey vessel).

Southern right whales are known to have coastal aggregation areas inshore of the Otway Basin 2DMC MSS Operational Area. The southern Australian waters are important to the southern right whales as they use the coastal aggregation areas at different times of the year for biologically important behaviour such as calving, foraging, resting or migration. Extensive literature searches have been incorporated into the development of this EP to gain an understanding of when the southern right whales will and won't be in the region so that there can be some temporal exclusion of the calving periods from the Otway Basin 2DMC MSS. However, there is always some uncertainty around dates, and there is no definitive knowledge on the exact timing of when the mother and calves leave the shallow waters or what path they take when they leave. As a result, it has to be assumed that there is potential to come across a mother and calf pair during the Otway Basin 2DMC MSS. If this was the case, and a mother and calf southern right whale was observed there would be an immediate shut-down of the acoustic source, regardless of the distance of the whales away from the acoustic source.

The whales will be observed and tracked by the MMOs to see which way they are travelling, and the start-up procedures of the acoustic source will not commence until it is estimated that the whales are at least 8 km away. This distance is based on the vessel speed of 4.5 kts or 8.1 km/hr, which equates to 1 hour and is also approximately twice the behavioural disturbance distance for marine mammals in a water depth of 1,600 m, as an average across the Operational Area.

The adaptive management measures that will be in place during the Otway Basin 2DMC MSS include:

- If high numbers of whale detections result in three or more shut-downs within a 24-hour period, then adaptive management measures will apply, and the seismic vessel will relocate to another survey line at least 10 km away (i.e. two survey lines away);
- If a southern right whale mother and calf pair is observed at any time during the Otway Basin 2DMC MSS, the acoustic source will be immediately shut-down. Start-up and soft-start procedures will not commence until the whales have disappeared from observable distance for at least one hour or approximately 8 km away; and
- If whale sightings are higher than anticipated, then a discussion will be held with the DoEE for any additional management measures required.

3.4.7.5 Survey Design Mitigations

SLBs Otway Basin 2DMC MSS design also confers a degree of mitigation against disturbance to whales in the following ways:

- The Operational Area is located in open ocean; hence, will not affect any confined water body or migratory corridor; and

- The 5 km line spacing will ensure that the survey vessel will not focus in any specific area for a long period of time or expose any whales to potential cumulative effects from acoustic noise.

4 Stakeholder Engagement

Stakeholder engagement is an integral component of the project development and planning phase of any MSS, and SLB acknowledges that undertaking an effective stakeholder engagement programme is critical to the success of the Otway Basin 2DMC MSS. SLB is aware of the obligations around appropriate consultation, as defined under the Environment Regulations and has developed an inclusive and ongoing stakeholder engagement process that will extend beyond the completion of the Otway Basin 2DMC MSS.

Throughout the stakeholder engagement process SLB has some guiding principles which are implemented through the stakeholder engagement objectives to assist with developing an effective process that enables stakeholders to understand the potential risks and impacts, as well as for SLB to understand the concerns raised by stakeholders, assess those risks and impacts and to develop control measures so that those risks and impacts can be reduced to **ALARP** and an **Acceptable Level**.

4.1 Regulatory Requirements and Guidelines

The engagement process is an on-going process for SLB which has provided the opportunity to share information with stakeholders about the proposed Otway Basin 2DMC MSS and for stakeholders to have the opportunity to ask specific questions and have open and honest communication with SLB.

The Environment Regulations require SLB to consult with 'relevant persons' who may be affected by the Otway Basin 2DMC MSS so that they are given the opportunity to assess what is being proposed (i.e. the MSS) and then raise any objections or claims of any environmental, social or economic nature that they may have. It is then expected that any such objections that are raised are considered and addressed by SLB as part of the development of the EP that is submitted to NOPSEMA.

The parties considered as 'relevant persons' and who have been engaged with as part of the stakeholder engagement programme are defined within **Section 4.3**. For the purpose of this EP, the definition of a relevant person was interpreted broadly, so that a wide range of groups, organisations, associations and persons were included within the stakeholder engagement programme and processes are implemented to ensure these groups will be included throughout the lifespan of the project.

In developing this EP and the stakeholder engagement programme, SLB has incorporated recommendations provided by: *NOPSEMA Guidance Document N-04750-IP1411 Consultation Requirements under the Offshore Petroleum and Greenhouse Gas Storage (Environmental) Regulations 2009* and the publication produced by NOPSEMA *Requirements for Consultation and Public Comment on Petroleum Activities in Commonwealth Waters*, (https://www.nopsema.gov.au/assets/Publications/A626193.pdf).

4.2 Stakeholder Engagement Objectives

SLB identified a set of key objectives for the stakeholder engagement programme. These objectives were developed with the intention to assist the stakeholders (i.e. relevant persons) to understand the environmental impacts and risks of the proposed Otway Basin 2DMC MSS in relation to their activities or concerns and for the development of control measures that reduce impacts and risks to **ALARP** and to an **Acceptable Level**.

The key stakeholder engagement objectives that were implemented included:

- Identify relevant stakeholders;
- Initiate open and honest communication with all relevant stakeholders;
- Provide relevant stakeholders with sufficient information to allow them to make an informed assessment of the possible consequences of the activity on their functions or activities;
- Provide an adequate opportunity (i.e. reasonable period) for relevant stakeholders to consider the information and provide feedback;
- To provide a mechanism for assessing the merit of any objections or claims received;
- To demonstrate that control measures (where applicable) where they have been incorporated as a result of stakeholder engagement feedback are considered appropriate;
- A commitment to support ongoing stakeholder identification and engagement as the project continues; and
- To demonstrate to NOPSEMA that ongoing stakeholder engagement throughout the life cycle of the Otway Basin 2DMC MSS is meeting the objectives of the Environmental Regulations.

4.3 Identification of Stakeholders

A number of different methods were used to identify the stakeholders relevant to the Otway Basin 2DMC MSS. The primary method for determining who was considered as 'relevant persons' was based on the descriptions provided within the Environment Regulations 11A(1).

At the outset of the planning stage of Otway Basin 2DMC MSS a 150 km buffer was placed around the Operational Area, or the area which the acoustic source could be active during the MSS. This then defined the different State's, stakeholders, interest groups, industry bodies, associations, marine parks, protected areas, other tourism operations etc. that needed to be included within the engagement process. However, in some instances the stakeholders engaged did extend well beyond this distance, as SLB preferred to adopt a 'capture all' approach.

SLB identified that the commercial fisheries within and surrounding the Operational Area were going to form a fundamental part of the stakeholder engagement process. The commercial fishers or licence holders are the stakeholders that are out on the water making a living from the sea, so any potential impact on their activities could have a potential impact on their livelihoods. For this reason, engagement with commercial fishers was taken very seriously. Following the expectations of Australian Fisheries Management Authority (**AFMA**) in that operators should consult directly with fishing operators, SLB intended to manage all consultation activities with the identified fisheries stakeholders; however, given the extensive areas covered by the proposed operations, SETFIA were engaged to undertake a fisheries assessment of the Operational Area. This assessment allowed SLB to gain a thorough understanding of the fishing activity in the region, and to accurately identify those licence holders whose fishing activity may be affected by the survey.

In addition, SIV and TSIC were contracted to engage with all of their licence holders, quota holders and members and were the representative body on behalf of all of their members. A lot of the stakeholders were not able to be engaged with in any other way than through their representative bodies, so having these arrangements in place was a very effective way for SLB to communicate all of the information out to the relevant stakeholders so that everyone was well informed and had the opportunity to ask any questions they had about an concerns in regards to the proposed survey. SIV and TSIC have developed a consultation policy for engagement between the fishing industry and the oil and gas industry and this policy provided the framework for the process that was followed.

The stakeholders identified for the Otway Basin 2DMC MSS were then broken down into four categories as defined under the Environment Regulations 11A, which can be summarised as:

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

A database has been developed and maintained to include the contact details of the stakeholders that have been engaged with during the stakeholder engagement programme as part of the development of this EP for the Otway Basin 2DMC MSS. This database will be maintained and updated throughout the MSS planning and acquisition phases. All correspondence received from stakeholders is also filed on record.

SLB has made best efforts to engage with all relevant stakeholders that have been identified through the preparation of this EP; however, it is noted a number of stakeholders did not respond, despite multiple attempts. SLB has always been open and honest in all communications with stakeholders about the proposed activities and their associated impacts and risks.

4.4 Stakeholder Engagement

The list of stakeholders that have been contacted as part of the stakeholder engagement programme for the Otway Basin 2DMC MSS are provided in **Appendix B**. These stakeholders have been split into the four different categories following the definitions prescribed under Environment Regulation 11A.

SLB are required to ensure full transparency is maintained during the stakeholder engagement process. This is to allow NOPSEMA to determine whether consultation has been undertaken appropriately and in accordance with the requirements of the Environment Regulations.

Environmental Regulations 16(b)(iv) requires SLB to include a copy of the full text of any response that has been submitted by a relevant person in the EP. The regulations also require inclusion of the written response by SLB and any written correspondence received from any other relevant person during the stakeholder engagement programme.

The unedited versions of all correspondence with relevant persons that formed part of the stakeholder engagement process are provided in **Appendix C**.

In addition to this, where face to face meetings were held between SLB and stakeholders or relevant persons or phone conversations were held, meeting minutes or memos were documented of the engagement. This documentation of the engagement is in accordance with the 2011 Explanatory statement to the Environment Regulations, which states that the summaries included from stakeholder engagement should promote transparency of all levels of consultation undertaken. These minutes and memos are included within **Appendix D**.

In the Environment Regulations there is no definition as to what is considered "Sufficient Time", and it is acknowledged that this is assessed on a case by case basis, depending on the stakeholder, and their relevance to the survey, i.e. are they are licence holder who spends time offshore, or are they are government department. The stakeholder engagement process has provided some insight to guide SLBs own definition of when a stakeholder is likely to respond to having been contacted about the survey with information.

Throughout the stakeholder engagement process, there have generally been two responses. One is that there has been a response or submission to the mail out or contact within 2 – 3 days, or the alternative is after multiple attempts there is no correspondence. It is considered that after making multiple attempts of engagement and providing updates of the survey details and any changes/revisions as well as offering to come and meet with them, that if no response is received after this, then that is considered 'sufficient time'.

As discussed above, no responses have been received beyond a week after providing information to stakeholders, if anyone is going to provide comment, it has all been provided reasonably promptly. This appears to have been largely due to a lot of submissions having been pre-populated or prepared from prior engagements with previous operators looking to undertake seismic surveys in the area.

4.5 Stakeholder Engagement Approach

4.5.1 Information Pack

After the relevant stakeholders were identified, the stakeholder engagement process commenced to determine what values, sensitivities, fish stocks, access rights, risks, social impacts, marine habitats or areas are of most concern within the marine environment to these stakeholders in relation to the proposed Otway Basin 2DMC MSS.

The relevant stakeholders identified were contacted and provided with an Information Pack in August/September 2018 (**Appendix E**) and this information was subsequently made available to stakeholders as they became identified through the development of the EP, fisheries assessment, working relationship with SIV and TSIC, and the wider stakeholder engagement process.

The following information was provided to stakeholders within the Information Pack:

- A high-level description of the proposed location of the MSS;
- Description of the proposed seismic activity;
- SLBs commitment to communication during the MSS;
- SLBs commitment to environmental performance;
- A request for feedback from stakeholders on the proposed MSS with full contact details;
- An opportunity to meet with SLB;
- Location map of proposed survey area and survey lines; and

- Coordinates of Operational Area and distances to key regional features.

All stakeholders were encouraged to engage, ask questions and invited to provide comment or request additional information if they require. All of the stakeholders were extended an opportunity to meet face to face with SLB during a number of visits that SLB made to the regions associated with the proposed Otway Basin 2DMC MSS (i.e. South Australia, Victoria and Tasmania) or it was made clear for those that were considered to be more potentially impacted by the proposed activities (i.e. fishing industry) that SLB would visit them whenever required.

A detailed record of all feedback received from stakeholders and the responses provided by SLB are provided in **Appendix F**.

SLB is confident that the concerns that have been raised through the stakeholder engagement process have been fully considered through the EP process, and where required those concerns have been reflected within the control measures against the relevant receptors. It is also considered that the control measures that have been included will address any additional concerns which may be raised by any late submissions which may come up after the submission of this EP to NOPSEMA. SLB is fully committed to meaningful and ongoing engagement with stakeholders throughout the duration of the Otway Basin 2DMC MSS and this engagement programme will also include a close-out round of engagement following the successful completion of the survey to discuss the process of the MSS and to seek feedback on how SLB performed and whether there is anything that could have been done differently as a way of continual improvement for future MSSs and EP applications.

4.5.2 First Round of Stakeholder Engagement

The first round of stakeholder engagement was undertaken in September 2018 in Victoria and South Australia with the purpose of an introductory meeting with some of the key industry associations to introduce SLB and the proposed Otway Basin 2DMC MSS. SLB intended to use this first round of engagement to identify the sensitivities in the area, determine the next steps for the engagement process and establish some relationships for mutual sharing of information between all parties.

A number of requests were made to meet with stakeholders, some of which were accepted, others were unavailable at that time, while some groups did not respond. Minutes from these meetings can be found in **Appendix D**.

Feedback from this first round of stakeholder engagement was incorporated into the survey planning and design phase, as well as the control measures. The biggest change to the survey plan following the initial round of stakeholder engagement was a reduction to the Operational Area based on the sensitivities of the coastal area, particularly the rock lobster fishery. As a result, the Operational Area was reduced by 25,000 km^2 along the inshore boundary (**Figure 59**).

4.5.3 Second Round of Stakeholder Engagement

The second round of stakeholder engagement was undertaken in October 2018 in Victoria, Tasmania and South Australia. This round of engagement was a follow up meeting for those groups that were met on the first round, while it was an initial meeting for those groups that were not available on the first round of engagement.

Similar to the first round of engagement, there were some unavailability's and no responses, but the offer of invite was made for SLB to come back at a time that was convenient or to answer any further questions those stakeholders may have. Minutes from these meetings can be found in **Appendix D**.

4.5.4 Second Information Pack

For the purpose of the second round of stakeholder engagement, the Information Pack was revised to reflect the Operational Area reductions. At this time, the proposed commencement date was also delayed until January 2019 due to the extensive stakeholder engagement process that was required for the Otway Basin 2DMC MSS.

This provided another opportunity for stakeholders to provide additional questions, and any new stakeholders identified to be included in the process as well.

The second Information Sheet is provided in **Appendix E**.

4.5.5 Third Information Pack

At this stage in the process it was recognised that the earliest the survey could commence, pending regulatory approval was late January/February. The Information Pack was updated to reflect this revised timing which resulted from the consultation to date and the thorough development process for the EP. This revised timing also instigated another reduction to the survey area to ensure that the survey could still be completed during suitable weather conditions. The revised timing also served to reduce temporal overlap with peak fishing activity in December.

As a result of this revision, 2,700 km of survey lines were removed from the proposed programme and the Operational Area was reduced by 73,000 km^2, largely from the eastern portion of the Operational Area, closest to Tasmanian waters, where proposed operations will now only occur beyond the 1,000 m bathymetry contour.

The third Information Sheet is provided in **Appendix E**.

This Information Pack was only sent out to those stakeholders that it was directly relevant to. As a result, the updated information pack was distributed to the commonwealth fishers and also the Tasmanian licence and quota holders, which the latter was done via their representative body – TSIC.

4.5.6 Fourth Information Pack

At the end of 2018, Schlumberger were not comfortable that sufficient and effective engagement will all parties was complete, primarily with the commercial fishing industry, as feedback was still to arrive from SIV and TSIC. As a result of this, SLB made the decision to delay the Otway Basin 2DMC MSS until the 2019-2020 summer period with a new acquisition window of October 2019 to June 2020. This deferral allowed SLB to complete their engagement process and receive all the feedback from SIV and TSIC in particular, prior to lodging the EP, rather than lodging the EP.

It was also made very clear to the stakeholders that once the EP was submitted; the engagement process was not going to end. SLB were committed to engaging with the stakeholders for the duration of the programme and have planned to visit stakeholders even after the EP is submitted as part of the ongoing stakeholder engagement programme.

The fourth Information Sheet is provided in **Appendix E**.

This Information Pack was sent out to all stakeholders who had previously been engaged with and explained the deferral timeframe and reasoning. A summary email of the Information Sheet, the control measures and the engagement process were provided and the offer to provide further clarity or answer any questions was made.

Only one response was received from all of the emails sent out.

4.5.7 Engagement with Commercial Fishing Industry

The commercial fishing industry are the primary stakeholders with a commercial interest in the marine environment within and surrounding the Otway Basin 2DMC MSS Operational Area. There are many licence holders that fish the waters of Tasmania, Victoria, South Australia and the commonwealth, and identification of the relevant stakeholders was an important part of the stakeholder engagement process.

SLB engaged with the key industry bodies in these regions as a way of engaging with their members and focusing the engagement process. A summary is provided below of these key groups.

4.5.7.1 South East Trawl Fishing Industry Association Engagement

SLB has been working with the South East Trawl Fishing Industry Association (**SETFIA**) (**Section 5.5.2.2**) since the commencement of the stakeholder engagement programme to effectively engage with the quota owners and fishermen in the South East Trawl Fishery, Commonwealth Trawl Sector and the Shark Gillnet and Shark Hook Sector.

In addition to this, SETFIA have also assisted SLB with providing a fisheries assessment, which was developed specifically for the Otway Basin 2DMC MSS Operational Area to identify the fisheries affected by the proposed survey and to quantify the extent to which they were potentially affected. A copy of this fisheries report is provided in **Appendix G**.

SETFIA identified each of the different fisheries that operate in and surrounding the proposed Otway Basin 2DMSS Operational Area and these include both commonwealth and state fisheries (**Table 14**).

Table 14 Commercial and State Fisheries that Operate in the Area of the Otway Basin 2DMC MSS Operational Area

Jurisdiction	Fishery – Subsector	Comments
Commonwealth	SESSF – CTS Otterboard Trawl	Considerable effort in the area
Commonwealth	SESSF – CTS Danish Seine	Unlikely to be much effort
Commonwealth	SESSF – GhaT Scalefish Hook	Considerable effort in area
Commonwealth	SESSF – GhaT Shark Gillnet	Some effort in area
Commonwealth	SESSF – GhaT Shark Hook	Considerable effort in area
Commonwealth	Southern Squid Jig Fishery	Some effort in area
Commonwealth	Small Pelagic Fishery	Negligible
Commonwealth	Eastern Tuna & Billfish Fishery	Negligible
Commonwealth	Western Tuna & Billfish Fishery	Negligible
Commonwealth	Southern Bluefin Tuna Fishery	Negligible
Commonwealth	Bass Strait Central Zone Scallop Fishery	Negligible if any
Commonwealth	Eastern Skipjack Fishery	No recent effort in fishery
Commonwealth	Western Skipjack Fishery	No recent effort in fishery
South Australia	Marine Scalefish Fishery	Considerable effort in area
South Australia	Giant Crab Fishery	Data is confidential, potential effort
South Australia	Charter Boat Fishery	Some effort in area
South Australia	Southern Zone Rock Lobster Fishery	Considerable effort in area
South Australia	Sardine Fishery	No recent effort this far south
South Australia	Southern Zone Abalone Fishery	Potentially considerable effort in reporting areas that overlap with area
Tasmania	Giant Crab	Considerable effort in area
Tasmania	Rock Lobster Fishery	Considerable effort in area
Tasmania	Marine Scalefish Fishery	Some effort in area
Tasmania	Scallop Fishery	Unlikely to be any effort
Tasmania	Abalone Fishery	Unlikely to be any effort
Victoria	Rock Lobster (W)	Considerable effort in area
Victoria	Giant Crab Fishery	Considerable effort in area
Victoria	Ocean General Fishery	Potentially some effort
Victoria	Scallop (Ocean) Fishery	None
Victoria	Western Zone Abalone Fishery	Potentially some effort

Note: GHaT = Gillnet Hook and Trap Fishery, SESSF = Southern Scalefish and Shark Fishery, CTS = Commonwealth Trawl Sector.

SETFIA have a policy around MSSs and engaging with operators proposing to undertake a MSS, where they acknowledge that hydrocarbons are required for the fishers to catch fish and they want to be good neighbours and share the resources; however, they expect that the operators undertake the required work and do their due diligence to determine the fisheries that are present in the proposed area of operations, the importance of any commercial fishing grounds present and then take reasonable steps where possible to try and minimise effects on the fishing industry.

As discussed above, SLB have engaged SETFIA to assist in this process and will continue working with SETFIA for the duration of the Otway Basin 2DMC MSS. Based on fisheries data provided by different government departments, SETFIA provided SLB with an assessment of the potential overlap between the fisheries provided in **Table 14** and the Operational Area, including an assessment of the potential impact of the Otway Basin 2DMC MSS on these fisheries based on percentage of catch potentially impacted and annual average catch value of potentially affected catch. This assessment was use to describe the commercial fisheries operating within and in the vicinity of the Operational Area (**Section 5.5.2.5**) and will be provided to NOPSEMA as well as the commercial fishing stakeholders whom SLB have been engaging with through this process, or anyone else that requests a copy as part of the ongoing stakeholder engagement programme (**Section 4.5.8**).

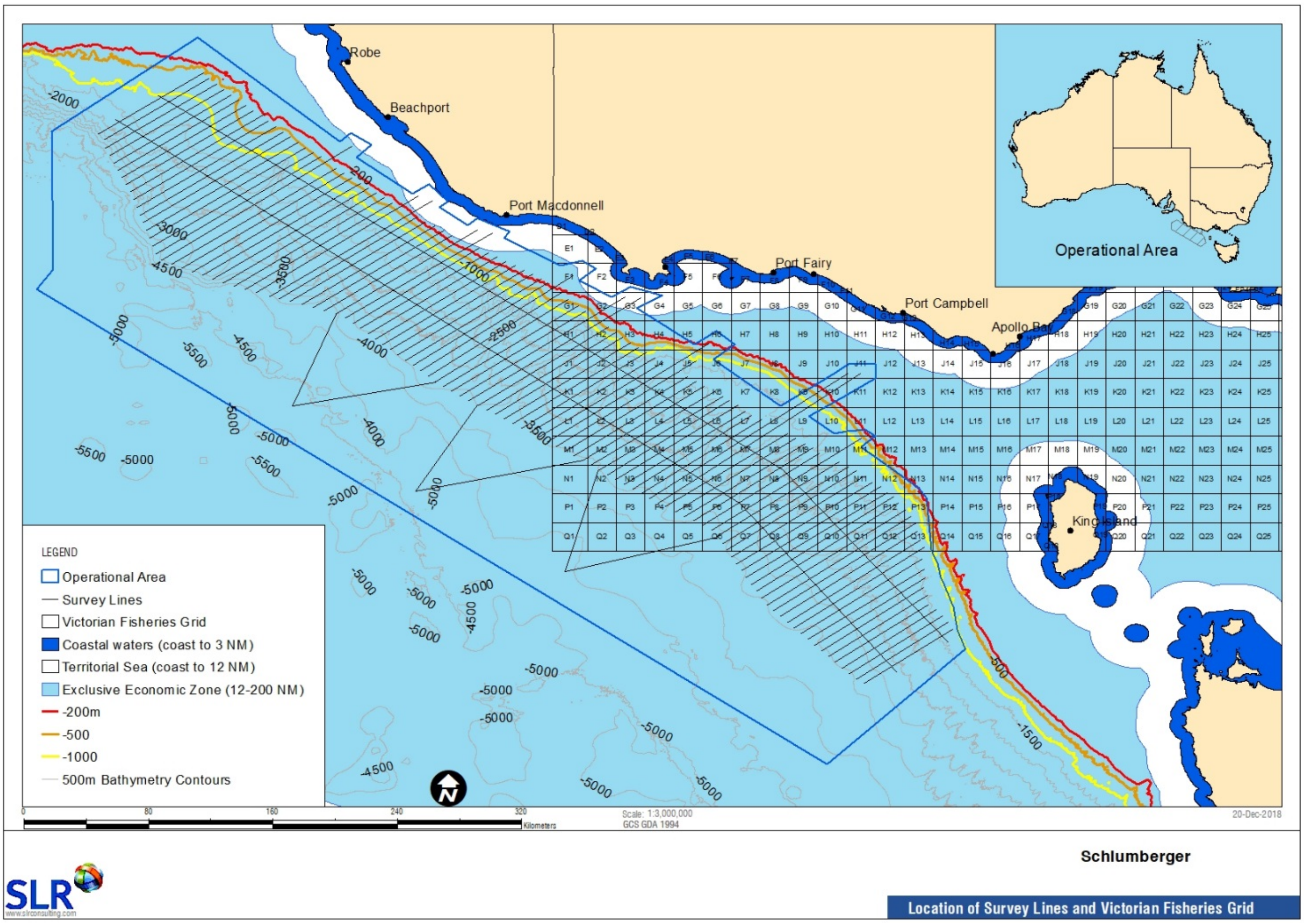
In addition to the identification of fisheries influenced by the proposed MSS, SETFIA are very well connected and will be assisting with the notification process of the MSS to the fishers during the acquisition phase, where SMS warnings will be provided to a number of the fishers of the fishing fleet prior and during the Otway Basin 2DMC MSS.

4.5.7.2 Seafood Industry Victoria Engagement

SLB have been working with Seafood Industry Victoria (**SIV**) (**Section 5.5.2.4**) from the commencement of the stakeholder engagement process in accordance with SIV's policy for consultation between the mining, gas and petroleum sector with the professional seafood industry. As indicated in **Section 5.5.2.4**, SIV represent the Victorian seafood industry.

To enable a more effective engagement process with the members of SIV and to make it easier for them to assess where any potential for conflict or overlap may arise with the proposed Otway Basin 2DMC MSS and where they fish, the reporting grids for Victoria were overlaid on the Otway Basin 2DMC Operational Area. This is provided in **Figure 10**.

Figure 10 Otway Basin 2DMC MSS Operational Area and Victoria Catch Reporting Grid Lines



In addition, four questions were directly asked along with this map, to assess the level of disturbance of conflict that may arise from the proposed Otway Basin 2DMC MSS and consisted of:

- Do you fish in the proposed Operational Area?
- What fish species do you target between months of October and April each year? (the earlier questions that were distributed asked information for January and April)
- What method of fishing do you undertake?
- What depth range do you fish for your target species?

The responses to these questions from the licence holders were incorporated into SIVs report "*Seafood Industry Victoria Industry Communication & Engagement towards Proposed Schlumberger Otway Basin 2D Seismic Survey*", and a full copy of this report is provided in **Appendix H**. SLB's response to the questions and comments raised within the SIV report is provided in **Appendix I**.

4.5.7.3 Tasmanian Seafood Industry Council Engagement

SLB have been working with the Tasmanian Seafood Industry Council (**TSIC**) (**Section 5.5.2.4**) in regard to engaging with the interests of the wild capture fishers, marine farmers and seafood processors in Tasmania. SLB provided the information sheet with the four questions provided above to seek feedback directly from those relevant persons that could be directly affected by the Otway Basin 2DMC MSS.

The responses received from these questions and members of TSIC in general were combined into a report prepared by TSIC called "*Industry Communication & Engagement Concerning Proposed Schlumberger 2D Seismic Survey in the Otway Region*". A copy of this report is provided in **Appendix J**. SLBs response to the questions and comments raised within the TSIC report is provided in **Appendix K**.

4.5.8 Ongoing Stakeholder Engagement

SLB will continue to engage with the relevant authorities of the Commonwealth, State and all other relevant persons (i.e. SIV, TSIC, SETFIA, Wild Catch, SRL etc.) for the duration of the Otway Basin 2DMC MSS in accordance with the Environment Regulations 14(9).

SLB has developed an ongoing consultation strategy for the Otway Basin 2DMC MSS to achieve the following outcomes:

- Continual identification of relevant persons that may be affected by the Otway Basin 2DMC MSS;
- Incorporation of the SETFIA fisheries assessment findings;
- Provision of sufficient information to all relevant persons identified; and
- Continual identification and resolving of any issues that may arise as identified by relevant stakeholders.

The identification of relevant persons throughout the Otway Basin 2DMSS will be achieved by:

- At least six weeks prior to survey commencement, SLB will perform a desktop review to assess for any new stakeholders in the region. This assessment will include all relevant EP submissions and a review of stakeholders identified by other proponents of seismic operations in any newly accepted EPs;
- If a new stakeholder is identified by SLB, they will be contacted as soon as possible with a request to arrange a meeting, or if that is not possible, to provide them with sufficient information about the Otway Basin 2DMC MSS and the control measures that are being implemented so that it is clear to see that the risks and impacts to this particular stakeholder are being reduced to **ALARP** and **Acceptable Levels** through the management measures in place;
- SLB will have support vessel(s) on the water during the Otway Basin 2DMC MSS. These vessels will be in contact with other maritime users and will be able to identify any vessels that are unaware of the survey operations; and
- SLB will make Information Sheets available at certain locations that target recreational users who are transient to the Operational Area. For example, retailers that sell recreational fishing gear and dive shops may have Information Sheets provided.

As part of the ongoing stakeholder engagement programme, if stakeholders raise any concerns or provide feedback that has not previously been considered within the development of the EP, the potential impacts and risks would be reassessed based on the inclusion of the new information and any literature relevant to the particular issue.

If it was determined that a new or increased impact was identified from these concerns, which resulted in a significant modification to the activity (i.e. Otway Basin 2DMC MSS) the EP would have to be updated and resubmitted to NOPSEMA in accordance with Regulation 17 of the Environment Regulations. The following criteria would be applied to assess whether any potential change in impacts or risks was significant:

- Classifications of impact and risk within the risk assessment matrix in this EP;
- Legislative requirements, guidelines, standards;
- Relevant literature;
- STLM results;
- Sound thresholds within the EPBC Act; and
- The Temporary Threshold Shift (**TTS**) and Permanent Threshold Shift (**PTS**) for the relevant receptors identified within the Operational Area (**Table 62**).

4.5.9 Assessment of Merit, Objections and Responses

A number of responses were received from stakeholders after they had considered the Information Sheet that SLB provided to them. Some were positive, some were asking for further information while some were opposed to the proposed MSS. In accordance with the Environment Regulations 16(b)(ii) all submissions have been considered in the assessment of risk and responses have been provided back to all submitters. All concerns raised have been considered within the development of this EP and control measures have been tailored where necessary to reduce the risks to **ALARP** and an **Acceptable Level**.

Control measures in **Section 7** that will be implemented throughout the Otway Basin 2DMC MSS will address all potential impacts to reduce them to **ALARP** and an **Acceptable Level**. Where existing control measures did not address any objections or claims made, additional control measures were implemented.

In accordance with the Environment Regulations 16(b)(iii), the claims that have been made by stakeholders are summarised in **Appendix F**, with the response by SLB and the relevant section within the EP where those concerns are addressed. The full correspondence between the relevant person and SLB is provided in **Appendix C**.

4.5.10 Pre-activity Notification to Stakeholders

Prior to commencing the Otway Basin 2DMC MSS, SLB will provide specific details to all relevant stakeholders in relation to project timing and location. The Otway Basin 2DMC MSS Operational Area has a large geographical spread so it is important to keep stakeholders up to date. A number of mitigation measures in regard to temporal mitigations have been implemented into the survey planning to reduce the impacts on either stakeholders, sensitive species or areas to **ALARP** and an **Acceptable Level** during the survey.

SLB has also committed to providing the commercial fishers who are interested with 48-hour look-ahead of where the vessel will be, so that they can then incorporate the plans of the seismic vessel into their fishing plans. This look ahead will be updated every 24 hours.

Navigational warnings and Notice to Mariners will also be issued on maritime radio and via email correspondence which provide information about the survey vessel and it being restricted in its ability to manoeuvre due to towing the streamer.

A summary of the pre-activity notification process by SLB is provided in **Table 15**.

Table 15 Pre-Activity Notifications by SLB

Timing – prior to MSS	Stakeholder	Information to be Provided
Approval of EP	Director of National Parks	That the EP has been approved by NOPSEMA via email to MarineParks@environment.gov.au
4 Weeks	All relevant stakeholders	Summary of proposed activity Summary of vessel and seismic gear Operational Area coordinates Date of activity commencement Duration of activity SLB contact details
4 Weeks	Australian Defence Force	Operational area coordinates Date of activity commencement
10 days (at least) prior to any seismic activities occurring within the marine park and conclusion of that activity.	Director of National Parks	Provide notification that the survey is to be conducted within the Network of Marine Parks (i.e. Nelson and Zeehan Marine Parks) as per the Class Approval requirements and the NOPSEMA Guidance Note. Contact shall be made via email through MarineParks@environment.gov.au
10 days prior	NOPSEMA	Written notification of the date of intention to commence the Otway Basin 2DMC MSS that is included within this EP.
Up to two days prior	AMSA's Joint Rescue Coordination Centre (**JRCC**)	Vessel details (name, call sign, Maritime Mobile Service Identity (**MMSI**)) Satellite communication details Operational Area coordinates Date of activity commencement Duration of activity Summary of proposed activity SLB contact details

4.5.11 Post-activity Notifications

There are also some post-survey notifications that SLB are required to adhere to. These are provided in **Table 16.**

Table 16 Post-Activity Notification Requirements

Timing – post MSS	Stakeholder	Information to be Provided
Relevant time post-completion	All relevant stakeholders	Notification that the survey is now complete, and the survey vessel is no longer in the area.
Relevant time post completion	AMSA	Summary of any significant or noteworthy interaction with commercial shipping during the Otway Basin 2DMC MSS.
10 days post completion	NOPSEMA	Written notification to NOPSEMA advising of the completion of the Otway Basin 2DMC MSS.
As soon as practicable	NOPSEMA	Written notification to NOPSEMA advising that all of the activities and obligations covered under the EP have been completed.

4.5.12 Provision of Sufficient Information

Regulation 11A(2) of the Environment Regulations states that:

> *"For the purpose of the consultation, the titleholder must give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person."*

As detailed within **Section 4.5.1** the initial consultation included the provision of an information pack to all relevant stakeholders; consisting of an, information sheet and a detailed email. This information pack outlined various aspects of the proposed MSS including the location of the Operational Area (including the GPS coordinates of the corner boundaries), the survey lines within the Operational Area, a description of the proposed seismic activity, approximate timing, the adherence of SLB to the relevant legislation throughout the Otway Basin 2DMC MSS and provided an opportunity for all stakeholders to meet with SLB. This information pack provided enough information for those stakeholders to determine whether their activities would potentially be impacted by the proposed Otway Basin 2DMC MSS. Some stakeholders responded saying they had no concerns, or it was not relevant to their operations, while other stakeholders did consider that their interests could be affected – in these instances, this information provided the starting point for further discussions. This then enabled stakeholders to engage with SLB for additional rounds of consultation, request further information or seek clarity on the proposed MSS, as well as provide comments on the proposal based on their experience in the area. As a result, a number of the comments and feedback received by stakeholders was included in the development of various control measures or operational procedures that are proposed to be implemented during the Otway Basin 2DMC MSS.

NOPSEMAs Guidance Document on consultation requirements (*Consultation requirements under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*) states that "*relevant persons should consider whether the information provided has been sufficient and if not, state the grounds on which additional information should be provided*". No parties, either in the face to face meetings or via email or phone correspondence stated at any point that the information provided to them by SLB was insufficient in order for them to determine the potential impacts and risks associated with the proposed Otway Basin 2DMC MSS in regard to their activities.

Despite an extensive approach to the engagement process, only a small number of parties responded with comments or questions on the information pack. Primarily the questions or concerns raised were from fishing interests in and around the proposed Operational Area. Based on this, SLB focused consultation efforts on those parties which had concerns or comments on the proposal, although further information packs were provided to all parties at later dates to outline changes in the Operational Area and timing as detailed within **Sections 4.5.4** to **4.5.6**.

In addition, SLB engaged SETFIA, SIV and TSIC to assist with the stakeholder engagement with the Commonwealth, Victorian and Tasmanian fishers respectively, in accordance with their consultation policies (**Section 4.5.7**). This engagement resulted in more extensive correspondence than that exchanged with other general stakeholders due to the commercial importance of the Operational Area to these fishers.

Examples of how SLB provided additional information for the commercial fishers to enable those fishers or licence holders to determine what amount (if any) of impact the proposed Otway Basin 2DMC MSS may have on their activities or interests included:

- To assist the Victorian fishers, SLB developed maps of the Otway Basin 2DMSS overlaid on the Victorian fishery reporting grids (**Figure 10**), which they have to report against a grid for all fish landed; and

- Squid fishers had concerns about impacts on squid and catch rates as well as squid spawning areas. As a result, SLB provided detailed maps showing bathymetry contours within and inshore of the Operational Area to provide context for the location of the survey lines in relation to the areas the squid fishers were concerned about. This was also further informed with STLM results.

Further detail on the consultation with the fishing industry is outlined within **Section 4.5.7**. The consultation process with the commercial fishing industry and the industry representatives is an ongoing process and will continue for the duration of the Otway Basin 2DMC MSS as well as post-survey. Working with and alongside these organisations provided SLB with a greater understanding of the potential impacts the proposed MSS may have on the licence holders and their activities; and subsequently, additional control measures and operational procedures were developed to alleviate these concerns (such as significantly reducing the Operational Area and removing survey lines).

Based on the discussion and information provided above, SLB considers that the information provided to the relevant persons during the consultation process was sufficient and in accordance with the Environment Regulations.

5 Existing Environment

This section describes the existing environment and the key sensitivities/receptors that exist within the marine and coastal environment considered relevant to the proposed Otway Basin 2DMC MSS. Features and receptors found within the Operational Area and wider environment (approximately 100 km radius around the Operational Area) have been included. Any high value marine or coastal features, or other receptor identified slightly beyond the wider environment (i.e. >100 km) were also included for completeness.

With the acoustic source being one of the primary impacts associated with the Otway Basin 2DMC MSS, it was considered necessary to include the wider receiving environment than just the Operational Area, extending out to 100 km and beyond to higher sensitive areas to capture potential effects further afield, since background noise levels may not be reached for >100 km, depending on propagation conditions (this is discussed in detail in **Section 7.2.1.3**).

This EP has been prepared in accordance with the Environment Regulations and has utilised various sources of information, including relevant policy documents, recovery plans, conservation advice, guidelines and gazettal instruments and plans of management on the DoEE website. In addition to this, a thorough search of all relevant scientific literature has been undertaken to identify and inform the existing environment in and around the Operational Area. Utilising scientific research, along with Governmental information, has resulted in SLB utilising the most reliable and recent up to date information as possible, whilst removing bias and uncertainty as far as practicable. A full list of the sources of information can be found within **Section 12**.

5.1 Physical Environment

5.1.1 Meteorology

The Otway Basin 2DMC MSS Operational Area (**Figure 4**) lies within the Southern Ocean, at the western end of Bass Strait. This cool temperate region is typified by cold, wet winters and warm dry summers. Sub-tropical high-pressure systems dominate in summer while sub-polar low-pressure systems are frequent in winter. Located within the westerly wind belt known as the 'Roaring Forties', low-pressure systems often carry strong westerly winds and cold fronts that produce strong winds from the west, north-west and south-west quarters.

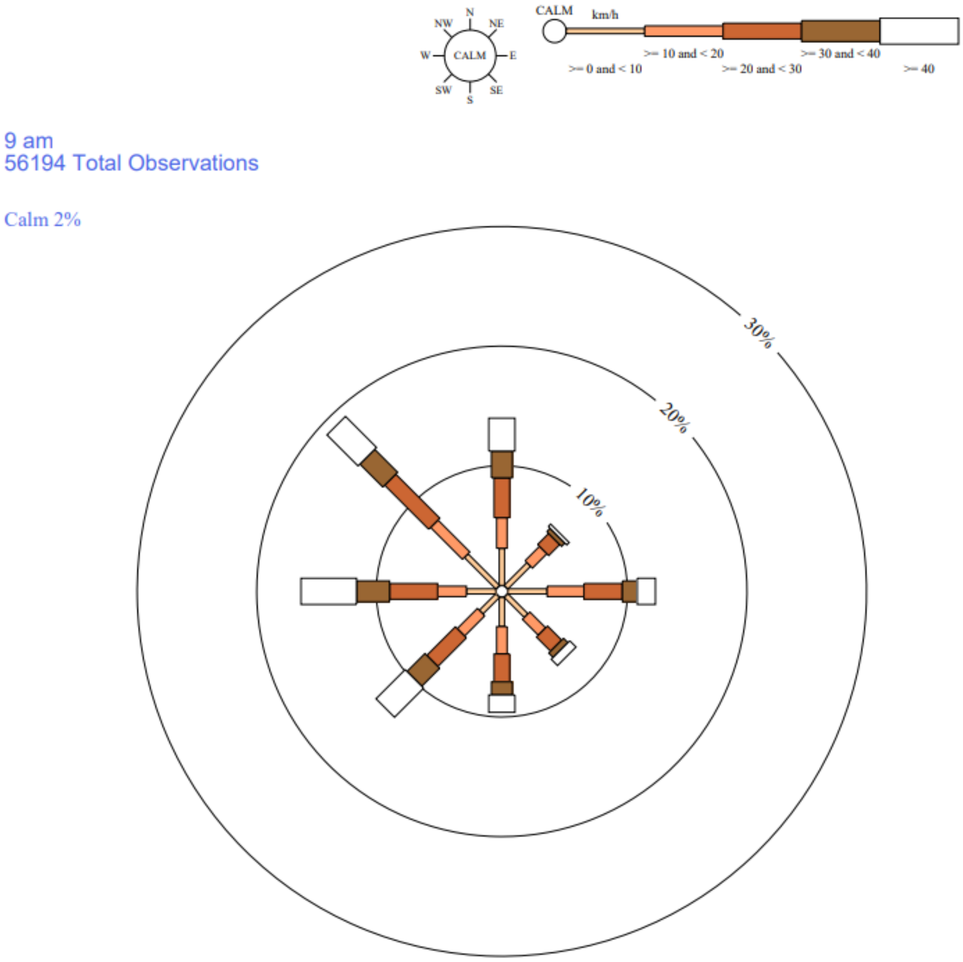
The Cape Otway Lighthouse climate station, which opened in 1861, provides air temperature, rainfall, and wind speed data that are relevant to the Operational Area. The climate station is still in use, so the following data summary, accessed from the Australian Government Bureau of Meteorology (**BOM**) online lookup tables, is valid at the time of writing (BOM, 2018).

The BOM data set accessed to assess meteorological conditions for the Otway region consists of 154 years of measurements. Mean monthly maximum air temperatures vary from 21.6°C (February) to 13.0°C (July), and mean monthly minimum air temperature varies from 14°C (February) to 7.5°C (July).

The mean annual rainfall over this period was 895 mm, which is notably wetter than Melbourne Airport (average 534 mm), particularly during winter months.

Wind from the northwest is most common (approximately 19% of the time), followed by west, north and southwest (**Figure 11**). The mean monthly wind speed varied from 22.0 km/h (March) to 27.6 km/h (August).

Figure 11 Wind Rose for Cape Otway Lighthouse Climate Station



Source: BOM, 2018

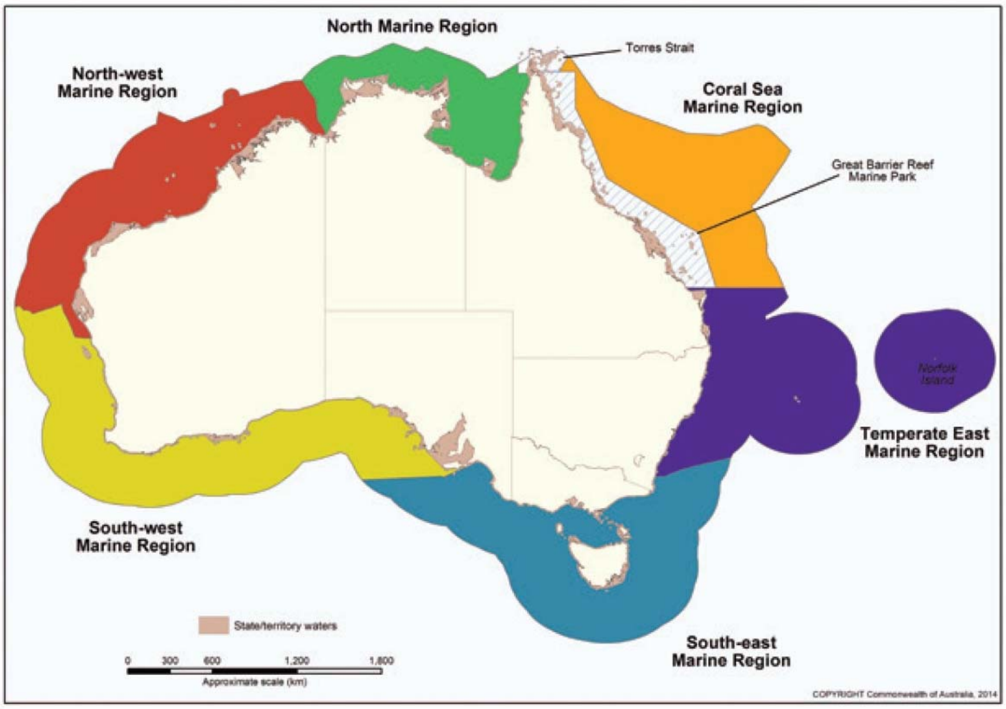
5.1.2 Air Quality

Air quality across the Operational Area is expected to be high given that air flow originates in the Southern Ocean, and there are no intervening land masses that could influence the quality of air from any anthropogenic or natural terrestrial sources.

5.1.3 Currents and Waves

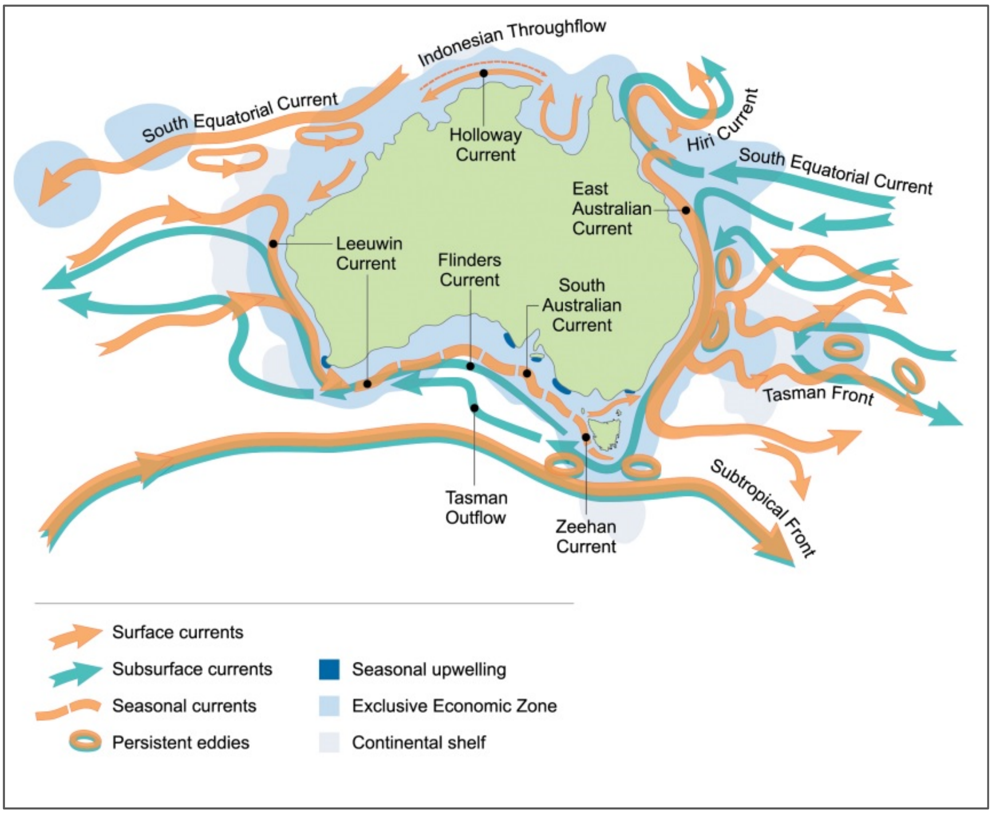
The Otway Basin 2DMC MSS Operational Area lies within the oceanographically complex South-east Marine Region (**Figure 12**), which is principally influenced by the Leeuwin/South Australian, Flinders, and Zeehan Currents (**Figure 13**).

Figure 12 Australia's Marine Regions



Source: Commonwealth of Australia, 2015

Figure 13 Major Ocean Currents and Features Influencing Australia's Marine Environment



Source: Evans *et al*., 2017

The Leeuwin and Zeehan Currents are seasonally influenced, where stronger currents are present in winter compared to summer months (Creswell, 2000; Commonwealth of Australia, 2015). Warm low-salinity subtropical waters from the Leeuwin Current move south down the Western Australia coast before flowing east into the Great Australian Bight (Ridgway & Condie, 2004). Within the Great Australian Bight, the Leeuwin and Zeehan Currents mix and continue to move east as the South Australian Current, and through the Operational Area, splitting into Bass Strait and south along Tasmania's west coast, introducing warm, saline waters to the region. The Leeuwin Current exhibits considerable inter-annual variability, varying relative to coastal winds (Ridgway & Condie, 2004) and is strongest in the austral winter (Waite *et al*., 2007) when southerly winds are strongest (Deng *et al.,* 2008). The path of the Zeehan Current is consistent from year to year as a result of the bathymetric contours along the shelf break where it flows (Ridgway, 2007).

The Leeuwin Current is considered to be relatively narrow (approximately 100 km wide) and shallow (<300 m) (Rennie *et al.,* 2007), with speeds across the Great Australian Bight of approximately 0.3 – 0.5 ms^{-1} (Cresswell & Domingues, 2009). The Zeehan Current is even narrower and slower flowing, where it is approximately 40 km wide (Baines *et al*., 1983) with mean speeds of up to 0.3 ms^{-1} (Cirano & Middleton, 2003).

The westward flowing Flinders Current is described as a northern boundary current resulting from surface wind stresses (Middleton & Cirano, 2002). The Flinders Current originates in the Southern Ocean and is associated with deep upwelling over the continental shelf at depths of 600 – 1,000 m (Middleton & Platov, 2003). This current is present year-round (Middleton & Cirano, 2002; Kämpf, 2010) although it is generally strongest in the summer and weakest in winter (Middleton & Bye, 2007). The Flinders Current increases in speed from 0.05 ms^{-1} in the east to 0.2 ms^{-1} in the west where it meets the Leeuwin Current in winter.

The Otway Basin 2DMC MSS Operational Area is also influenced by a number of seasonal upwelling systems that introduce nutrient rich waters into an otherwise nutrient-poor area (Gill, 2002; Kämpf *et al*., 2004). These upwelling systems include the Bonney Upwelling (**Section 5.3.8.1**, **Figure 41**) and Bass Strait Cascade (Commonwealth of Australia, 2015).

The Bonney Upwelling is the largest and most predictable upwelling in southeast Australia and is present throughout the summer period (November – March) (Butler *et al*., 2002). The upwelling is driven by seasonal movements of a subtropical ridge that lies over the Great Australian Bight in summer and pushes southeast winds along the Bonney Coast which interact with regional ocean circulation and climate patterns (as referenced in Nieblas *et al*., 2009). Open ocean waters are moved onto the continental shelf resulting in a shallow thermocline (**Section 5.1.4**) with increased nutrient concentrations below (Nieblas *et al*., 2009). Within the Bonney Upwelling there are 2 – 3 major upwelling events, each lasting approximately one week (Kämpf *et al.*, 2004). The highly productive Bonney Upwelling system provides a feeding ground for a number of cetaceans (particularly blue whales) (**Section 5.2.6.1**), pinnipeds (**Section 5.2.7**), seabirds (**Section 5.2.8**), and fish (**Section 5.2.3**), and is important to a number of fisheries (e.g. rock lobster) (**Section 5.5.2**) (Butler *et al*., 2002).

The Bass Strait Water Cascade is a down-welling current originating in the shallow waters of Bass Strait. The cascade flows down the continental slope into the Tasman Sea (Tomczak, 1987). Winter cooling of the saline waters within Bass Strait forms water that is denser than the adjacent Tasman Sea (Middleton & Cirano, 2005). Water cascades to depths of 300 m or more (Middleton & Cirano, 2005), with the down-flow of denser water creating high-salinity intrusions along the continental slope (Tomczak, 1987).

Due to the relatively wide and shallow continental shelf of the Operational Area and wider South-east Marine Region, this coast is subject to large storm surges. Bass Strait in particular, is subject to large storm surges on account of the narrowing of the shelf at the entrance to the Strait (McInnes & Hubbert, 2003). These storm surges are caused by predominantly westerly winds associated with cold fronts, and although they occur year-round, they are more common in winter (McInnes & Hubbert, 2003).

5.1.4 Thermoclines and Sea Surface Temperature

Thermoclines occur when cold and relatively warm water separate vertically in the water column. They can develop as a result of solar heating of the upper water column during warmer months. Stratification profiles vary with local environmental conditions; for example, storm conditions can cause significant vertical mixing and breakdown of the thermal structure, and local tides and currents can either enhance or damage the structure of the thermocline. Consequently, a well-defined thermocline is not always present.

In the Otway Basin, the winter thermocline intersects the seafloor at the shelf edge. This is caused by the deep cold water from the Flinders Current moving northward along the continental slope at the same time as surface warm water from the Leeuwin Current moves from west to east (Boult *et al*., 2006). In the summer, the strength of the Leeuwin Current decreases and the Flinders Current becomes more dominant. The thermocline then moves onto the continental shelf (Boult *et al*., 2006).

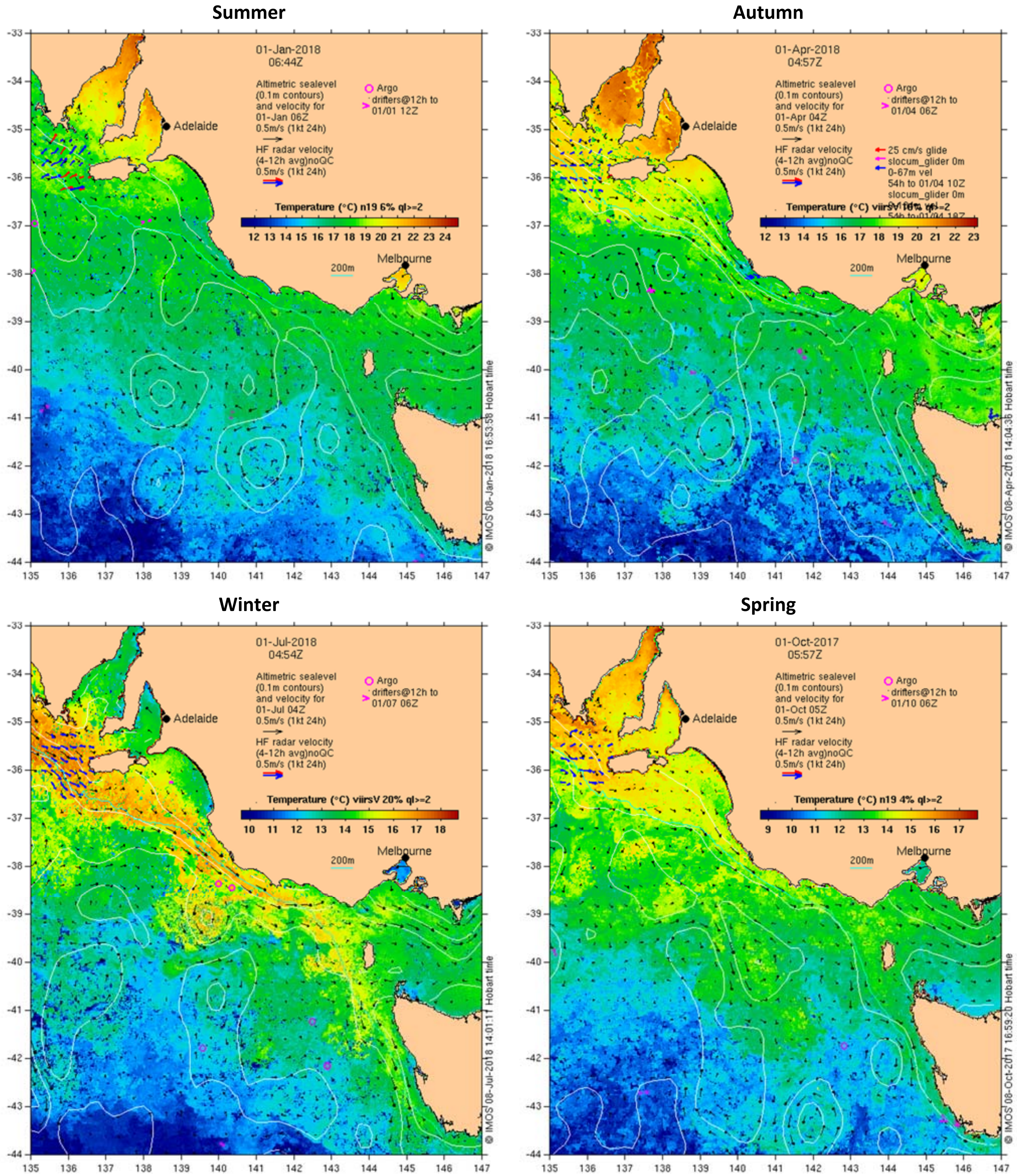
Thermoclines can be observed through processed seismic data. A thermocline is characterised by a negative sound speed gradient and can be acoustically reflective. This is a result of a discontinuity in the acoustic impedance of water created by the sudden change in density resulting from the temperature difference. A temperature change of 1°C can result in a change in the speed of sound of 3 ms^{-1} (Simmonds *et al*., 2004).

Sea surface temperatures vary seasonally, and real-time temperatures for the past 12 months are presented in **Figure 14**. Approximate sea surface temperature ranges from the images in **Figure 14** are:

- Summer: 16 – 19°C;
- Autumn: 16 – 18°C;
- Spring: 12 – 15°C; and
- Winter: 14 – 17°C.

The seasonal sea surface temperature range for each season represents the coastal and offshore regions included in the Otway Basin 2DMC MSS Operational Area.

Figure 14 Seasonal Sea Surface Temperature, Otway Basin



Graphs represent 2018 data for Summer (January), Autumn (April), Winter (July), and Spring (October)

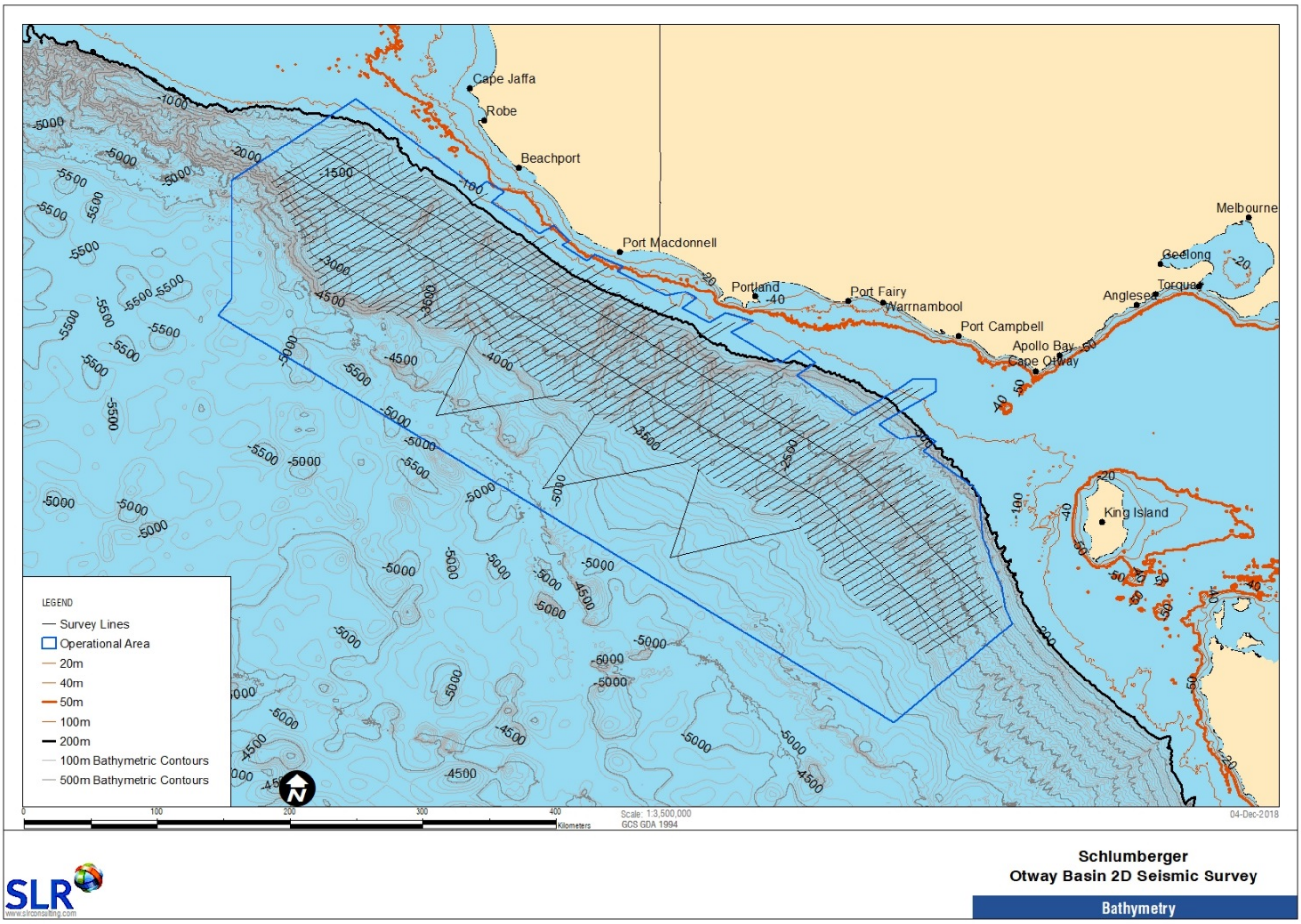
Source: http://oceancurrent.imos.org.au/

5.1.5 Bathymetry

The Otway Basin 2DMC MSS Operational Area spans the coastal margins of the continental shelf, down the continental slope and rise to the continental margin and onto the abyssal plain. Bathymetry within the Operational Area ranges from 50 m on the continental shelf nearshore to 5,600 m offshore on the abyssal plain (**Figure 15**). The shelf is narrow (10 – 25 km wide) along the coast of South Australia, Victoria and Tasmania, but widens within Bass Strait, where water depth averages 50 – 60 m. The bathymetry and regional climate combine to intensify currents, eddies and upwellings, creating a rich and productive area for biodiversity.

There are numerous sea-floor canyons along the continental margin throughout the region. Many of these are identified by the Australian Government as Key Ecological Features (**KEF**) (see **Section 5.3.8** for more detail). Canyons can have steep or rugged topography and provide habitat for sessile organisms which attract fish and other mobile, higher order species (Commonwealth of Australia, 2015). Depending on their size, shape and orientation, canyons can change local currents and subsequent nutrient availability, enhancing productivity and biodiversity.

Figure 15 Bathymetry of the Otway Basin 2DMC MSS Operational Area



5.1.6 Ambient Noise

The exposed offshore nature of the Otway Basin 2DMC MSS Operational Area is expected to incur ambient noise levels that are associated with predominantly natural sources, such as wind and wave movement, seabed sediment movements and the sound-based communication of marine fauna, such as crustaceans, fish and marine mammals.

Measurements of underwater ambient noise levels in the Operational Area are not available, but levels can be inferred from other deep-water areas with comparable shipping activity. For much of the world's oceans, low frequency noise (10 to 500 Hz) due to distant shipping and wind noise dominates the overall ambient noise environment. The shipping noise component is the result of ship traffic within an entire ocean basin since these low frequency sources propagate over long distances. At 1,000 m depth in at a generalized deep-water site low frequency spectral noise levels range from a minimum of about 60 dB re 1 $\mu Pa^2 Hz^{-1}$ (in the absence of shipping, with low wind) up to around 90 dB re 1 $\mu Pa^2 Hz^{-1}$ with distant shipping (Hildebrand, 2009).

The main anthropogenic noise evident throughout the Operational Area is associated with commercial vessels along the shipping routes, in addition to commercial fishing and recreational vessels. The nearest point sources of 'industrial' noise are associated with the existing offshore gas fields (**Figure 55**) in the northeast corner of the Operational Area. The main shore-based sources of industrial noise are at Portland (Victoria), where the Alcoa Aluminium Smelter operates (approximately 14 km from the nearest point of the Operational Area), and the Port of Portland handles the import and export of bulk commodities.

5.1.7 Geology and Seafloor Sediments

The Otway Basin 2DMC MSS Operational Area is predominately located within the Otway Basin, with a small southeast portion of the Operational Area located in the Sorell Basin, off Tasmania.

The Late Jurassic-Cenozoic Otway Basin formed by multi-stage rift-sag and inversion phases (Geoscience Australia, 2018). The main rock types are siliciclastic sediments, sedimentary and carbonate rocks – various sandstones, shales and mudstones.

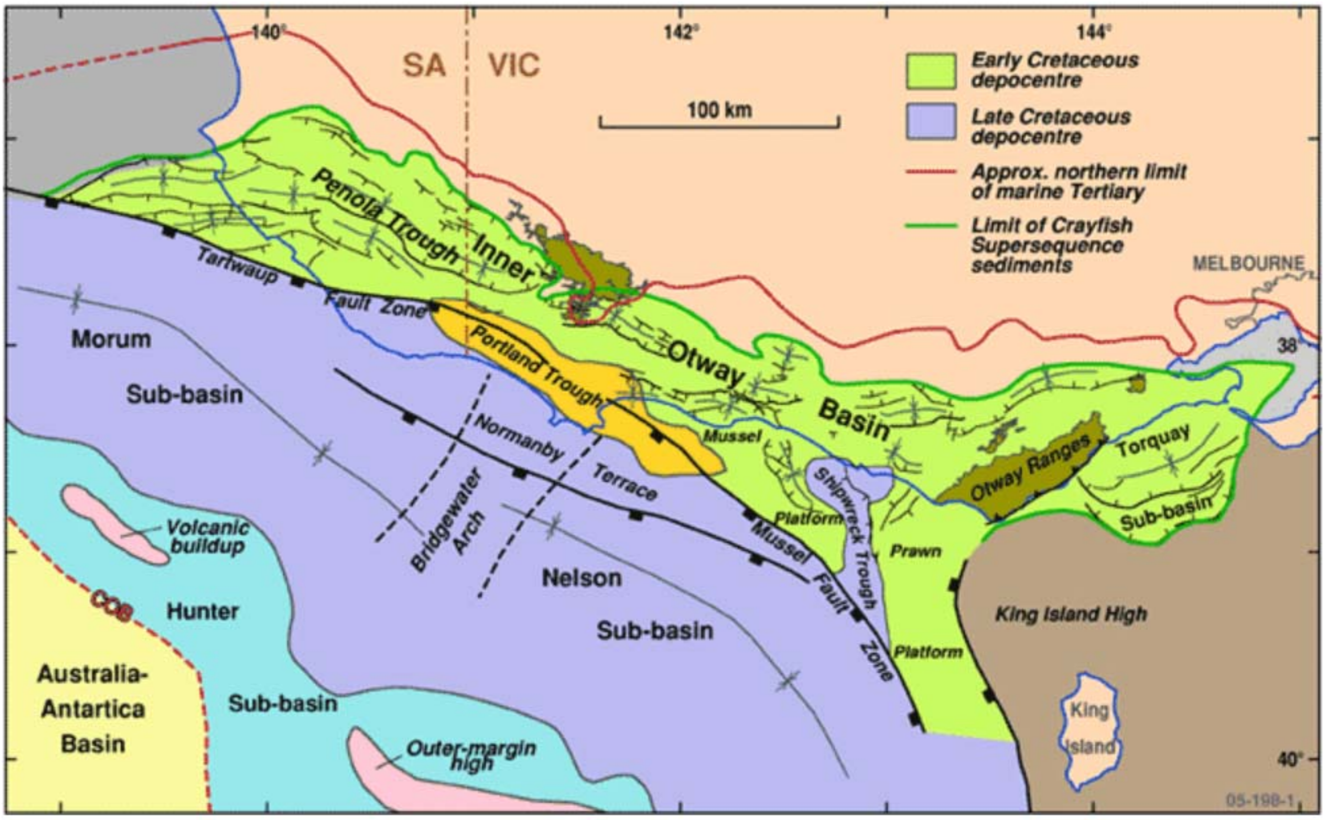
The Basin's depositional environment is mainly marine in Late Cretaceous and Cenozoic, with sediment thickness up to 13 km (Geoscience Australia, 2018). Depositional basins include five major 'depocentres', or areas of maximum deposition (**Figure 16**):

- Inner Otway Basin;
- Morum Sub-basin;
- Nelson Sub-basin;
- Hunter Sub-basin; and
- Torquay Sub-basin.

These basins and sub-basins vary in thickness by up to 8 km, where coastal plain, deltaic and marine sediments can be up to 5 km thick. The offshore component of the basin comprises a thick Late Cretaceous depocentre that is up to 13 km thick and characterised by the progradation of a marine deltaic complex (Geoscience Australia, 2018).

The Sorell Basin is contiguous with the Otway Basin to the north (Geoscience Australia, 2018a) and is not labelled in **Figure 16** but can be observed as the grey shaded basin to the northwest of the Inner Otway Basin. However, the Sorell Basin sediments comprise Early – Late Cretaceous, mostly non-marine sediments (fluvial), overlain by younger post-rift paralic and shallow marine siliciclastics and carbonates. Sediments are 3.0 – 6.5 km thick in the Sorrell Basin.

Figure 16 Depositional Environment of the Otway Basin



Source: Geoscience Australia, 2018b.

5.2 Biological Environment

5.2.1 Plankton and Primary Producers

The term ‘plankton’ describes the drifting organisms that inhabit aquatic environments. Plankton travel with the ocean currents and although some plankton can move vertically within the water column, their horizontal distribution is primarily determined by the surrounding currents.

There are four broad functional planktonic groups:

- Viroplankton – viral organisms in the size range of 0.02 – 0.2 µm that cannot survive without infecting a host;
- Bacterioplankton – bacteria that are free floating within the plankton and usually of a size range from 0.2 – 2.0 µm;
- Phytoplankton – free-floating organisms capable of photosynthesis which includes diatoms and dinoflagellates. Phytoplankton fulfil the primary producer role in the ocean and form the basis of the marine food web; and
- Zooplankton – free-floating animals which includes copepods, jellyfish and larval stages of larger animals.

Oceanic productivity occurs when phytoplankton (or algae/seagrasses) photosynthesise and form the basis of the marine food web. The amount of productivity results from many factors including currents, climate and bathymetry. Nutrient rich waters and areas of upwelling enhance productivity and such conditions are ideal for the growth of plankton and plankton-consuming animals. Areas of high productivity are associated with aggregations of marine organisms (Hosack & Dambacher, 2012).

In the Operational Area, plankton distribution is influenced by prevailing ocean currents such as the Leeuwin, Flinders, and Zeehan Currents, as well as flows from Bass Strait and Southern Ocean masses (**Section 5.1.3**). There are additional areas of enhanced productivity, including seasonal phytoplankton blooms in the East Tasmania Subtropical Convergence Zone, which occur to the east of the Operational Area, and high productivity relating to the upwelling of cool nutrient-rich waters along the mainland coast north-east of Bass Strait (Commonwealth of Australia, 2015).

Within the Operational Area there are two notable features that promote productivity (Commonwealth of Australia, 2015):

- The Bonney Coast upwelling (**Section 5.3.8.1**) - a regular seasonal event which brings cold nutrient-rich water to the surface. This results in increased plankton abundance, high productivity and high diversity of marine animals which rely on plankton as a food source; and
- The West Tasmanian Canyons (**Section 5.3.8.2**) - located in eastern region of the Operational Area, these are also areas high in productivity and diversity due to the upwelling of nutrient-rich water at the head of the canyons.

Data on plankton populations in the Otway Basin is limited; however, studies in Bass Strait report regions of high productivity and high phytoplankton biomass, particularly in nutrient-rich shallow areas. Within Bass Strait, a large portion of the zooplankton community is comprised of the larval stages of commercial fish species which rely on phytoplankton for growth and survival. Watson and Chaloupka (1982) reported in excess of 170 species of zooplankton in eastern and central Bass Strait, with copepods dominating the community. Kimmerer and McKinnon (1984) also reported high diversity but found 80% of the community to be comprised of only seven dominant species. The zooplankton species, *Nyctiphanes australis,* which is known as a coastal krill, is important to the region as it provides an important food source for blue whales which frequent southern Australian waters in summer and autumn (**Section 5.2.6.1**). There are a number of other consumers in the area which rely on plankton as a food source, some of which are fished commercially (i.e. sardines).

In the eastern Great Australian Bight, van Ruth and Ward (2014) reported that the highest zooplankton densities occurred in summer, and it was shown that there were clear seasonal differences among the composition of zooplankton communities. However, throughout the year, copepods and cladocerans dominated the zooplankton community. There was a positive relationship between elevated chlorophyll-α concentrations during summer/autumn which were correlated with high zooplankton densities during this period.

It is considered that plankton populations in Bass Strait and the eastern Great Australian Bight are likely to be similar to those in the Otway Basin area given the geographical closeness and environment similarities; although there will be variation in these communities on both spatial and temporal scales.

5.2.2 Benthic Invertebrates

The composition of benthic communities is influenced by many factors including seafloor habitat, depth, water temperature, wave action and currents. Due to the Operational Area having a depth range down to almost 6,000 m, a range of different habitat/substrate types, and consequently benthic communities, will be present. The West Tasmanian Canyons – located in the eastern region of the Operational Area – are likely to have higher abundances of epifauna and sessile invertebrates such as corals, as well as higher order species.

Information on benthic invertebrate communities within the Operational Area is limited. However, the likely benthic invertebrate communities within the Operational Area are based on studies for nearby areas. The southern Australian waters are reported as having a variety of seabed habitats, supporting diverse infaunal and epifaunal communities, which display little evidence of any distinct biogeographic regions (Poore *et al.*, 1985; Wilson & Poore, 1987). Benthic communities in the adjacent Bass Strait and eastern Great Australian Bight have been the subject of considerable research and therefore provide valuable insight into the typical benthic communities likely to be present in the Operational Area.

Many benthic surveys have occurred in Bass Strait. One of the most extensive surveys was carried out by the Museum of Victoria between 1979 and 1983, which found a highly diverse benthic invertebrate community dominated by crustaceans and polychaetes. Other abundant taxa included sponges, octocorals, pycnogonids, opisthobranch molluscs, ascidians, bryozoans and brachiopods (Poore *et al.*, 1985; Wilson & Poore, 1987).

The 1998 “Victorian coastal benthos study” sampled along the entire length of the Victorian coastline and benthic diversity in Bass Strait was reported to be higher than that recorded in any other previous study worldwide. This was potentially attributed to historic-evolutionary factors, and temporal climatic variability resulting from the El Nino Southern Oscillation (Heislers & Parry, 2007).

Studies in the Great Australian Bight have also reported a high diversity of benthic invertebrates. Ward *et al*. (2006) found 797 epifaunal species during a series of epibenthic sled surveys in the eastern Great Australian Bight. The samples were dominated by porifera, ascidians and bryozoans, and these authors suggested that the eastern Great Australian Bight may support one of the world's most diverse soft-sediment ecosystems. Infaunal communities in the same area were much less diverse, with Currie *et al*. (2009) reporting 240 taxa from 65 sites sampled in the eastern Great Australian Bight. Unlike the epifauna, most of the infaunal species were uncommon, with 96% of species representing less than 2% of the total number of individuals collected. In the inner shelf area, sessile filter feeders dominated, whereas in the shelf break, motile deposit feeding organisms with more abundant.

The Flora and Fauna Guarantee Act 1998 lists the following marine species, which could potentially occur within the Operational Area, as vulnerable: the sea cucumbers *Apsolidium densum, Apsolidium falconeri, Apsolidium handrecki, Pentocnus bursatus, Thyone nigra* and *Trochodota shepherdi*; the chiton *Bassethullia glypta*; the opisthobranches *Platydoris galbana* and *Rhodope* sp.; the stalked hydroid *Ralpharia coccinea;* the brittle stars *Amphiura triscacantha* and *Ophiocomina australis;* and the shrimps *Michelea microphylla, Athanopsis australis* and *Eucalliax tooradin*. It is noted that some of these species have a very limited known distribution (e.g. *A. triscacantha*, *O. australis*) and/or occupy specific habitats (e.g. seagrass) and therefore, although possible, are unlikely to occur within the Operational Area.

Commercial species in southern Australian waters include lobster, crab, prawn, oysters, scallops, blacklip and greenlip abalone and the Maori octopus. Information on fisheries associated with the Operational Area is provided in **Section 5.5.2**.

5.2.3 Fish

Over 5,000 species of fish are currently known to occur in Australia's marine environment and these play important ecological roles in coastal and offshore waters. Fish populations from the Operational Area are represented by demersal and pelagic species, with a number of larger migratory pelagic species visiting the area seasonally. Some of the taxa potentially occurring in the survey area include albacore, Australian grayling, Australian herring, Australian sardine, anchovy, barracouta, blue morwong, short boarfish, Ray's bream, congolli, flatheads, flounder, garfish, gemfish, blue grenadier, groper, gurnard, harlequin fish, jack mackerel, leatherjacket, pink ling, luderick, mackerel, marlin, mullet, mulloway, orange roughy, perch, pike, pipefish, pipehorses, pufferfish, redbait, salmon, Samson fish, seadragons, seahorses, skipjack tuna, snapper, snook, southern bluefin tuna, sprat, sweep, warehou, swordfish, tiger flathead, toadfish, trevally, silver warehou, whiting, wrasse, yellowfin whiting, yellowtail kingfish and yellowtail scad.

5.2.3.1 Bony Fish

Four bony fish species listed in the EPBC Act 'List of Threatened Fauna' may occur in the survey area: one species is listed as 'vulnerable' and three species are listed as 'conservation dependent' (see **Section 2.2** for definitions of these terms). These species are listed in **Table 17** and a description of each species is provided below including known spawning timing and locations.

Table 17 Bony Fish Species Listed in the EPBC Act 'List of Threatened Fauna' Which May Occur in the Otway Basin 2DMC MSS Operational Area

Scientific Name	Common Name(s)	EPBC Act List Status	Distribution
Prototroctes maraena	Australian grayling	Vulnerable	Species or species habitat may occur within Operational Area
Hoplostethus atlanticus	Orange roughy, deep-sea perch, red roughy	Conservation dependent	Species or species habitat likely to occur within Operational Area
Seriolella brama	Blue warehou	Conservation dependent	Species or species habitat likely to occur within Operational Area
Thunnus maccoyii	Southern bluefin tuna	Conservation dependent	Species or species habitat likely to occur within Operational Area

5.2.3.1.1 Australian Grayling (*Prototroctes maraena*)

The Australian grayling is a relatively small (average length 17 – 19 cm) slender fish with large yellow eyes. This fish occurs in both freshwater and marine environments; the larvae and juveniles occur in coastal waters while the adults inhabit freshwater streams and rivers (Miles *et al*., 2013). The Australian grayling spawns during late summer and winter, with eggs hatching after 10 – 20 days. Larvae drift downstream to the ocean and spend around six months at sea before returning permanently to the freshwater environment (Berra, 1982; Backhouse, *et al*., 2008).

The Australian grayling occurs in freshwater environments on the eastern and southern flanks of the Great Dividing Range, from Sydney, southwards to the Otway Ranges of Victoria, and in Tasmania (DoEE, 2018a). As such, larvae and juveniles may occur in coastal waters of the inshore portion of the Otway 2DMC MSS Operational Area.

There is a recovery plan detailing the distribution and biology, conservation status, threats, and recovery objectives and actions necessary to ensure the long-term survival of the Australian grayling. The identified threats are largely freshwater catchment based (e.g. barriers to fish migration, changes in river flows, degradation of riparian habitat, etc.) and there is no mention of any specific threats from seismic activities (e.g. noise or marine pollution) in the recovery plan (Backhouse *et al*., 2008). The Australian grayling is listed as vulnerable under the EPBC Act.

5.2.3.1.2 Orange Roughy (*Hoplostethus atlanticus*)

Orange roughy are a deep-sea fish species that lives and feeds on or near the seafloor, generally at depths of 500 – 1,400 m (Gomon *et al*., 2008; DoEE, 2018b). Adults are commonly 35 – 45 cm in length and weigh from 0.8 – 1.5 kg (Yearsley *et al*., 1999). Orange roughy are slow-growing and can live for up to 150 years; they are late to mature and have low fecundity and as such, populations have a low resistance to threats and exploitation. Orange roughy have a wide diet and opportunistically feed on mesopelagic and benthopelagic organisms like prawns, fish, squid, mysids, amphipods and euphausiids (Lack *et al*., 2003).

Orange roughy are distributed worldwide and often aggregate near oceanic features such as seamounts, canyons and plateaus to feed and/or spawn (Lack *et al*., 2003; AFMA, 2006). In Australia, orange roughy occur in waters from central New South Wales through to south-Western Australia, including Tasmania. This distribution includes the Operational Area. Notable feeding and spawning hotspots include the South Tasman Rise Cascade Plateau and Lord Howe Rise (Kailola *et al*., 1993).

Since the establishment of the Australian orange roughy fishery in the late 1980s, populations have declined significantly (DoEE, 2018b). There are no Recovery Plans or Conservation Advices for orange roughy. The species is listed as conservation dependent under the EPBC Act.

5.2.3.1.3 Blue Warehou (*Seriolella brama*)

Blue warehou are a medium-sized fish found in Australian and New Zealand waters. Adults can reach up to 76 cm in length and weigh up to 4 kg. They can live for up to 15 years and have a diet dominated by salps, euphausiids, krill, crabs and small squid (AFMA, 2014).

In Australia, blue warehou occur throughout southeast waters (New South Wales, Victoria, Tasmania and South Australia) in continental shelf and upper slope areas, generally at depths of 50 – 300 m (Smith, 1994; AFMA, 2014). Blue warehou reach maturity at 2 – 3 years of age and spawn during winter and spring. This highly mobile species has a broad distribution of breeding locations, including western Victorian and Tasmanian waters (Knuckey & Sivakumaran, 1999). Larval aggregations have also been observed from Kangaroo Island in South Australia, to southern Tasmania - including concentrations off the north-western coast of Tasmania and off the eastern Victoria/New South Wales border (Knuckey & Sivakumaran, 1999). Consequently, breeding and/or larvae may occur in the Operational Area.

Blue warehou are listed as Conservation Dependent under the EPBC Act and are managed under AFMA *Blue Warehou Stock Rebuilding Strategy* (AFMA, 2014). Objectives and threats provided within this strategy focus on recreational and commercial fisheries, as a result, there is no mention of seismic activities within this strategy.

5.2.3.1.4 Southern Bluefin Tuna (*Thunnus maccoyii*)

Southern bluefin tuna are large pelagic migratory fish that can reach up to 2.25 m in length and 200 kg in weight. These slow-growing apex predators have a long life span, living for over 40 years and reaching sexual maturity at 11 – 12 years where they feed opportunistically on a wide variety of prey including fish, crustaceans, cephalopods and salps (DoEE, 2018c).

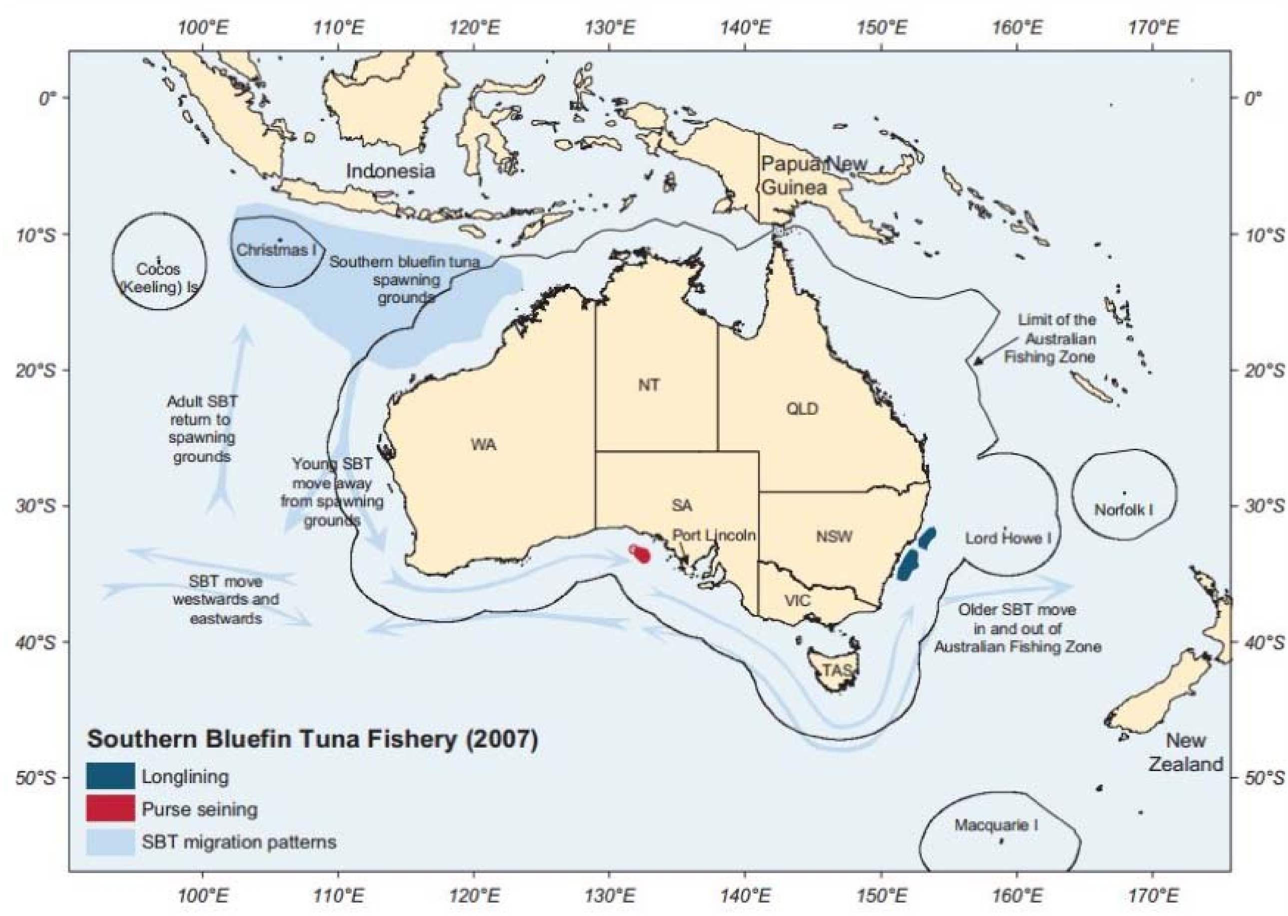
Southern bluefin tuna were listed as Conservation Dependent under national environmental law (the EPBC Act) in 2010, and also carry the following official conservation status at international, national and state levels:

a. IUCN 2000: Critically Endangered as of 1996;
b. ASFB 2002: Lower Risk - near threatened;
c. Pogonoski *et al.* 2002: listed as Lower Risk - near threatened;
d. Victoria: listed on Schedule 2 of the Flora and Fauna Guarantee Act 1988 as a threatened species; and
e. New South Wales: Protected from New South Wales commercial fishing under the Fisheries Management Act.

The New South Wales Department of Primary Industry Fisheries Scientific Committee report recommended southern bluefin tuna to be classed as an endangered species in Schedule 4 of the Fisheries Management Act 1994.

Globally, southern bluefin tuna are found in the southwest and southeast Atlantic Ocean, east and West Indian Ocean, and the southwest Pacific Ocean (Collette *et al*., 2011). In Australia, this species occurs from north Western Australia to south Australian waters, including Tasmania, and to north New South Wales. Southern bluefin tuna spawn from August to April, close to the surface of warm waters (>24°C). Only one spawning ground is known, which lies in the Indian Ocean between northern Western Australia and Java (Caton, 1991; Basson *et al.,* 2012) (**Figure 17**). Based on genetic analyses, there is considered to be only one global population of southern bluefin tuna.

Figure 17 Southern Bluefin Tuna Spawning Grounds and Migration Routes



Source: AFMA, 2018

Southern bluefin tuna migrate along the West Coast of Australia before passing through the Great Australian Bight then head to the east into the Tasman Sea, or west into the Indian Ocean (Basson *et al*., 2012). Migrating southern bluefin tuna tend to be found in deeper waters seaward of the continental shelf but will come in very close to shore in locations where the deep-water/shelf is close to shore. Over the summer period (December – April), southern bluefin tuna, of a range of ages and sizes are found to aggregate in large schools near the surface in the coastal waters off the southern coast of Australia, but tend to migrate to spend winters in deeper, temperate oceanic waters (DoEE, 2012).

Tagging of juvenile (1 – 4-year-old) southern blue fin tuna, has revealed that juveniles move down to the Great Australian Bight and waters south of Western Australia from spawning grounds south of Indonesia, with the Great Australian Bight representing the highest preference summer location in the Southern Ocean (Basson *et al*., 2012).

Juveniles begin moving south from spawning grounds to waters off southwest Australia when they are one year of age, with these movements aided by the southwards flow of the Leeuwin Current. These young fish are resident throughout the summer months along the southwest coast of South Australia (Fujioka *et al,* 2010), and are generally occurring in waters <200 m deep (Hobday *et al.,* 2009). As the fish age, they begin moving eastward during summer; however, some fish remain in southern Western Australia waters throughout winter.

At an age of 2 – 4 years, southern bluefin tuna are common in the Great Australian Bight during summer months, particularly in waters with a warm surface layer (17 – 22 °C) and a shallow thermocline at 60 – 80 m (Bestley *et al*., 2008). While in the Great Australian Bight, juvenile southern bluefin tuna aggregate in large schools, spending a large proportion of their time in the upper 100 m of the water column during the day (Bestley *et al*., 2009).

Aerial surveys and commercial spotting data (from spotter planes in the commercial tuna fishery) have identified that the highest densities of southern bluefin tuna are in a band inside and parallel to the continental shelf break, with the exact location varying between years (Hobday *et al.,* 2015). While the southern bluefin tuna are within the Great Australian Bight, individuals have been observed to exhibit short-term school fidelity, suggesting that schools break up and reform relatively frequently (Willis & Hobday, 2007), and that schooling behaviour is not a serious issue for juvenile southern bluefin tuna (Basson *et al*., 2012).

As the surface waters begin to cool and upwelling ceases, the southern bluefin tuna begin to leave the Great Australian Bight. Basson *et al.* (2012) revealed that 2 – 3-year-old tuna carry out annual migrations between the Great Australian Bight summer feeding grounds and winter feeding grounds located in the central and southeast Indian Ocean, or the Tasman Sea (**Figure 18**). The majority of southern bluefin tuna appear to now move west from the Great Australian Bight into the eastern Indian Ocean, with a change in preference for the Indian Ocean from the Tasman Sea since the 1990's and 2000's (Basson *et al.,* 2012; Evans *et al*., 2017). The findings of Basson *et al*. (2012) on the migrations of southern bluefin tuna to and from the Great Australian Bight can be summarised as follows:

- In summer, juvenile bluefin tuna are primarily resident in the Great Australian Bight and off southern Australia, with fish almost exclusively resident in February and March. The highest level of residency in southern Australia occurs in January through to May. Summer site fidelity is high, with all tagged fish returning to South Australia in summer;
- In winter, some individuals remain in waters off southern Australia, but most move to feeding grounds in the Indian Ocean and in the Tasman Sea. Tagging data suggests a less strong winter site fidelity, with fish often switching between the Indian Ocean and Tasman Sea foraging grounds in consecutive winters;
- Juvenile southern bluefin tuna migrate throughout the latitudinal band of approximately 30 – 40°S;
- Migrations out of the Great Australian Bight to winter feeding grounds begin in May and continue to September, although the majority of movement occurs in June to August. Migrations back to the Great Australian Bight summer feeding grounds begins in October and continues through to January, with the majority occurring in November and December;
- Movements out of the Great Australian Bight is more gradual than the return to the Great Australian Bight, with fish departing over a wide range of times and moving to a wide range of locations; and
- Juvenile southern bluefin tuna are capable of travelling up to 200 km per day when migrating, although they move on average, 100 km per day. When resident, juveniles move relatively little longitudinally, but may move up to 70 km per day.

Patterson *et al*. (2018) further adds that the migrations of southern bluefin tuna are unusual in that migrations are specific to juveniles, the timing of migrations is not synchronised and is instead highly variable, and there is no obvious latitudinal component that could be associated with seasonal temperature, nor evidence of a correlation with environmental drivers (e.g. sea surface temperature and surface chlorophyll-α).

Patterson *et al*. (2018) reports on the movements of 110 tagged juvenile southern bluefin tuna spanning 1998 – 2011. Throughout this period, juvenile southern bluefin tuna within the Great Australian Bight were consistently associated with low surface productivity. This is consistent with previous findings of southern bluefin tuna, but inconsistent with other bluefin tuna (e.g. Pacific) whose movements track seasonal productivity maxima (Boustany *et al*., 2010; Whitlock *et al*., 2015).

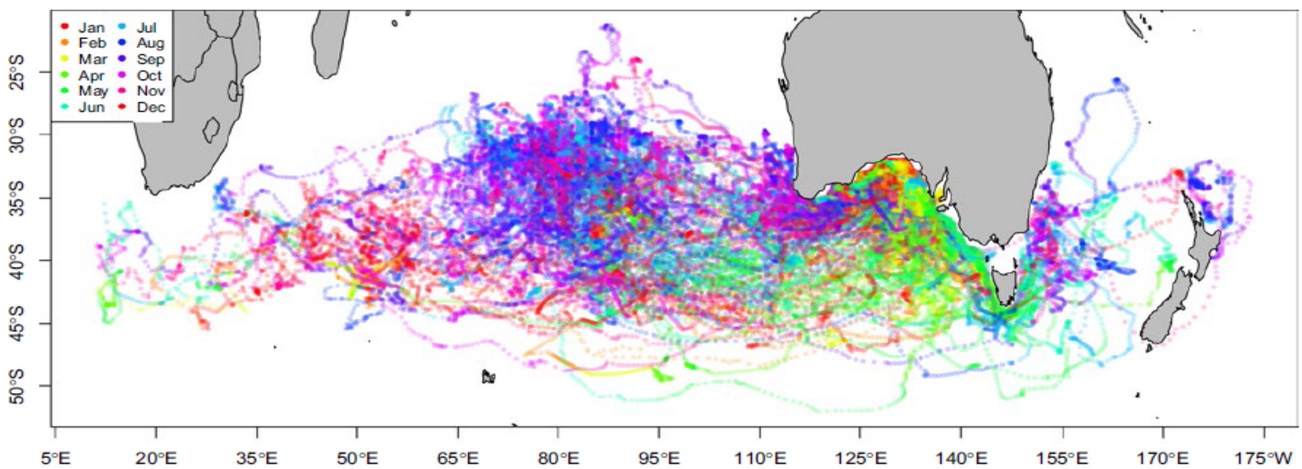
Potential explanations for this are:

- Southern bluefin tuna prefer to hunt in clear waters away from areas of high turbidity such as those associated with high primary productivity;
- The energy transfer from primary to intermediate (i.e. tuna prey) levels in the food web involves a time lag, offsetting the presence of apex predators from high levels of primary productivity; and
- Areas of concentrated productivity are likely to operate at smaller spatial scales than those at the scale that tuna residency was investigated.

The distribution of juvenile southern bluefin tuna within the Great Australian Bight is not well understood; however, anecdotal evidence in addition to tagging studies has been used to describe seasonal movements throughout the Great Australian Bight over summer – autumn. Anecdotal evidence and tagging studies suggest that the smaller, younger southern bluefin tuna (1 – 2 year olds) are more associated with inshore regions in Western Australia (Fukioka *et al*., 2010), with older fish (2 – 4 year olds) more abundant in central regions of the Great Australian Bight close to the shelf break (**Figure 19**) (Eveson & Farley, 2016; Evans *et al.,* 2017a).

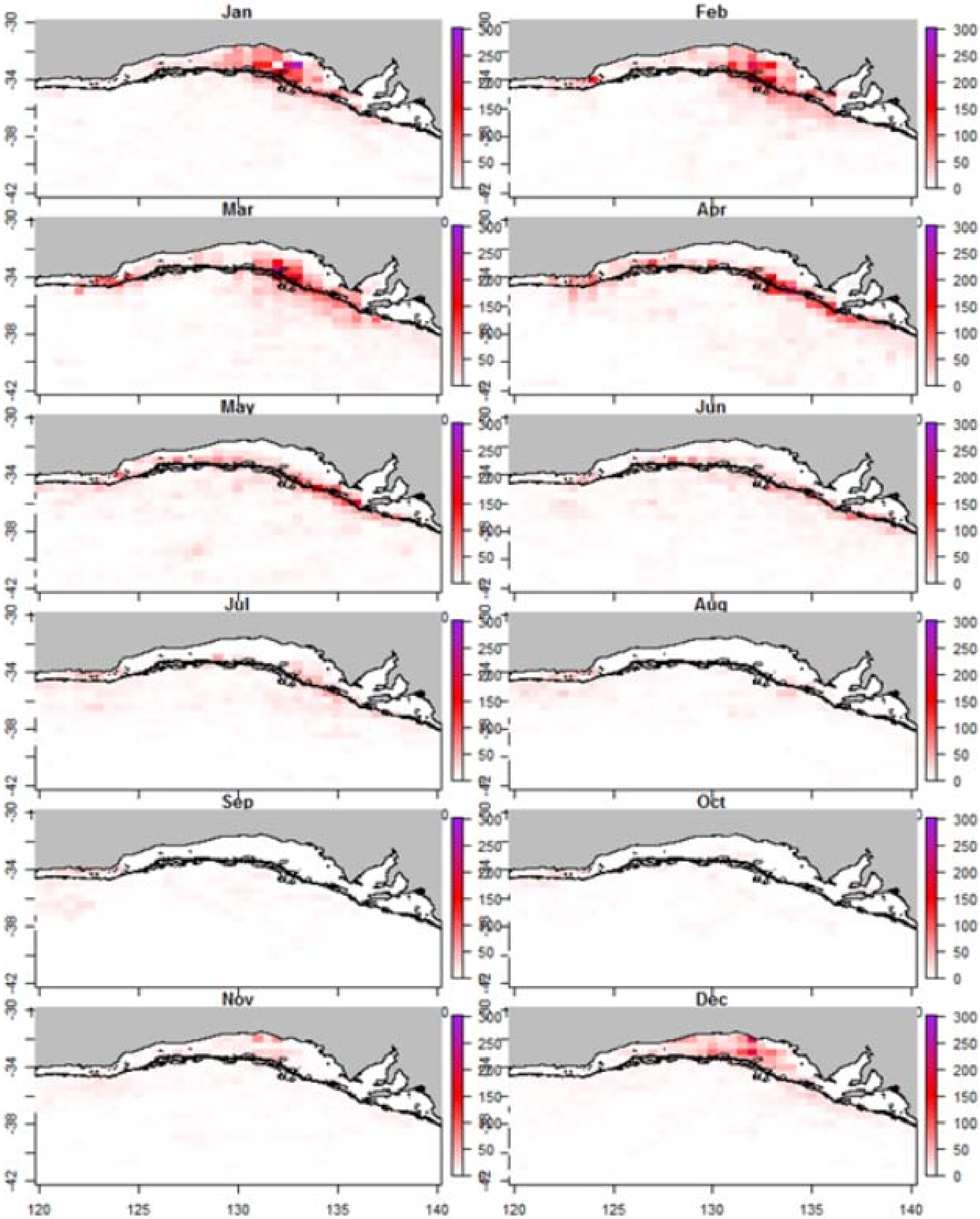
Peak periods in juvenile southern bluefin tuna residency within the Great Australian Bight broadly coincides with the high abundance of Australian sardines/pilchards (*Sardinops sagax*) (Ward *et al*., 2006a; Itoh *et al*., 2011), suggesting that juvenile southern bluefin tuna move to waters of the Great Australian Bight due to the high density of prey.

Figure 18 Estimated Movements of Juvenile Southern Bluefin Tuna (coloured by month) Derived from Deployments of Archival Tags 1998 - 2011



Source: Patterson *et al*., 2018

Figure 19 Monthly Aggregated Counts of Position Estimates Derived from Juvenile Southern Bluefin Tuna Tagged with Archival Tags 1998 – 2011 Including Bathymetric Contour Lines Associated with Shelf Breaks (black)



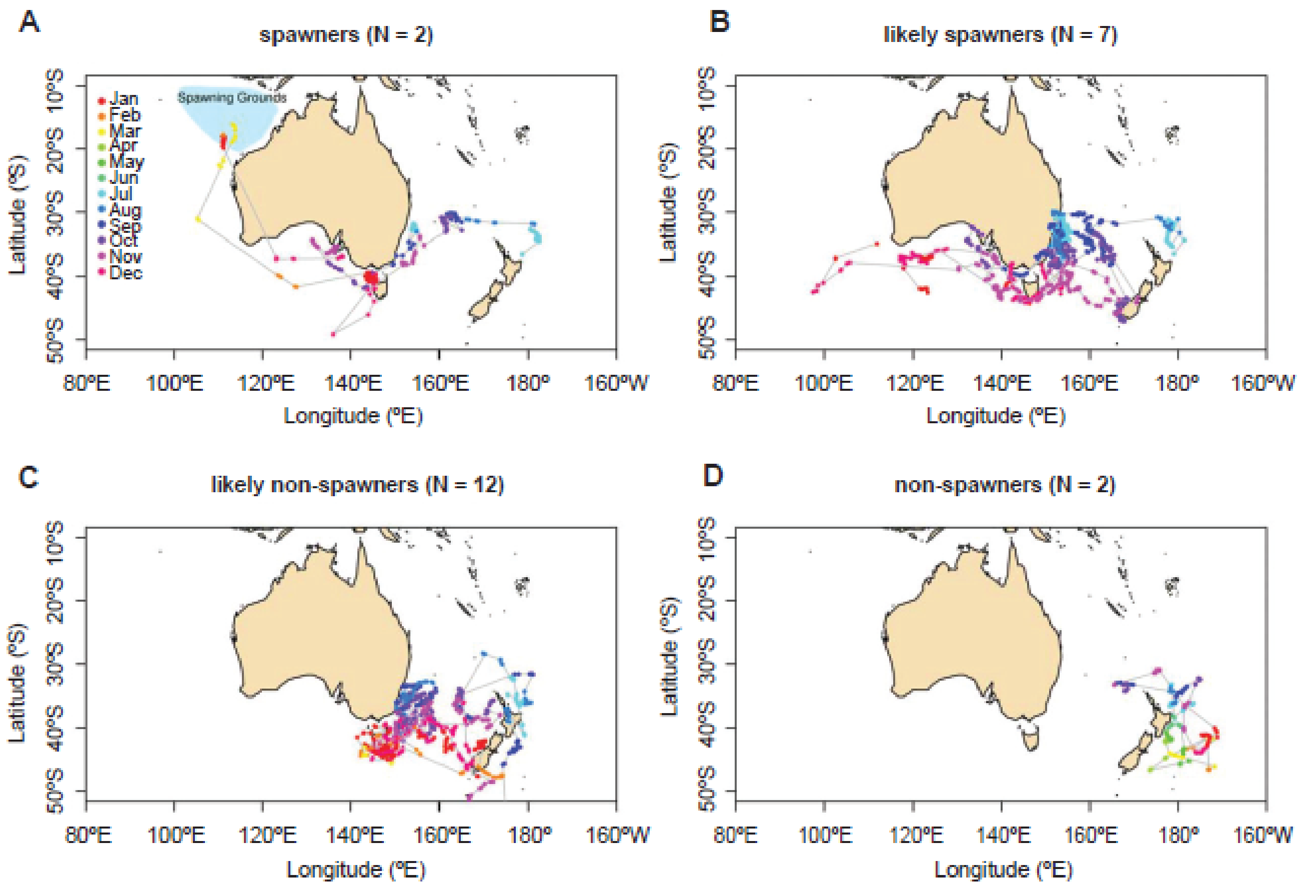
Source: Evans *et al*., 2017a

Southern bluefin tuna continue to undertake the above-described seasonal migrations until they reach approximately 5-years of age, after which they disperse throughout waters in the Pacific, Indian and Atlantic Oceans (Hobday *et al.,* 2015) during winter, before migrating to spawning grounds from spring to autumn (Caton, 1991). Adults present in the Tasman Sea move south into waters around Tasmania in the end of spring/beginning of summer.

Following this, their movements take south of Australia, then north up the Western Australia coastline towards the spawning ground (**Figure 20**). Tagged sub-adult and adult southern bluefin tuna caught in the Tasman Sea demonstrate temperature preferences for waters 18 – 20 C and depths <250 m, although depths >600 m are also utilised (Patterson *et al*., 2008). Adult movements are relatively fast and direct, lasting approximately 110 days (Hobday *et al*., 2015). Based on the tracks of tagged adult southern bluefin tuna depicted in **Figure 20**, adults may be present in the Operational Area from October to December (Patterson *et al*., 2015).

There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for southern bluefin tuna.

Figure 20 Movements of Adult Southern Bluefin Tuna Categorised by Putative Spawning Behaviour



Source: Hobday *et al.,* 2015

Key: (A) spawners showing movements from the tagging region to the spawning grounds (defined in blue); (B) likely spawners which made large westward migrations; (C) likely non-spawners remained in the Tasman Sea region until late in the spawning season and (D) non-spawners which remained resident in the Tasman for a full spawning cycle.

5.2.3.2 Elasmobranchs

Over 300 species of elasmobranchs (sharks, skates and rays) are known to inhabit Australian waters. Half of these are found nowhere else in the world. Shark species known to occur in or near to the Operational Area include white sharks, whale sharks, dogfish, school sharks, mako sharks, porbeagles, bronze whalers, gummy sharks, grey nurse sharks, Port Jackson sharks, broadnose sharks, wobblegong sharks, thresher sharks and dusky whalers. Of these, shark species which are listed on the EPBC Act list of threatened fauna are shown in **Table 18** and described below.

Table 18 Shark Species Known to Occur in or near the Operational Area

Scientific Name	Common Name(s)	EPBC Act List Status	Distribution
Carcharodon carcharias	White Shark, Great White Shark	Vulnerable, Migratory	Species or species habitat likely to occur within Operational Area
Rhincodon typus	Whale Shark	Vulnerable	Species or species habitat may occur within Operational Area
Centrophorus zeehaani	Southern Dogfish, Endeavour Dogfish, Little Gulper Shark	Conservation dependent	Species or species habitat known to occur within Operational Area
Galeorhinus galeus	School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark	Conservation dependent	Species or species habitat may occur within Operational Area
Isurus oxyrinchu	Shortfin mako	Migratory	Species or species habitat likely to occur within Operational Area
Lamna nasus	Porbeagle	Migratory	Species or species habitat likely to occur within Operational Area

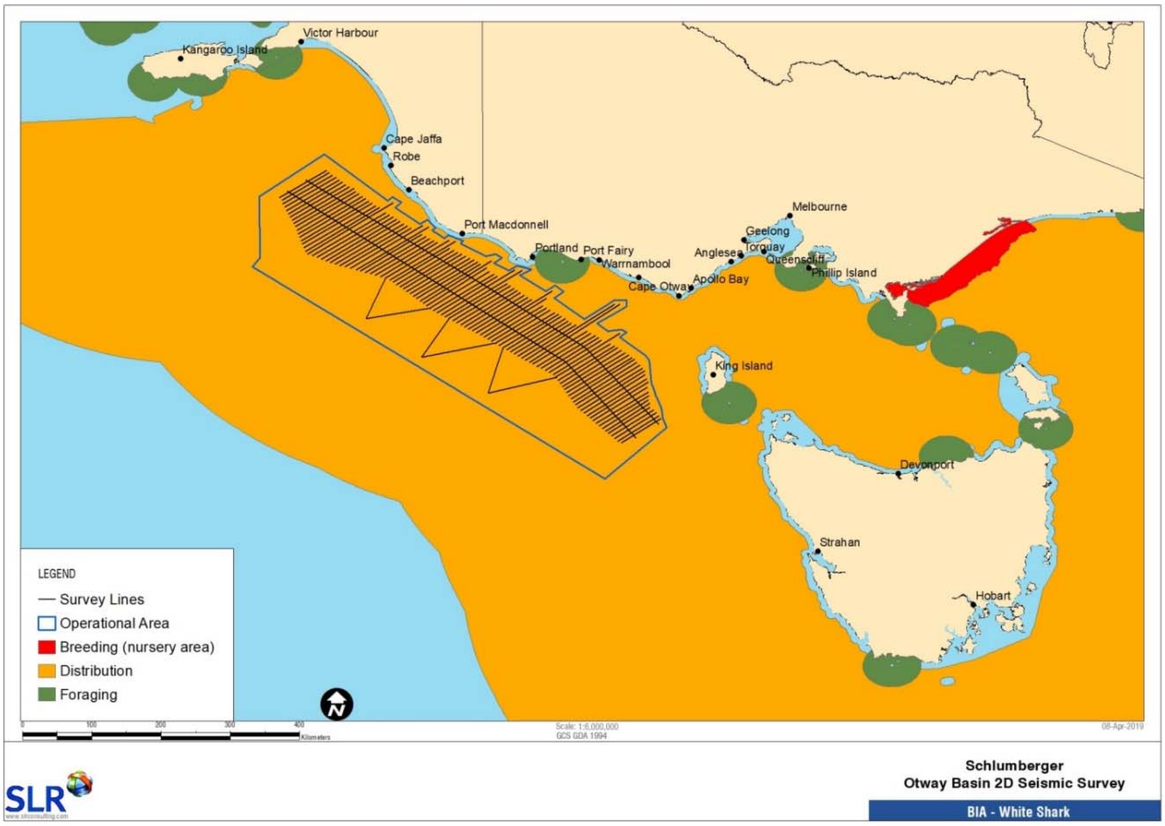
5.2.3.2.1 White Shark (*Carcharodon carcharias*)

White sharks grow to a minimum of 6 m in length and can weigh up to 3,000 kg (Mollet & Cailliet, 1996; Last & Stevens, 2009). They have been sighted in all Australian coastal areas apart from in the Northern Territory; however, they generally occur from central Queensland around the south coast to northwest Western Australia. Australian white sharks tend to move north from the south and east Australian coasts during autumn and winter, returning to southern Australian waters in late spring/early summer (Bruce *et al*., 2006). These sharks can be found in inshore and coastal waters extending to the outer continental shelf and slope (Pogonoski *et al*., 2002 in DEWHA, 2013). In southern Australian waters, white sharks have been most frequently spotted around the Neptune Islands and in areas off the Great Australian Bight. Juveniles have been recorded aggregating seasonally at Ninety Mile Beach in eastern Victoria, the Portland region of western Victoria, and the coast off the Goolwa region of South Australia (Bruce & Bradford, 2008 and DoEE, 2018d). The Portland region is within the Operational Area and most of the other areas occur within close proximity to it. Australian pupping areas are unknown although neonate white sharks have been caught as by-catch in the west Great Australian Bight and in Bass Strait (DEWHA, 2013).

White sharks are apex predators, at the top of the food chain and have a wide diet which includes finfish, other sharks and rays, marine mammals, squid, crustaceans and seabirds. These sharks are often found in areas where prey species aggregate, such as seal and sea lion colonies (DoEE, 2018d). The declining population of these apex predators and their low reproductive potential has led to them being classified as Vulnerable on the EPBC list of Threatened Species. A recovery plan, outlining the conservation requirements of white sharks across their range and identifying the actions to be taken to ensure the species' long-term viability was created in 2002 and revised in 2013 to help conserve the populations of white shark (DSEWPC, 2013). Activities related to MSSs have not been identified within this plan as a threat to the viability of white shark populations.

The Otway Basin 2DMC MSS Operational Area is within the 'indicative distribution' portion of the BIA for white sharks (**Figure 21**).

Figure 21   White Shark Biologically Important Areas of Relevance to the Operational Area



5.2.3.2.2 Whale Shark (*Rhincodon typus*)

Whale sharks are the largest known living fish species, reaching up to 12 m in length, although more commonly measuring 4 – 10 m (Colman, 1997). It is estimated that whale sharks may live for over 100 years (Taylor, 1994). These sharks have a wide, large mouth which is used to suction filter feed a range of pelagic prey including small crustaceans, schooling fishes (e.g. sardines, anchovies and mackerel), tuna and squid (Last & Stevens, 1994).

Whale sharks occur worldwide, usually in tropical and warm temperate seas between latitudes 30° N and 35° S (DoEE, 2018e). In Australia, whale sharks are most commonly seen in waters off northern Western Australia, Northern Territory and Queensland; however, they have also been sighted in New South Wales, and very occasionally in Victoria and South Australia (Last & Stevens 1994). Due to their migratory status, their preference for warm temperate seas, and the fact that they have only been observed on occasional visits to the cooler Southern Australian waters, it is unlikely that whale sharks will occur in the Operational Area during the Otway Basin 2DMC MSS.

There is no adopted Management Plan or Recovery Plan for whale sharks; however, a Conservation Advice note was established under the EPBC Act and approved on 1 October 2015. Potential impacts associated with MSSs that have been identified as threats to whale sharks within this plan include boat strike from large vessels and disturbance from marine debris. The Conservation Advice recommends minimising offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark interactions; however, as already noted above, it is unlikely that whale sharks will occur within the Operational Area.

5.2.3.2.3 Southern Dogfish (*Centrophorus zeehaani*)

Southern dogfish are small deep-water sharks which grow up to just over 1 m in length. They are demersal, living and feeding on or near the seafloor, and tend to inhabit depths of 180 – 900 m in the southeast marine region (Williams *et al*., 2012). Southern dogfish are endemic to southern Australian waters and tend to occur from Newcastle on the east coast, to Banks Strait Gullies off Tasmania, as well as off the south coast, from Warrnambool in Victoria, to Ceduna in South Australia (Commonwealth of Australia, 2015). This area includes the Operational Area. They also occur in the west Great Australian Bight and up to Mandurah in Western Australia (Commonwealth of Australia, 2015).

The southern dogfish's diet is largely comprised of fish and invertebrates, and the species is slow growing with low fecundity (Commonwealth of Australia, 2015). Under the EPBC Act they are listed as conservation dependent. There is no adopted Management Plan, Recovery Plan, or approved Conservation Advice for southern dogfish.

5.2.3.2.4 School Shark (*Galeorhinus galeus*)

School sharks are shallow-bodied bronze-grey sharks which have a long, elongated snout and a large sub-terminal lobe on their caudal fin (Stevens, 2005). Adults can grow up to 175 cm in length and individuals weigh an average of 6 – 12 kg (Last & Stevens, 1994; Daley *et al*., 2002). School sharks occur in temperate waters worldwide and, in Australia, they move extensively throughout Southern coastal waters. Their distribution extends from Moreton Bay in southern Queensland, to Perth in Western Australia (Pogonoski *et al*., 2002). They are found in shallow waters out to waters up to 550 m deep (Last & Stevens, 1994); the shallow coastal areas provide important birthing and nursery grounds (TSSC, 2009). Important pupping areas have been identified around Tasmania, particularly in the south-east, and in Victoria these include Port Phillip Bay, Western Port Bay and Corner Inlet (AFMA, 2009). These pupping areas are located to the east of the Operational Area.

School sharks have a varied diet consisting of fish and other benthic and pelagic species including cephalopods (Stevens, 2005). They are listed as conservation dependent under the EPBC Act. There is no adopted Management Plan, Recovery Plan, or approved Conservation Advice for school shark.

5.2.3.2.5 Shortfin mako (*Isurus Oxyrinchus*)

The shortfin mako is a large and fast mackerel shark, reaching up to 4 m in length and exhibiting speed bursts of 18.8 ms^{-1}. They are considered to be the fastest swimming shark species (Last & Stevens, 2009). Shortfin mako are highly migratory and occur globally in tropical and temperate waters above 16°C. They occur widely in Australia's offshore oceanic waters and are regularly recorded in the South-east Marine Region. Shortfin mako sharks are likely to occur in the offshore region of the Operational Area. These apex predators feed predominately on fish and cephalopods (Last & Stevens, 2009).

5.2.3.2.6 Porbeagle (*Lamna nasus*)

The porbeagle is a migratory species of mackerel shark with a very large dorsal fin and long, narrow pectoral fins. It can reach lengths exceeding 2 m and can weigh up to 230 kg (DoEE, 2018f). Porbeagles have a broad diet, feeding on prey such as teleost fish (mackerel, herring, cod, hake, lampfish), elasmobranchs (i.e. dogfish) and cephalopods (primarily squid) (Joyce *et al*., 2002; Last & Stevens, 2009).

Porbeagles inhabit temperate, sub-Arctic and sub-Antarctic waters in the North Atlantic and Southern Hemisphere (Francis *et al*., 2002). In Australia, they inhabit areas from southern Queensland to southwest Australia (Last & Stevens, 2009), a distribution which includes the Operational Area, and usually occur in oceanic waters and around the continental shelf. Porbeagles are listed as migratory under the EPBC Act and there is no adopted Management Plan, Recovery Plan, or approved Conservation Advice for this species.

5.2.3.2.7 Rays and Skates

The rays and skate species listed in **Table 19** have been recorded as occurring in or near the Operational Area. This includes one eagle ray species, five skate species, seven stingaree species, one fiddler ray species, and one shovelnose ray species. None of these ray and skate species are on the EPBC Act list of threatened species although the coastal stingaree (*Urolophus orarius*) is listed as endangered on the International Union for Conservation of Nature (**IUCN**) Red List.

Table 19 Ray and Skate Species Recorded as Occurring in or near the Operational Area

Scientific Name	Common Name
Eagle Rays	
Myliobatis tenuicaudatus	Southern eagle ray
Skates	
Spiniraja whitleyi	Melbourne skate
Irolita waitii	Southern round skate
Dentiraja lemprieri	Thornback skate
Dipturus cerva	Whitespotted skate
Dipturus gudgeri	Bight skate
Stingarees	
Urolophus viridis	Greenback stingaree
Urolophus cruciatus	Banded stingaree
Urolophus expansus	Wide stingaree
Urolophus gigas	Spotted stingaree
Urolophus orarius	Coastal stingaree
Urolophus paucimaculatus	Sparsely-spotted stingaree
Trygonoptera imitata	Eastern shovelnose stingaree
Trygonoptera mucosa	Western shovelnose stingaree
Fiddler Rays	
Trygonorrhina dumerilii	Southern fiddler ray
Shovelnose Rays	
Aptychotrema vincentiana	Western shovelnose ray

Note: Grey shaded species have been recorded in the Operational Area, but these represent rare sightings and their normal distribution does not normally include the Operational Area.

5.2.4 Cephalopods

All cephalopods consist of a mantle, head, and eight arms (and two long tentacles in the case of some squid). This class of animals includes cuttlefish, squid, octopus and nautilus. Cephalopods are highly significant ecologically within the marine environment, both as top-level predators and as prey for numerous vertebrates, including fish, seals, cetaceans and seabirds. Australian waters contain the highest diversity of cephalopods found anywhere in the world and, according to the Atlas of Living Australia (ALA, 2018), 26 species of cephalopods have been recorded in southern Australian waters. Cephalopods, particularly squid, are an important food source for many fish, bird, elasmobranch and marine mammal species that inhabit the Operational Area.

More than 30 cuttlefish species are known from Australian waters. Cuttlefish live in a range of habitats including reefs, sand, mud and among seagrass and seaweed. They have a lifespan of one to two years and are productive breeders. Six cuttlefish species are known to inhabit the region in or around the Operational Area (*Sepia apama, S. braggi, S. chirotrema, S. cultrata, S. hedleyi,* and *S. novaehollandiae*) occupying shallow depths up to approximately 1,000 m (ALA, 2018). There is a well-known annual migration of the Australian giant cuttlefish (*S. apama*) to the waters of the upper Spencer Gulf in South Australia every winter. This is approximately 415 km northwest of the Operational Area.

Seven squid species have been recorded in southern Australian waters according to the Atlas of Living Australia (ALA, 2018). In the southeast region, a Commonwealth fishery exists for Gould's squid, primarily operating in Bass Strait and waters adjacent to western Victoria (see **Section 5.5.2.5.8**). Gould's squid inhabit pelagic environments in water depths of up to 825 m and are most abundant from depths of 50 – 200 m over the continental shelf. Squid have rapid growth rates and most live for up to only one year, dying shortly after spawning.

Octopuses mainly live on the seafloor and are the largest predators on reefs, feeding on crustaceans and shellfish (Te Ara, 2018). Thirteen octopus species are listed in the Atlas of Australia as having been recorded in South Australian waters; these species could be present within the Operational Area but are most likely to be affiliated with reefs.

There are six living species of Nautilus, none of which have been recorded in the Operational Area. The chambered nautilus (*Nautilus pompilius*) has been recorded (rarely) to the west of the Operational Area, near Port Lincoln and Marion Bay (ALA, 2018). Nautiluses generally inhabit waters of around 300 m in depth rising to approximately 100 m during the night to feed, mate and lay eggs.

No cephalopod species are included in the EPBC Act List of Threatened Fauna.

5.2.5 Marine Reptiles

Six marine turtle species are found in Australian waters, all of which are protected under the EPBC Act 1999 and various State and Northern Territory legislation. Five out of these six species have been reported in southern Australian waters (i.e. South Australia, Victoria, and Tasmania) and two of these species; the leatherback turtle (*Dermochelys coriacea*) and the loggerhead turtle (*Caretta caretta*) have distributions which may include the Operational Area (DoEE, 2018g; DoEE, 2018h). Both species are migratory and have an EPBC Act listing status of endangered.

Leatherback and loggerhead turtles are managed under the 2017 Recovery Plan for Marine Turtles in Australia. Entanglement and ingestion of marine debris, chemical discharge (including oil from vessels), vessel disturbance (boat strike), and noise interference (including seismic surveys) have been identified within the Recovery Plan as major threats to marine turtles and are of relevance to the Otway Basin 2DMC MSS. Noise interference has been assessed as having a 'low' risk to marine turtles, while the other threats have been assessed within the Recovery Plan as 'moderate' to 'very high'. Despite these threats, there are no actions within the Recovery Plan of direct relevance to MSSs and the Otway Basin 2DMC MSS survey.

5.2.5.1.1 Leatherback turtle (*Dermochelys coriacea*)

Leatherback turtles are the largest of all sea turtles, growing up to 1.6 m in carapace length. They occur in tropical and temperate waters in Australia and are regularly seen in southern Australian waters (Bone, 1998). The South-east Marine Region (**Figure 12**) is an important feeding area for leatherback turtles and they generally feed in the open ocean on jellyfish and other soft-bodied invertebrates (Commonwealth of Australia, 2015). Breeding tends to occur in summer months, where these turtles migrate to warmer waters in Queensland or northern neighbouring countries. No nesting areas have been reported in southern Australian waters (DoEE, 2018g).

Leatherback turtles are listed as Endangered and Migratory under the EPBC Act A Conservation Advice was approved for leatherback turtles on 17 December 2008. Threats listed under this Conservation Advice of relevance to the Otway Basin 2DMC MSS include boat strike and ingestion of marine debris.

5.2.5.1.2 Loggerhead turtle (*Caretta caretta*)

Loggerhead turtles generally occur in tropical, subtropical and warm temperate waters. They only rarely occur in Bass Strait and southern Australian waters and as such, are unlikely to be present in the Operational Area. The carapace of this species grows to approximately 1 m and like leatherback turtles, loggerheads are carnivorous and breed during late spring and early summer in more northern waters (DoEE, 2018h).

Loggerhead turtles are listed as Endangered and Migratory under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan for loggerhead turtles.

5.2.5.1.3 Sea Snakes

Thirty of the 70 known sea snake species worldwide occur in Australian waters. Sea snakes generally live in surface waters and occur at depths that rarely exceed 30 m (Cogger, 1975). Therefore, there is potential for them to be influenced by activities occurring in these environments. However, most sea snakes live in coastal tropical waters and as such, their Australian distribution is concentrated in the more northern regions and they occur very rarely in southern Australian waters.

The yellow-bellied sea snake (*Pelamis platurus*) has been recorded in Tasmania and Victorian waters so, although highly unlikely, it could potentially occur within the Operation Area (Australian Museum, 2018). However, note that the present distribution of this species, based on best available knowledge, does not include southern Australian waters (DoEE, 2018i). This sea snake feeds in the pelagic zone and is the most pelagic of all know sea snakes. It often occurs in calm areas and those with marine debris (Kropach, 1971) and is usually found within a few kilometres of the coast. The yellow-bellied sea snake is listed as marine under the EPBC Act, but it is not considered to be threatened. There is no approved Conservation Advice or Recovery Plan for yellow-bellied sea snakes.

5.2.6 Cetaceans

Toothed whales (suborder Odontoceti) and baleen whales (suborder Mysticeti) comprise the 45 cetacean species that have been recorded in the wider South-east Marine Region (Commonwealth of Australia, 2017).

Baleen whales (characterised by baleen plates in the mouth) occur throughout the world in coastal areas out to deep pelagic waters (Clapham *et al*., 1999). Most baleen whales undertake large seasonal migrations between summer feeding grounds in polar waters and winter mating and calving areas in the tropics (Pomilla & Rosenbaum, 2005). Migration routes vary between species; however, high mobility and movement across international boundaries are features of most baleen whales (Clapham *et al*., 1999).

The toothed whales are characterised by teeth instead of baleen, use specialised echolocation, and are found in all oceans across a range of habitats (Hooker, 2009). Unlike baleen whales, toothed whales do not carry out large migrations and instead tend to remain resident in an area (Berkenbusch *et al.,* 2013). Toothed whales include the large sperm whales as well as all species of dolphin.

The sections below summarise the cetacean species which have been identified by Commonwealth of Australia (2015) as potentially present within the Operational Area based on predicted distributions that have been determined by ecological data and research information. Where possible, a discussion on the distribution, seasonality, and vocalisations of each species has been provided.

An assessment of the likelihood of each species being encountered in the Operational Area during the Otway Basin 2DMC MSS has been made based on the definitions provided in the EPBC Act Policy Statement 2.1 (see **Section 2.2.1**). To aid in this, an assessment of the likely timing of cetacean presence within the Operational Area has been undertaken within **Table 20**.

Table 20 Timing of Cetacean Presence within Operational Area

Species	January	February	March	April	May	June	July	August	September	October	November	December
Baleen Whales												
Southern right whale												
Pygmy right whale												
Minke whale												
Sei whale												
Bryde's whale	Seasonality unknown											
Blue whale												
Fin whale												
Humpback whale				North							South	
Toothed Whales												
Sperm whale	Seasonality unknown											
Pygmy sperm	Seasonality unknown											
Common dolphin												
Long-finned pilot whale												
Short-finned pilot whale												
Risso's dolphin	Seasonality unknown											
Hourglass dolphin	Seasonality unknown											
Dusky dolphin	Seasonality unknown											
Southern right whale dolphin	Seasonality unknown											
Killer whale												
False killer whale												
Common bottlenose dolphin												
Indian Ocean bottlenose dolphin	Seasonality unknown											
Spectacled porpoise	Seasonality unknown											

Key:

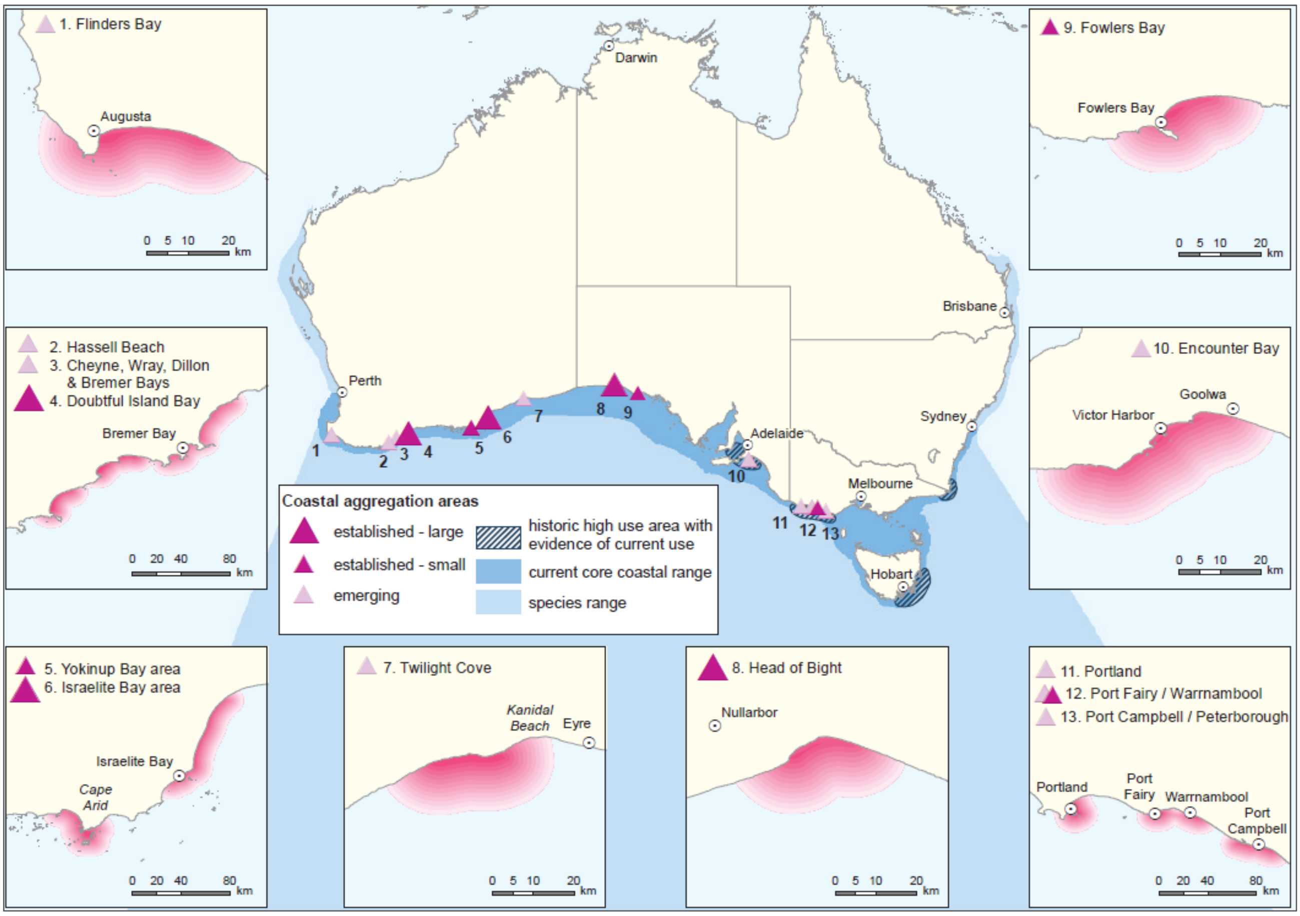
Breeding/calving		Peak breeding/calving	
Presence during migrations/movements		Resident population, or consistent presence of transients	
Feeding		Peak feeding	
Most likely time of presence with unspecified activity – most likely feeding			

5.2.6.1 Baleen whales (suborder Mysticeti)

5.2.6.1.1 Southern right whale (*Eubalaena australis*)

Southern right whales have a circumpolar distribution throughout the Southern Hemisphere between 16°S and 65°S and occur throughout Australia's southern coastline as far north as Sydney on the east coast and Perth on the west coast. In coastal habitats they are usually within 2 km of the shore where they tend to be distinctly clumped in aggregation areas (**Figure 22**) (Commonwealth of Australia, 2012), and undertake coast-wide movements (Burnell, 2001). Depth appears to be the most influential determinant for habitat selection, with whales preferentially occupying water depths less than 10 m at coastal aggregation areas (Pirzl, 2008). Southern right whales in Australia travel as far south as 65°S during foraging movements (Bannister *et al*., 1999), while calving and non-calving animals have been known to move between Australia and sub-Antarctic New Zealand coastal habitat (Pirzl *et al*., 2008). Feeding/foraging grounds are found in cool Southern Ocean waters and are occupied by southern right whales during summer months (Commonwealth of Australia, 2012), with the preferred feeding ground for each whale culturally inherited through the maternal line (i.e. whales forage at the same grounds as their mother) (Valenzuela *et al*., 2009; Carroll *et al*., 2015). Historically, whales migrating north along the east coast of Tasmania moved from east to west along the southern coast of south and Western Australia, with this migratory pattern thought to still be extant (Kemper *et al*., 1997; Burnell, 2001).

Figure 22 Coastal Aggregation Areas for Southern Right Whales



Source: Adapted from Commonwealth of Australia, 2012

Southern right whale coastal calving/nursery grounds occur in shallow coastal waters between 16°S and 52°S (IWC, 2010). Australian calving/nursery grounds are occupied from May to October (Commonwealth of Australia, 2012). Female-calf pairs remain at the calving grounds for 2 – 3 months (Burnell & Bryden, 1997), while most of the other population classes have departed the coast by September (Burnell, 2001). There is no evidence that mothers are feeding during the initial months of lactation at calving/nursery grounds (Miller *et al*., 2012). The Warrnambool Region (shown as Area 12 on **Figure 22**) is considered to be a principal/established calving area for the south-east population (Commonwealth of Australia, 2012) and overlaps with a small portion of the Operational Area. Also located in this region are the Portland (Area 11, **Figure 22**), Port Fairy (Area 12, **Figure 22**), and Port Campbell/Peterborough (Area 13, **Figure 22**) emerging aggregation areas. Emerging aggregation areas are those that are not occupied every winter, but in some winters contain more than a threshold number (i.e. more than three) of calving females at the peak of the season. These areas may become established aggregation areas over time (Commonwealth of Australia, 2012). This species has a three-year calving cycle; a resting year with no migration follows the year of calving, then a mating year during which animals migrate to areas alternate to their selected calving ground (Brandão *et al*., 2011), with the selected calving ground based on maternal site fidelity (Burnell, 2001; Patenaude *et al*., 2007). Genetic differences have demonstrated that southern right whales in Australian waters comprise two demographically separate populations that may interact for the purpose of mating; a south-east Australia and a south-west Australia population (Carroll *et al*., 2011). The south-east population is considered to be demographically small, with population estimates in 1993 suggesting only 76 whales belong to this population (Kemper *et al*., 1997). Carroll *et al*. (2011) has suggested that loss of 'cultural memory' (i.e. the passing on of information through generations) may restrict the ability of the south-east population to increase.

Gill *et al*. (2015) carried out aerial surveys of cetaceans from western Bass Strait to the eastern Great Australian Bight between 2002 and 2013. Although effort within this survey was biased towards coverage of the Bonney Upwelling and the corresponding presence of pygmy blue whales (i.e. November – April), effort occurred within all months. Throughout the study, a total of 12 sightings making up 52 individual southern right whales were noted, with all sightings made between June and September. Despite the highest sighting effort occurring for blue whales in November to April, no southern right whales were observed during this period. Southern right whales occurred in shallower waters than all other cetacean groups in depths, with all sightings of this species occurring in the depth band of 0 – 100 m (average water depth for this species was not reported). Southern right whale cow/calf pairs and mating behaviours were regularly observed in winter (Gill *et al*., 2015). Based on these findings, it would appear that the presence of southern right whales in the Otway region occurs in winter, and is not related to the presence of summer upwelling systems (i.e. the Bonney Upwelling); however, while the Gill *et al*. (2015) survey provides an extensive data-set spanning numerous years, the authors note that care must be taken with regard to conclusions about temporal occurrence due to unequal effort across seasons and the rarity of most species.

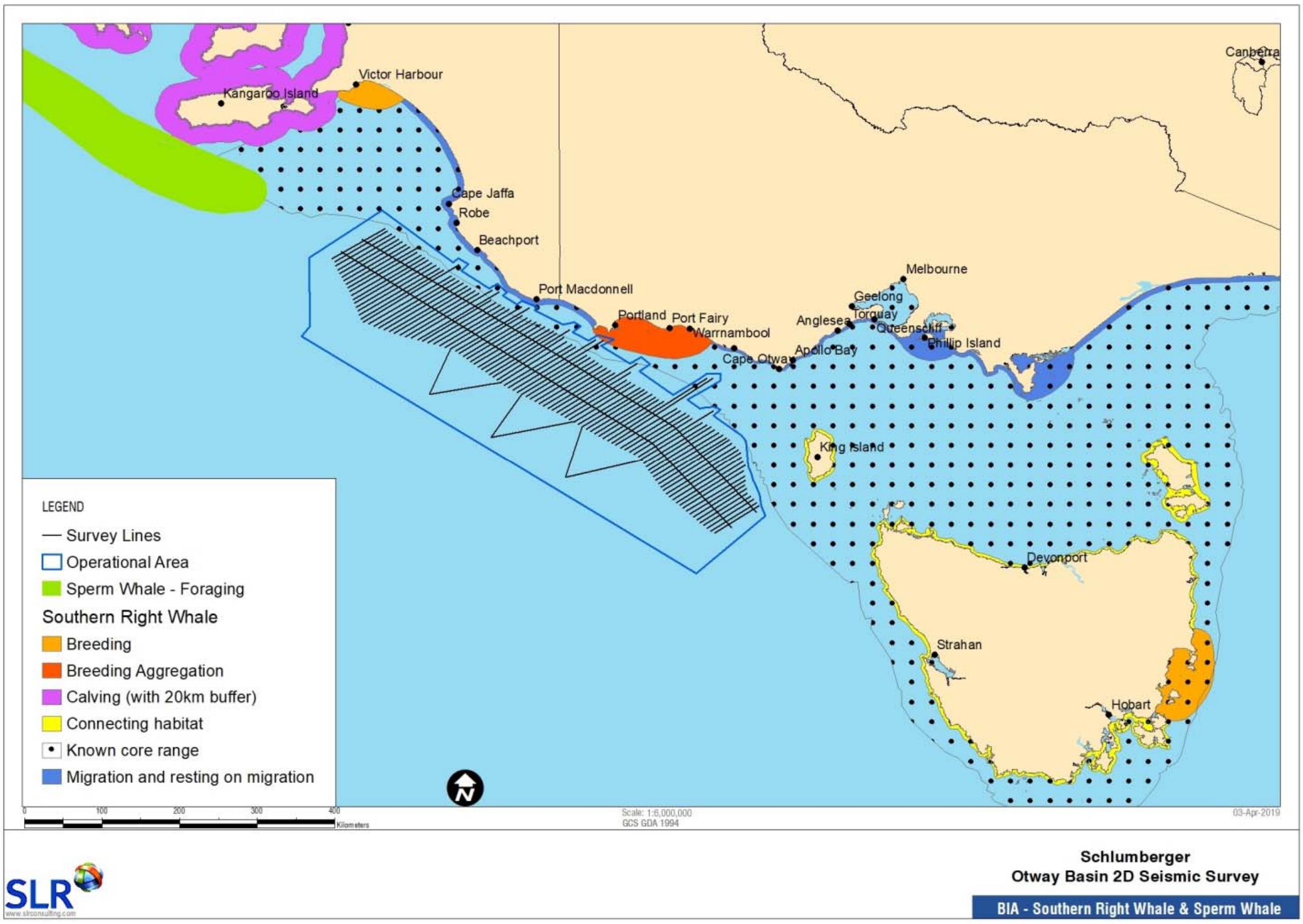
Southern right whales produce low-frequency social sounds including stereotyped upcalls used as contact calls and other tonal sounds for mate attraction (Parks & Tyack, 2005). Such vocalisations range in frequency from 50 – 600 Hz (Parks *et al*., 2007; 2011) at sound levels from 172 – 187 dB re 1 µPa @1 m (as referenced in Erbe, 2002).

The coastline inshore of the Operational Area covers part of the southern right whale BIA in the South-east Marine Region (**Figure 23**). This BIA was established to encompass the following areas as defined by Commonwealth of Australia, 2012:

- Large established aggregation areas used for calving and nursing. Established aggregation areas are important for recovery as they are the sites of highest calf production and contribute most to overall abundance increases;

- Small and potentially emerging areas used for calving and nursing. These areas are important for recovery in terms of expanding the habitat occupancy of southern right whales and contributing to the maintenance of genetic diversity. Emerging areas will contribute to overall population increases and enable calf production to regularly occur at a greater number of sites as recovery progresses;
- Coastal connecting habitat. This may serve a migratory function, or encompass locations that will emerge as calving habitats following recovery progress; and
- Historic high use areas or suitable habitat in parts of the coastal range currently not used or under-used and potentially important to support full spatial recovery. Sighting records suggest a number of additional BIAs are emerging within these areas.

Figure 23 Southern Right Whale and Sperm Whale Biologically Important Areas of Relevance to the Operational Area



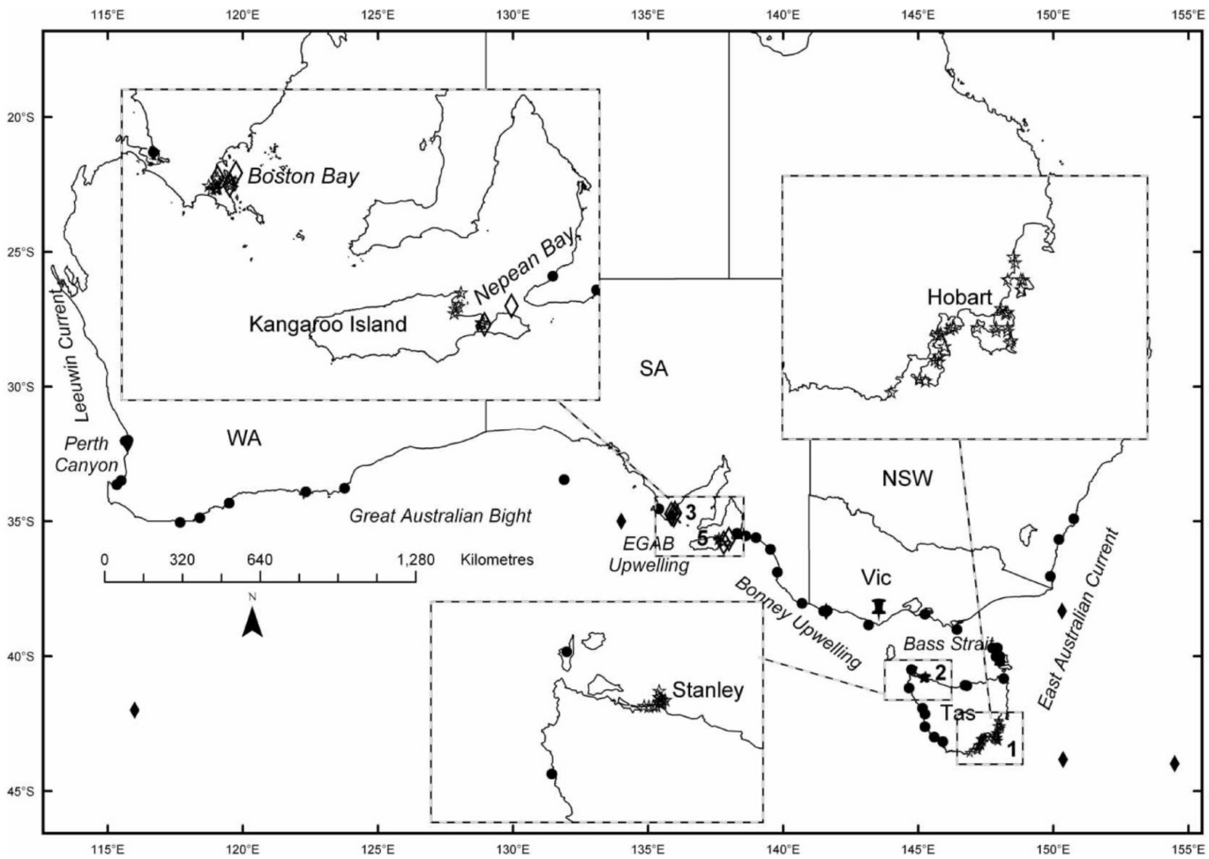
The likelihood of encountering southern right whales during the Otway Basin 2DMC MSS has been assessed to be '**moderate**' as there is the potential for some spatial and temporal overlap between the presence of this species and the Otway Basin 2DMC MSS, particularly in the inshore portion of the Operational Area and given that the survey timeframe starts at the end of the southern right whale breeding season (October).

Southern right whales are listed under the EPBC Act as *endangered*, *migratory* and *cetacean*. Due to their 'endangered' listing, southern right whales are managed under the 2011 – 2021 'Conservation Management Plan for the Southern Right Whale' (Commonwealth of Australia, 2012). Noise interference has been identified within the Conservation Management Plan as a threat to southern right whales, particularly within or close to aggregation areas where calves are present.

5.2.6.1.2 Pygmy right whale (*Caperea marginata*)

Pygmy right whales are the smallest, most cryptic and least known of the living baleen whales (Fordyce & Marx, 2012). They are found in the Southern Hemisphere's temperate and sub-Antarctic waters where surface temperatures are 5 – 20°C (Kemper, 2002). There have been more sightings of pygmy right whales in Australian waters than anywhere else in their range (Kemper, 2002). Kemper *et al.* (2013) reported the presence of two coastal 'hot spots' within, or in close proximity to, the Operational Area based on stranding and sighting records (**Figure 24**); Boston Bay in South Australia (370 km northwest of the Operational Area), and Perkins Bay (153 km to the east of the Operational Area) in north-west Tasmania. South Australia and western Victoria had more events (32% of all Australian records) than other regions on Australia's mainland, and overall had the most sightings of live whales. Almost all of the sightings were very close to shore (i.e. <2 km). A number of sighted whales were observed within the hotspots for more than one day, suggesting that these animals were not simply transiting the area. While records were made throughout the year, there was a trend of higher monthly frequencies during the austral spring and summer (September – February) (Kemper *et al.*, 2013). The distribution of pygmy right whales at these 'hotspots' was attributed by Kemper *et al.* (2013) to the presence of large upwelling systems bringing high abundances of zooplankton.

Figure 24 Distribution of Pygmy Right Whale Stranding's and Sightings off Australia



Source: Kemper *et al.*, 2013

Little information is known on the vocalisations of pygmy right whales, although it has been assumed that communication is similar to other baleen whales, in that this species communicates using loud low-pitched sounds (WhaleFacts, 2018). Recordings of a juvenile pygmy right whale documented paired short thump-like pulses or tone bursts with a down-sweep in frequency and decaying amplitude. Most of the energy of this call was between 60 and 120 Hz. Recorded source levels were in the lower end of the range of other baleen whales (Dawbin & Cato, 1992).

The likelihood of encountering pygmy right whales during the Otway Basin 2DMC MSS has been assessed to be '**low**'; as although the Operational Area is relatively proximate to known feeding 'hotspots', most sightings are within 2 km of the shore. However, the operational timeframe coincides with the key feeding times of pygmy right whales (September to February).

Pygmy right whales are listed as *migratory* and *cetacean* under the EPBC Act. There is no approved Conservation Advice, adopted Management Plan, or Recovery Plan for pygmy right whales.

5.2.6.1.3 Minke whales (*Balaenoptera acutorostrata* and *B. bonaerensis*)

Two species of minke whale occur in Australian waters; Antarctic minke (*Balaenoptera bonaerensis*) and dwarf minke (*B. acutorostrata*). Antarctic minkes undergo extensive migrations between summer feeding grounds in Antarctica and winter sub-tropical to tropical breeding grounds (Perrin & Brownell, 2002). The northward range of Antarctic minkes is restricted by the presence of warmer waters extending south along Australia's coasts (DoEE, 2018j). Dwarf minke whales migrate further north than Antarctic minke whales (Perrin & Brownell, 2002), and although sighting records exist from Victoria, the majority of sightings of dwarf minke whales in Australia have been from northern New South Wales to northern Queensland (Arnold *et al.*, 1987). Based on sighting records, Arnold *et al*. (1987) suggests minke whale abundances in Australian waters peak in July and August.

Recordings of a population of dwarf minke whales off Great Barrier Reef revealed complex vocalisations that span a wide frequency range (50 Hz – 9.4 kHz) and are composed of distinct repeated units. Broadband source levels for the recorded vocalisations were calculated to be 150 – 165 dB re 1 µPa @ 1 m (Gedamke *et al*., 2001).

Based on sighting records, the likelihood of encountering minke whales during the Otway Basin 2DMC MSS has been assessed to be '**low**'. The Operational Area does not spatially or temporally overlap with any biologically important habitat for Antarctic or dwarf minke whales, with their distribution in Australian waters considerably further south than the Operational Area. Dwarf minke whales (*B. acutorostrata*) are listed as *cetacean* under the EPBC Act, while Antarctic minkes (*B. bonaerensis*) are listed as *migratory, cetacean*. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for minke whales.

5.2.6.1.4 Sei whale (*Balaenoptera borealis*)

Sei whales tend to prefer warmer water temperatures than other baleen whales (Mizroch *et al.*, 1984); their preferred water temperature is between 8 and 18°C (Horwood, 2009). A number of sightings of sei whales have been reported for the Victoria waters (including within the Operational Area) and off Tasmania (Kato *et al.,* 1996; Gill, 2002), mainly during summer and early autumn months (Gill, 2002). Sei whales have been sighted 20 – 60 km offshore in the Bonney Upwelling (Miller *et al*., 2012a) between November and May (Gill *et al.,* 2015). Females with calves have been observed south of Tasmania (Ensor *et al*., 2002).

Sei whale vocalisations have been recorded as low-frequency down-sweep calls that sweep from 82 to 34 Hz over 1.4 seconds, most often produced as a single call but occasionally as pairs or triplicates (Baumgartner *et al*., 2008). As well as low-frequency tonal and swept calls, McDonald (2006) also recorded broadband sounds described as 'growls' or 'wooshes'. The maximum source level of tonal calls recorded by McDonald (2006) was 156 ±3.6 dB re 1 µPa @ 1 m.

The likelihood of encountering sei whales during the Otway Basin 2DMC MSS has been assessed to be '**moderate**', as the Operational Area is spatially and temporally proximate to a known feeding area (Bonney Upwelling), particularly throughout the summer period.

Sei whales are listed as *vulnerable*, *migratory*, and *cetacean* under the EPBC Act. There is no adopted Management Plan or Recovery Plan for sei whales; however, a Conservation Advice note was established under the EPBC Act and approved on 1 October 2015. The Conservation Advice recommends further research into the spatial and temporal distribution of this species to enable a better understanding of the potential impacts of underwater noise, including seismic surveys, and to ensure the ongoing recovery of sei whales.

5.2.6.1.5 Bryde's whale (*Balaenoptera edeni*)

The distribution of Bryde's whales is typically restricted to tropical and warm temperate waters with a latitudinal range of between 40°N and 40°S (Kato, 2002). Bryde's whales have been sighted in Victoria; however, they are more likely to be found along Australia's west and east coasts, with the south coast not an important location for this species (Bannister *et al.,* 1996). A point of difference between Bryde's whales and other baleen whales is that they do not migrate (Kato, 2002).

Oleson *et al*. (2003) analysed Bryde's whale calls from the Eastern Tropical Pacific, the Caribbean, and the Northwest Pacific. Whilst they concluded that regional variations in calls were present, Bryde's whales typically produce low frequency 'tonal' and 'swept' calls that are not dissimilar to other baleen whales. Virtually all calls analysed had a fundamental frequency below 60 Hz and were produced in extended sequences (Oleson *et al.*, 2003).

The likelihood of encountering Bryde's whales during the Otway Basin 2DMC MSS has been assessed to be '**low**', with the Operational Area outside of the typical distribution of this species.

Bryde's whales are listed as *migratory* and *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for Bryde's whales.

5.2.6.1.6 Blue whale (*Balaenoptera musculus*)

There are two subspecies of blue whale recognised in the Southern Hemisphere; the pygmy blue whale (*B. musculus brevicauda*) and the Antarctic blue whale (*B. musculus intermedia*). These two subspecies are difficult to distinguish without the use of genetic techniques, but differ in morphology, distribution, and vocal behaviour. Following an analysis of acoustic detections, and stranding, sighting and historical catch records, Branch *et al*. (2007) concluded that the majority of blue whales in the Australian region are probably pygmy blue whales, but that a few Antarctic blue whales may migrate to Australia in the austral winter.

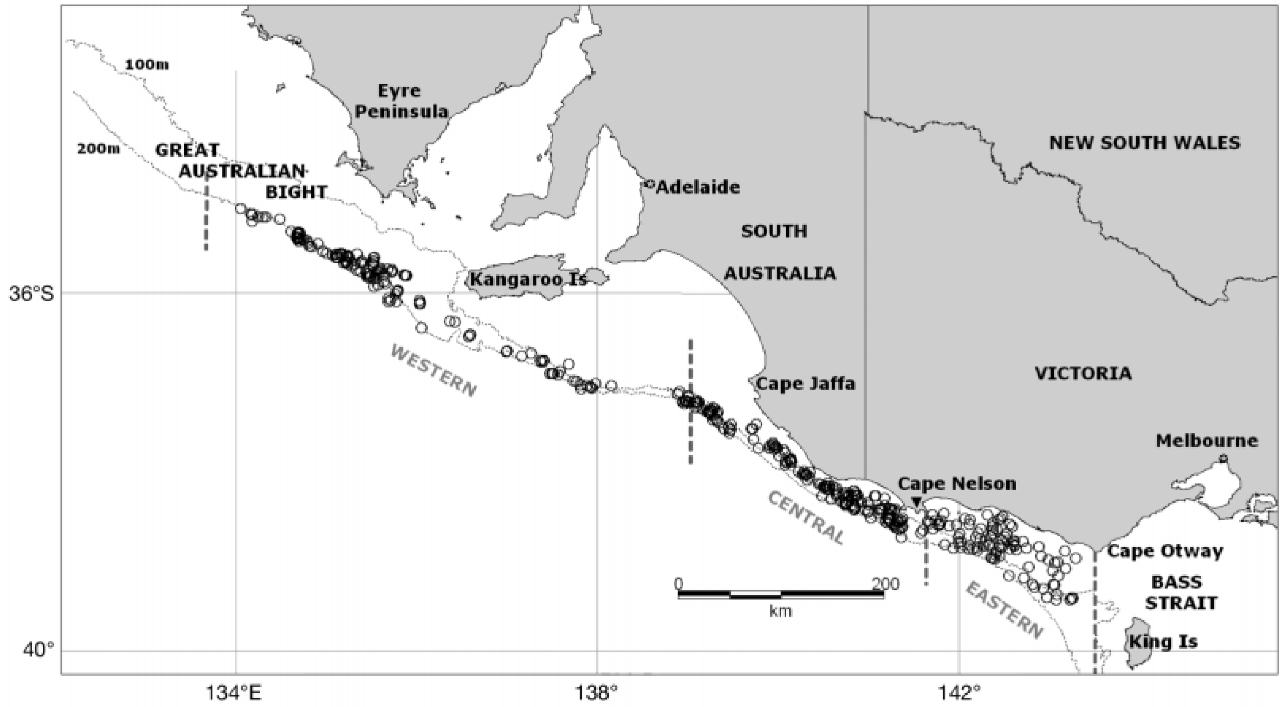
Pygmy blue whales use the western coast of Australia as part of their migratory route to and from breeding grounds. Breeding grounds of blue whales present in Australian waters are believed to include Indonesia (Branch *et al.,* 2007) and the Solomon Islands (Paton & Gibbs, 2003). During these migrations, pygmy blue whales travel along the shelf edge in water depths 500 – 1,000 m (Double *et al*., 2014). Acoustic recordings suggest that Antarctic blue whales travel along Western Australia and Tasmania when migrating between Antarctica and more northern wintering grounds (Stafford *et al*., 2004). There are two known summer feeding aggregations of pygmy blue whales in Australia; at the Perth Canyon off Western Australia (Rennie *et al*., 2009), and at the Bonney Upwelling and adjacent waters off South Australia and Victoria (Gill, 2002). The Bonney Upwelling feeding aggregation lies within the boundaries of the Operational Area. Genetic evidence supports the hypothesis that whales utilising both feeding grounds are of the same breeding stock (Attard *et al*., 2010).

Each summer blue whales aggregate in warmer waters directly adjacent the Bonney Upwelling system (see **Section 5.1.3**) off southern Australia (**Figure 25**) to feed on krill (*Nyctiphanes australis*) (Gill *et al.,* 2011). The Bonney Coast Upwelling is the largest and most unpredictable of upwellings in south-eastern Australia and represents a critical foraging area for blue whales. For this reason, the upwelling has been identified as a BIA for blue whales (Conservation Values Atlas, 2018). Within the upwelling system, the fine scale distribution of blue whales varies according to the local prevalence of krill, but in general foraging occurs in the west of the system early in the upwelling season, spreading eastward between Cape Jaffa and Cape Otway until April, then returning back towards the west prior to departure for winter grounds in April or May (Gill *et al.,* 2011). The area of coastline between Cape Jaffa and Cape Nelson (referred to as the 'Central' region, (**Figure 25**)) was the most consistently utilised area. Blue whales are present in this region from November, with abundances peaking in February before declining, suggesting a gradual movement out of this region from March to May. From Cape Nelson to Cape Otway (the 'Eastern' region, (**Figure 25**)), blue whale numbers increase from December, with abundances peaking in February followed by a decline through April and May. Within the Eastern region, blue whales are found have a more inshore distribution in February (Gill *et al.,* 2011). The majority of sightings of blue whales between Cape Jaffa and Cape Otway (i.e. within the Operational Area) occur in water depths ≤200 m (Gill *et al.,* 2011). As there was no visible krill at the surface of the majority of sightings (52%), the blue whales sighted were either in transit or feeding deeper in the water column (Gill *et al.,* 2011).

The findings of the aerial surveys performed by Gill *et al*. (2011) supports and adds to the findings of Gill (2002) which identified localised aggregations of blue whales feeding on coastal krill in southern Australian coastal waters from December to May and a noticeable absence of blue whales from the area in winter and spring months. Aggregations identified by Gill (2002) were to the west of the Operational Area, with blue whale distribution mirroring that of krill. Branch *et al.* (2007) analysed historic acoustic detections (see **Figure 26**) and found a peak in call rate of pygmy blue whales within the Australian region from February to May, and a limited number of Antarctic blue whale calls from May to October.

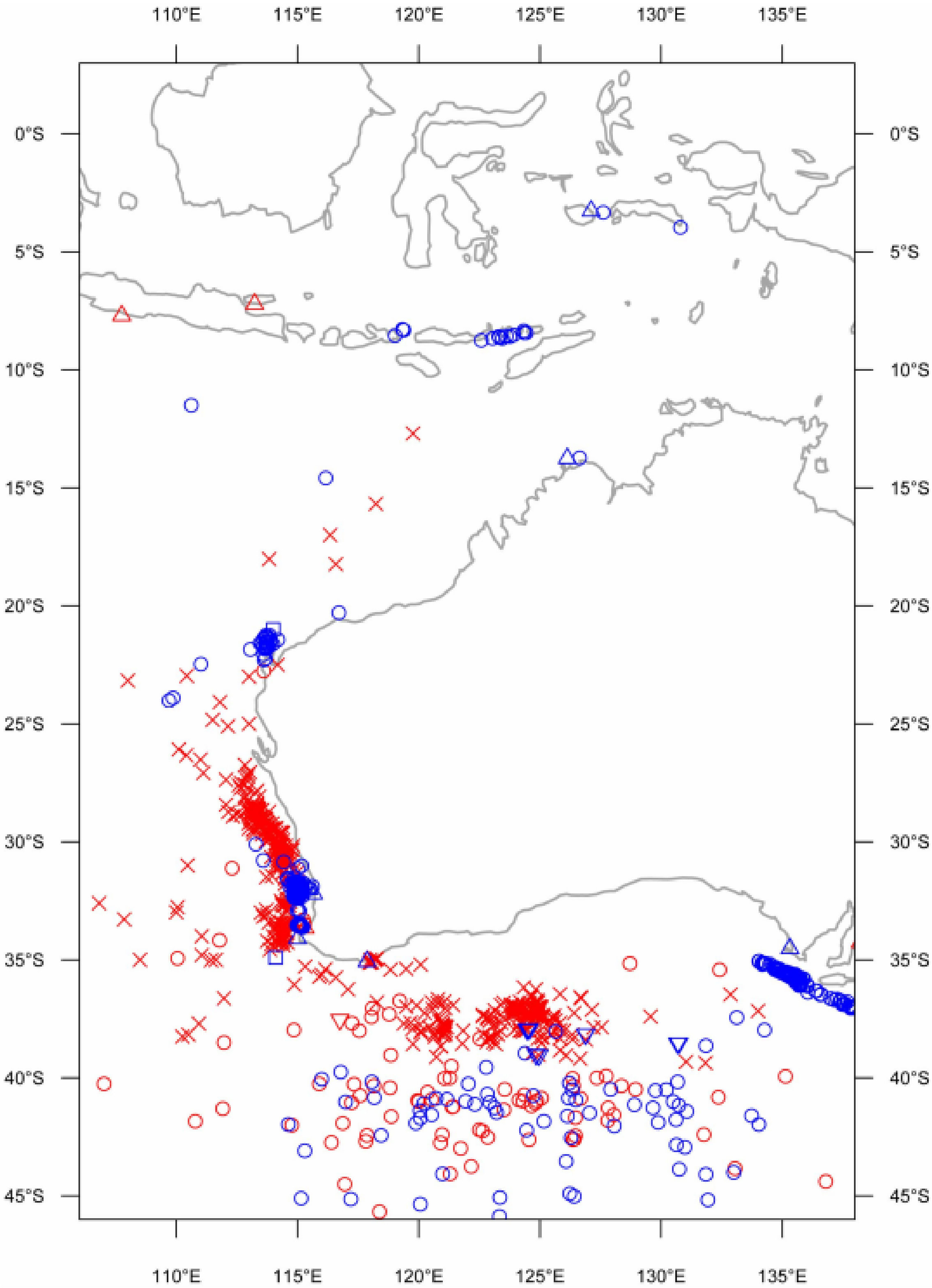
The movement of Antarctic blue whales is poorly understood, although Antarctic blue whales tend to have a more southern distribution than pygmy blue whales (Commonwealth of Australia, 2015a).

Figure 25 Distribution of Blue Whale Sightings, 2002 – 2007



Source: Gill *et al.*, 2011

Figure 26 Historic Catch (x), Sighting (o), Stranding (Δ), Acoustic Recordings (▫) and Discovery Mark (▽) Data of Pygmy Blue Whales



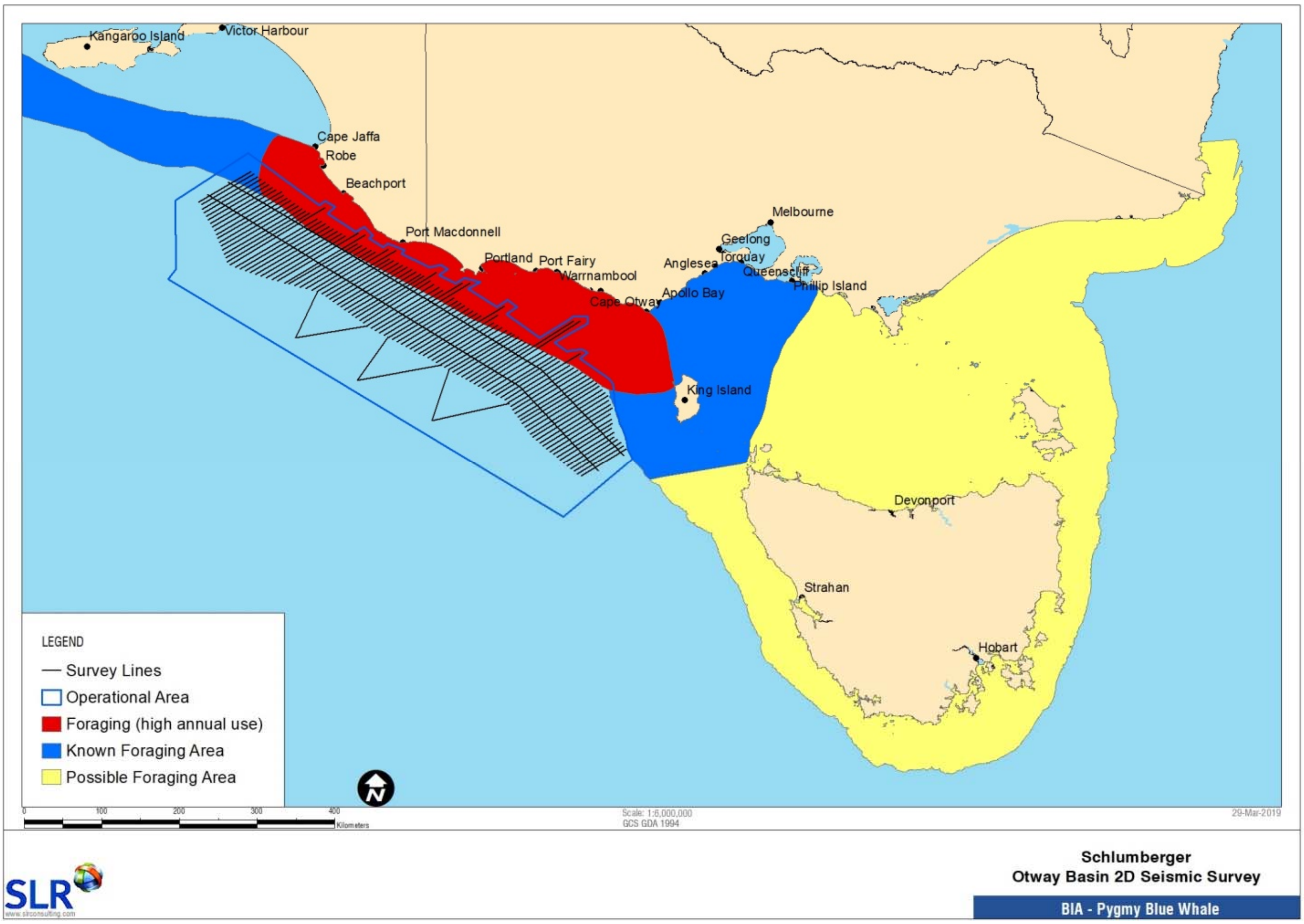
Source: Double *et al.* (2014) – modified from Branch *et al.* (2007)

Blue whales vocalise at a low frequency (average of 0.01 – 0.110 kHz) (McDonald *et al.*, 2001; Miller *et al.*, 2014), meaning that their calls travel hundreds of kilometres underwater. Vocalisations of pygmy blue whales off Cape Leeuwin (Western Australia) have been characterised as songs of either two or three repeating tonal sounds with harmonics (Gavrilov *et al.,* 2011). The most intense tonal sounds were recorded to have a source level of 179 ±2 dB re 1 µPa @ 1 m. Weaker short-duration calls of impulsive down-swept sounds were estimated to have source levels of 168 – 179 dB re 1 µPa @ 1 m (Gavrilov *et al.,* 2011).

While the majority of blue whales within the Operational Area are likely to be pygmy blue whales, the presence of Antarctic blue whales cannot be completely ruled out. The summer timing of the Otway Basin 2DMC MSS reduces the likelihood of encountering Antarctic blue whales to '**low**'.

The Operational Area overlaps with a BIA for pygmy blue whales (**Figure 27**). This BIA was established due to it being a known foraging area for pygmy blue whales and is a high use area by this species. Due to the presence of this BIA and overlap with the Operational Area, the likelihood of encountering pygmy blue whales during the Otway Basin 2DMC MSS has been assessed to be '**moderate to high**'.

Figure 27 Pygmy Blue Whale Biologically Important Areas of Relevance to the Operational Area



Blue whales are listed as *vulnerable*, *migratory* and *cetacean* under the EPBC Act. Due to the 'vulnerable' listing under the EPBC Act, blue whales are managed under the 2015 – 2025 'Conservation Management Plan for the blue whale' (Commonwealth of Australia, 2015). With regards to underwater noise, the Conservation Management Plan lists the following actions of direct relevance to seismic surveys:

- 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; and
- EPBC Act Policy Statement 2.1—Interaction between offshore seismic exploration and whales is applied to all seismic surveys.

5.2.6.1.7 Fin whale (*Balaenoptera physalus*)

Fin whales are found in offshore waters throughout the world (NOAA, 2018). Like other baleen whales, they head to high latitudes (between 50°S and 65°S) to feed over the summer months (Miyashita *et al*., 1995) and move to warmer lower latitude waters during winter to breed. Their migration paths are oceanic, and do not obviously follow coastlines (Bannister *et al.,* 1996).

The distribution of fin whales in Australian waters is mainly known from stranding events and historic whaling records, with stranding events reported in Victoria and Tasmania. Fin whales have been sighted inshore of the Bonney Upwelling in Victorian waters during aerial surveys carried out in summer and autumn months (Gill, 2002), between November and May (Gill *et al*., 2015). Feeding was also observed during these surveys and a cow/calf pair was observed here in April 2000 (Morrice *et al*., 2004); suggesting that this area may serve some importance for reproduction.

Fin whale communication vocalisations have been described as short (<1 second) down-swept tones, between 28 and 15 Hz at source levels of 189 ± 4 dB re 1 µPa @1 m (Širović *et al*., 2007).

The likelihood of encountering fin whales during the Otway Basin 2DMC MSS has been assessed to be '**moderate**' as the Operational Area is spatially and temporally proximate to a known feeding area (Bonney Upwelling), particularly during summer and autumn months (from November through to May).

Fin whales are listed as *vulnerable*, *migratory* and *cetacean* under the EPBC Act. There is no adopted Management Plan or Recovery Plan for fin whales; however, a Conservation Advice was established under the EPBC Act and approved on 1 October 2015. The Conservation Advice recommends further research into the spatial and temporal distribution of this species to enable a better understanding of the potential impacts of underwater noise, including seismic surveys, and to ensure the ongoing recovery of fin whales.

5.2.6.1.8 Humpback whale (*Megaptera novaeangliae*)

Humpback whales from Australia's east coast were hunted to near-extinction by the commercial whaling industry throughout the 1950s and early 1960s (Smith *et al*., 2012). Following the cessation of commercial whaling, populations of humpbacks along the east coast have steadily increased and is estimated to be at least 63% recovered to pre-whaling numbers with a long-term rate of increase estimated at 10.9% per annum and no evidence of a decline in growth rate (as referenced in Bejder *et al*., 2016). It has been suggested that on account of this strong and continuing recovery, Australian humpback whales no longer meet any of the EPBC Act Threatened Species criteria for the current listing of 'vulnerable' (Woinarski *et al*., 2014; Bejder *et al.,* 2016).

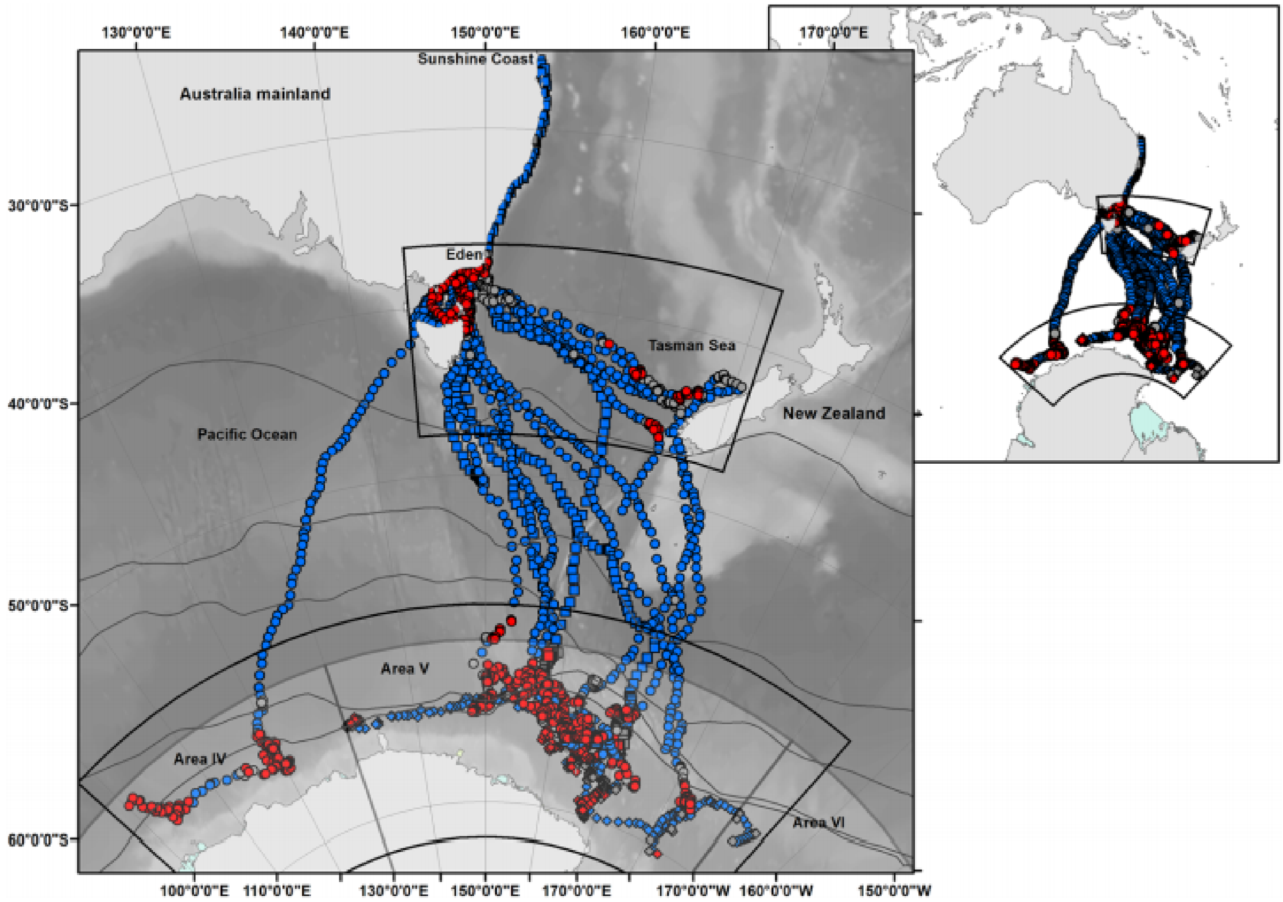
Humpback whales undertake the longest migration of any mammal (Jackson *et al.*, 2014). They are seasonal migrants that move between low latitude winter breeding grounds and mid- to high-latitude productive summer feeding grounds (Pomilla & Rosenbaum, 2005; Robbins *et al*., 2011). Although humpbacks may utilise deep oceanic waters during migrations, they are typically a coastal species when breeding and feeding (Smith *et al.,* 2012).

Peak migration times for the northern and southern migrations of humpback whales through Bass Strait have been reported in the Conservation Advice for humpback whales as April – May and November – December, respectively. It is also noted that cow and calf migration can occur up to four weeks after the southern peak migration period (TSSC, 2015).

There are two populations of humpback whales in Australian waters (D and E1 (Jenner *et al.,* 2001; Smith *et al*., 2012)); with the whales that breed off eastern Australia belonging 'breeding stock E1' (Noad *et al*., 2008). Breeding aggregations of whales belonging to 'breeding stock E1' are found off northeast Australia (in Great Barrier Reef waters (Chaloupka *et al.,* 1999; Noad *et al*., 2006)) and around islands and reefs in the southwest Pacific (Gales *et al.,* 2009). Breeding and calving occurs during winter months (June – September), and although breeding and calving areas are not clearly defined, water depths of 30 – 58 m are thought to be utilised (Smith *et al*., 2012).

Andrews-Goff *et al.* (2018) used satellite tagging technology to track the southern migration of humpback whales along three migratory trajectories off Australia's east coast (**Figure 28**). The 21 whales tagged off the eastern Australian coast migrated sound long the coastline and across the eastern entrance to Bass Strait in October. Twelve whales were also tracked in November moving south along the east coast of Tasmania, while one whale utilised the western coast of Tasmania where it continued in a southwest direction into the Pacific Ocean before heading towards Antarctic feeding grounds. Seven whales travelled eastwards into the Tasman Sea, with three animals spending time off the south west coast of New Zealand (Andrews-Goff *et al.,* 2018). All migrating humpbacks with transmitting tags had arrived in Antarctic feeding grounds by January (Andrews-Goff *et al.,* 2018). The tracks recorded by Andrews-Goff *et al.* (2018) are in agreement with those recorded in previous studies such as Gales *et al.* (2009). While on southern migrations off the headlands of the southern coastline of Queensland and New South Wales, the migratory corridor is narrow, with whales passing within 5 km of land (Noad *et al.,* 2008). Whales on northern migrations tend to use more offshore waters (Noad & Cato, 2001).

Figure 28 Migration Pathways for Humpback Whales Satellite-Tagged off the Eastern Coast of Australia – Dot Colours Show Recorded Behavioural State; Red ('Search'), Blue ('Transit'), Grey ('Uncertain')



Source: Andrews-Goff *et al.* (2018)

Feeding by humpback whales in Australian waters was initially thought to be opportunistic (Stockin & Burgess, 2005); however, recent satellite tracking suggests that humpback whales temporarily suspend migration to forage (Andrews-Goff *et al*., 2018). Recently identified supplemental feeding areas (i.e. those not at Antarctic feeding grounds) have been identified through Bass Strait, along the east coast of Australia, and within the eastern Tasman sea (e.g. Stockin & Burgess, 2005; Stamation *et al.,* 2007; Andrews-Goff *et al*., 2018).

Both male and female humpbacks produce communication calls, but only males emit the long, loud, and complex 'songs' associated with breeding activities. Dunlop *et al*. (2007) recorded social vocalisations of migrating east Australian humpbacks and recorded frequencies ranging from <30 Hz to 2.5 kHz over 34 different vocalisation types. The source level of singing humpback whales ranges from 123 – 183 dB re 1 µPa @ 1 m (Dunlop *et al.,* 2013). Surface-generated social sounds (e.g. breaches, pectoral slaps, and tail slaps) are also generated by humpback whales and are thought to have a communicative function (Dunlop *et al.,* 2010). These surface-generated sounds have been reported to be in the range of 133 – 171 dB re 1 µPa @1 m (Dunlop *et al.,* 2013).

Humpback whales have been assessed to have a '**moderate**' likelihood of occurring within the Operational Area during the Otway Basin 2DMC MSS. The MSS will occur temporally and spatially proximate to migratory pathways, particularly during the southward migration period which occurs in October – December.

Humpback whales are listed as *vulnerable*, *migratory* and *cetacean* under the EPBC Act. There is no Recovery Plan or Management Plan for humpback whales (a 2005 Recovery Plan ceased to be in effect from 1 October 2015); however, a Conservation Advice note for humpback whales was established under the EPBC Act and approved on 1 October 2015. With regard to potential impacts of underwater noise, the Conservation Advice states:

- That all seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1;
- 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;
- 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);
- Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified a noise management plan should be developed. This can include:
  - The use of Shut-down and Caution Zones;
  - Pre- and post-activity observations;
  - The use of marine mammal observers and / or PAM; and
  - Implementation of an adaptive management program following verification of the noise levels produced from the action (i.e. if the noise levels created exceed original expectations).

5.2.6.2 Toothed whales (suborder Odontoceti)

5.2.6.2.1 Sperm whale (*Physeter macrocephalus*)

Sperm whales have a cosmopolitan distribution throughout deep waters off the continental shelf (i.e. beyond 200 m water depth). While sperm whales have been recorded in all Australian waters (Bannister *et al*., 1996), females and young are restricted to warmer waters north of 45°S, while males travel to and from colder waters and to Antarctic pack-ice (DoEE, 2018k) and sperm whale sightings have also been observed along the upper continental slope from Port MacDonnell (SA) to King Island in Bass Strait; with 34 sightings (of 66 individuals) made during aerial surveys that occurred between 2002 and 2013 (Gill *et al*., 2015). Mean group size observed during these surveys was 1.9, with this species being detected between October and May with the majority of sightings occurring between 200-1000 m (Gill *et al.* 2015). Concentrations of sperm whales have been observed south-west of Kangaroo Island (DoEE, 2018k). While sperm whales do not undertake large-scale migrations along pre-determined routes, they can and do move considerable distances between foraging locations (Whitehead, 1996).

This species is reliant on echolocation to locate prey and for navigation. The echolocation clicks that sperm whales use during foraging enable them to determine the direction and distance of prey (Ocean Research Group, 2015). Clicks are also produced as a means of communication, to identify members of a group and to coordinate foraging activities (Andre & Kamminga, 2000). Sperm whale clicks have been reported to be multi-pulsed and broadband, ranging in frequency from 0.2 – 32 kHz (Backus & Schevill, 1966). Clicks from foraging male sperm whales have been recorded with source levels up to 236 dB re 1 µPa @ 1 m (Madsen *et al.,* 2002; Møhl *et al.,* 2003).

The likelihood of encountering sperm whales during the Otway Basin 2DMC MSS has been assessed to be '**moderate**' based on their cosmopolitan distribution in offshore waters and the presence of sperm whale concentrations in the vicinity of the Operational Area. A sperm whale BIA has been identified to the north-west of the Operational Area, although this BIA does not directly overlap with the boundaries of the Operational Area (see **Figure 23**); however as outlined above this species certainly utilises waters of the AOI for foraging.

Sperm whales are listed as *migratory* and *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for sperm whales.

5.2.6.2.2 Pygmy sperm whale (*Kogia breviceps*)

Pygmy sperm whales are seldom observed at sea on account of their low profile in the water and lack of a visible blow; for this reason, little information is available on this species. Pygmy sperm whales are thought to occur predominantly beyond the edge of the continental shelf (Caldwell & Caldwell, 1991). Stranded pygmy sperm whales have been reported for all Australian States (Ross, 2006).

Although sounds associated with echolocation, such as clicks, buzzes, and grating sounds, have been recorded, this species is not thought to be highly vocal (Ross, 2006). Data collected from live stranded animals has indicated that pygmy sperm whales emit click trains between 60 and 200 kHz (Marten, 2000).

Despite a lack of sightings data, pygmy sperm whales have been assessed to have a '**low**' likelihood of occurring within the Operational Area during the Otway Basin 2DMC MSS as there is no evidence to suggest that this region is of particular ecological importance for this species.

Pygmy sperm whales are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice, or adopted Management Plan or Recovery Plan for pygmy sperm whales

5.2.6.2.3 Dwarf sperm whale (*Kogia simus*)

Dwarf sperm whales occur in all waters apart from polar and sub-polar seas, feeding over the continental shelf. Stranded animals have been reported for South Australia and Tasmania. They are not known to migrate or exhibit strong seasonal changes in distribution (Ross, 2006).

Dwarf sperm whale vocalisations are thought to be similar to those of pygmy sperm whales (Bannister *et al.,* 1996).

Despite a lack of sightings data, dwarf sperm whales have been assessed to have a '**low**' likelihood of occurring within the Operational Area during the Otway Basin 2DMC MSS as there is no evidence to suggest that this region is of particular ecological importance for this species.

Dwarf sperm whales are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for dwarf sperm whales.

5.2.6.2.4 Beaked whales

Beaked whales are rarely observed at sea and are mostly found in small groups in cool, temperate waters with a preference for pelagic deep ocean waters or continental slope habitats at depths down to 3,000 m (Baker, 1999). Eleven species of beaked whale have been identified as potentially present within the Operational Area (Commonwealth of Australia, 2015):

- Arnoux's beaked whale (*Berardius arnuxii*) - circumpolar distribution in deep, cold temperate and sub-polar waters. Strandings have occurred in South Australia and Tasmania (Ross, 2006). Considered to be naturally rare throughout its range (Taylor *et al*., 2008);
- Andrew's beaked (*Mesoplodon bowdoini*) - found between 32°S and 55°S in the Southern Hemisphere where is it presumed to inhabit deep, offshore waters (Pitman, 2002). Known from sightings and strandings in Victoria and Tasmania (Rice, 1998);
- Blainville's beaked whale/dense beaked whale (*Mesoplodon densirostris*) - considered to have an oceanic and circum-global distribution, occurring in low to mid-latitudes in all oceans and both hemispheres (Mead, 1989). Known to have stranded in Victoria and Tasmania (Ross, 2006);
- Ginkgo-toothed beaked whale (*Mesoplodon ginkodens*) - most stranding and incidental capture (i.e. from the fishing industry) records for this species are from the tropical and warm temperate waters of the Indo-Pacific. Has stranded in western Victoria (Ross, 2006);
- Gray's beaked whale (*Mesoplodon grayi*) - a Southern Hemisphere species with a circumpolar distribution south of 30°S. Occurs in deep waters beyond the shelf edge (Taylor *et al*., 2008a). Strandings have occurred in Victoria, Tasmania, and South Australia (DoEE, 2018l);
- Hector's beaked whale (*Mesoplodon hectori*) - distributed circum-globally between about 35°S to 55°S. Few have been recorded in Australia; however, records exist for South Australia and Tasmania (Ross, 2006);
- Strap-toothed beaked whale (*Mesoplodon layardii*) - occur between 35°S and 60°S in cold temperate waters. Stranding seasonality suggest this species may migrate. Prefers deep waters beyond the shelf edge and is probably not as rare as other *Mesoplodon* sp. (Taylor *et al*., 2008b);
- True's beaked whale (*Mesoplodon mirus*) – one of the more widespread and common beaked whales in the Southern Ocean and adjoining waters, occurring between approximately 30°S and the Antarctic Convergence (Pitman, 2002). The most commonly stranded beaked whale in Australia, with records existing within South Australia, Victoria, and Tasmania (Ross, 2006);
- Shepherd's beaked whale/Tasman beaked whale (*Tasmacetus shepherdi*) - circumpolar distribution in cold temperate waters is presumed. Thought to be relatively rare and live in deep water usually well offshore. A stranding event in South Australia is one of three stranding records (Ross, 2006);
- Cuvier's beaked whale (*Ziphius cavirostris*) - thought to have the largest range of any beaked whale; found in deep waters (>200 m) of all oceans in both hemispheres. Thought to prefer steep bathymetry near the continental slope in water depths greater than 1,000 m. Genetic studies suggest little movement of individuals between ocean basins (Dalebout, *et al.*, 2005). Australian stranding records suggest a seasonality of occurrence from January to July (Ross, 2006); and
- Southern bottlenose whale (*Hyperoodon planifrons*) - circumpolar distribution in Southern Hemisphere, south of 30° where it is common in Antarctic waters in summer. Typically occurs over submarine canyons in waters deeper than 1,000 m (Taylor *et al.,* 2008c). Has stranded on the coast of Victoria, South Australia and Tasmania (Ross, 2006).

There has been a high number of strandings of Gray's, strap-toothed and Cuvier's beaked whales in the South-east Marine Region, suggesting regionally significant populations of these species may be found in this region (Commonwealth of Australia, 2015) and as a result, these species of beaked whale are the most likely to occur in the Operational Area.

Beaked whales produce a range of vocalisations including clicks, click trains, and buzzes. Blainville's beaked whales have been recorded producing clicks at frequencies ranging from 25 – 80 kHz (DOSITS, 2018), while Johnson *et al*. (2004) suggests that beaked whales of the genera *Mesoplodon* produce clicks with source levels in the range of 200 – 220 dB re 1 µPa @ 1 m.

There have been no biologically important habitats for beaked whales identified that spatially and temporally overlap with the Operational Area, therefore the likelihood of a beaked whale occurring in the Operational Area during the Otway Basin 2DMC MSS has been assessed as '**low**'. The exception to this is Gray's, strap-toothed, and Cuviers beaked whales, which have been assessed to have a '**moderate**' likelihood of occurring within the Operational Area on account of the suggestion that the South-east Marine Region is regionally significant for these species.

All beaked whales are listed as *cetacean* under the EPBC Act. There are no approved Conservation Advices, adopted Management Plans, or Recovery Plans for any of the beaked whales potentially present in the Operational Area.

5.2.6.2.5 Common dolphin (*Delphinus delphis*)

Common dolphins (also known as short-beaked common dolphins) occur over continental shelf and pelagic waters of the Atlantic and Pacific Oceans (Reeves *et al*., 2002). Their occurrence in Australian waters is poorly studied, with stranding and incidental capture records the main sources of information (Filby *et al.,* 2010). Filby *et al.* (2010) carried out the first distribution and abundance survey for common dolphins in South Australia waters. Although common dolphins were observed in all months surveyed (suggesting populations are resident), a summer seasonality to sightings was evident, with more encounters and larger groups recorded from December to April (Filby *et al*., 2010). Dolphins were only found in water depths less than 40 m (Filby *et al.,* 2010). While this survey was carried out to the west of the Operational Area, it provides an indication to the potential distribution and seasonality of common dolphins within the Operational Area. Based on the high numbers of common dolphin stranding events (including a mass stranding of 34 animals in Victoria (Ross, 2006)), regionally significant populations of common dolphins may be found in the South-east Marine Region (Commonwealth of Australia, 2015), and therefore the Operational Area.

Common dolphins are highly vocal animals, and use a variety of vocalisations including whistles, echolocation click-trains, burst pulse calls (Richardson *et al.,* 1995; Soldevilla *et al,* 2008), and other non-whistle pulsed sounds referred to as barks, yelps, or squeals (Ridgway, 1983). Petrella *et al*. (2012) determined the whistle characteristics of common dolphins in the Hauraki Gulf, New Zealand, indicating that the average frequency and length of whistles are 10 – 14 kHz and 0.27 seconds, respectively.

Common dolphins have been assessed as having a '**low**' likelihood of encounter during the Otway Basin 2DMC MSS. Although the planned timing of the Otway Basin 2DMC MSS will temporally overlap with the main seasonality of common dolphins, the majority of the Operational Area does not have any spatial overlap with biologically important habitat; 98% of survey lines occur in water depths greater than 200 m.

Common dolphins are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice, adopted Management Plan, or Recovery Plan for common dolphins.

5.2.6.2.6 Short and long-finned pilot whales (*Globicephala macrorhynchus* and *G. melas*)

There are two species of pilot whale: the long-finned pilot whale (*Globicephala melas*) and the short-finned pilot whale (*G. macrorhynchus*).

Long-finned pilot whales are widespread and relatively common throughout the Southern Hemisphere (Ross, 2006). They inhabit temperate and sub-Antarctic deep oceanic waters and zones of high productivity along the continental slope, venturing into shallower waters (<200 m) in search of prey (Ross, 2006). High numbers of long-finned pilot whales have stranded along the Victorian and Tasmanian coasts (Ross, 2006), suggesting that regionally significant populations may be present (Commonwealth of Australia, 2015). Mass stranding events along the Australian coast suggest a seasonal occurrence, with events historically occurring from September – March, with 60% of those occurring from December to March (Bannister *et al*., 1996).

Short-finned pilot whales are also widespread throughout the Southern Hemisphere, with a preference for warmer sub-tropical habitat compared to long-finned pilot whales. There are no known key localities in Australia for short-finned pilot whales; however, stranding events have occurred along the southern coastline of Australia (Ross, 2006). Short-finned pilot whales are generally nomadic with no known migration patterns, although short-term movements have been demonstrated in relation to prey movements such as squid spawning. A seasonal distribution shift also occurs with short-finned pilot whales occurring in shallower waters during winter (~370 m), compared to summer (~800 m) (Bernard & Reilly, 1999).

Pilot whales are known to be highly vocal when socialising at the surface (Jensen *et al.,* 2011), with vocalisations ranging from simple whistles while resting at the surface to complex whistles and pulses sounds during active behaviours (Weilgart & Whitehead, 1990). Calls of deep-diving pilot whales have been recorded with median peak frequencies of 3.9 kHz (Jensen *et al.,* 2011).

Due to the relatively high number of stranding records for the Victoria coast, there is potential that the Operational Area is spatially and/or temporally proximate to areas that provide important habitat for this species. As a result, the likelihood of encountering pilot whales during the Otway Basin 2DMC MSS has been assessed to be '**moderate**'.

Pilot whales are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice, adopted Management Plan, or Recovery Plan for short- or long-finned pilot whales.

5.2.6.2.7 Risso's dolphin (*Grampus griseus*)

Risso's dolphins have a cosmopolitan distribution and are generally considered to be pelagic and oceanic (Ross, 2006). High numbers of Risso's dolphins have stranded within the South-east Marine Region suggesting that regionally significant populations may be present (Commonwealth of Australia, 2015). Water depths from limited sighting data range from 180 – 1,500 m (Corkeron & Bryden, 1992).

Vocalisations of Risso's dolphins off Australia's east coast have been recorded and include broadband clicks, barks, buzzes, grunts, chirps, whistles, and simultaneous whistle and burst-pulse sounds. These sounds ranged in frequency between 30 Hz and 22 kHz (Corkeron & Van Parijs, 2001).

The likelihood of encounter has been conservatively assessed as '**moderate**', as although no biologically important habitats have been identified for this species, water depths within the Operational Area overlap with the reported water depths for Risso's dolphins.

Risso's dolphins are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for Risso's dolphins.

5.2.6.2.8 Hourglass dolphin (*Lagenorhynchus cruciger*)

Hourglass dolphins have a circumpolar distribution in Antarctic and sub-Antarctic pelagic waters (Ross, 2006). Although hourglass dolphins have been identified as potentially present within the South-east Marine Region (Commonwealth of Australia, 2015), they are unlikely to be present within the Operational Area on account of their more southern distribution.

As the Operational Area does not spatially overlap with any biologically important habitat for hourglass dolphins, their likelihood of encounter has been assessed as '**low**'.

Hourglass dolphins are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for hourglass dolphins.

5.2.6.2.9 Dusky dolphin (*Lagenorhynchus obscurus*)

Dusky dolphins are a Southern Hemisphere coastal species. Although identified as potentially present within the South-east Marine Region (Commonwealth of Australia, 2015), they are considered to be rare in Australian waters (Ross, 2006) and therefore unlikely to be present in the Operational Area. Dusky dolphin abundances in New Zealand increase during summer months (Würsig *et al*., 1997), and although sighting data is insufficient to determine seasonal trends in Australia an increase in abundance in summer is possible.

Based on the lack of records of dusky dolphins in Australian waters, the likelihood of encounter of this species during the Otway Basin 2DMC MSS has been assessed as '**low**'.

Dusky dolphins are listed as *migratory* and *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for dusky dolphins.

5.2.6.2.10 Southern right whale dolphin (*Lissodelphis peronii*)

Sightings of this species typically occur in cool, deep, offshore temperate and sub-Antarctic waters between 30 and 65°S (Hammond *et al*., 2012). The range within this latitudinal band is thought to be circumpolar (Hammond *et al*., 2012). Despite no abundance estimates being available, this species is considered to be relatively common throughout its range (Jefferson *et al*., 1994). Sightings have been recorded from around Tasmania and in the Great Australian Bight, and although sightings are rare this species may be more regular than believed (Ross, 2006). Upwelling areas have been suggested as important for this species, and although no key locations are known in Australia, the Bonney Upwelling could represent potential habitat for this largely un-studied species.

No information is available on the acoustic repertoire of this species; however, it presumably uses echolocation to navigate and locate food as with other odontocetes.

Due to the lack of sighting records, the likelihood of encountering southern right whale dolphins during the Otway Basin 2DMC MSS has been assessed as '**low**'.

Southern right whale dolphins are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for southern right whale dolphins.

5.2.6.2.11 Killer whale (*Orcinus orca*)

Killer whales (also known as orca) are distributed throughout all marine regions from the equator to polar waters (Reeves *et al.*, 2017). Concentrations of killer whales have been reported from around Tasmania, with animals also frequenting waters off Victoria (Ling, 1991). They are often observed along the continental slope and on the shelf, particularly around seal colonies (Ross, 2006). High numbers of killer whale strandings have been reported within the South-east Marine Region, suggesting regionally significant populations may be present (Commonwealth of Australia, 2015). Killer whales are known to make seasonal movements and although little is known of movement patterns, it is likely that the presence of killer whales in the Operational Area is highest in winter months (as referenced in DoEE, 2018m).

Echolocation characteristics vary between groups of whales and are thought to reflect the target prey species of a particular group (Barrett-Lennard *et al*., 1996). Whistles have an average dominant frequency of 8.3 kHz (Thomsen *et al*., 2001) and variations of these whistles (often referred to as dialects) have been documented between pods (Deecke *et al*., 2000).

Although the Operational Area is likely to spatially overlap with killer whale habitat, the likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**low**' as the summer survey operations are unlikely to temporarily overlap with their winter presence.

Killer whales are listed as *migratory* and *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for killer whales.

5.2.6.2.12 False killer whale (*Pseudocra crassidens*)

False killer whales are widespread in deep tropical and warm temperate waters (Odell & McClune, 1999). Although false killer whales are widely distributed throughout Australia (based on stranding records), they are not considered to be abundant (Ross, 2006). Despite this, high stranding numbers in the South-east Marine Region (including in Victoria, South Australia and Tasmania) suggests regionally significant populations may occur in this region (Commonwealth of Australia, 2015). Trends in stranding events suggest a seasonal movement inshore or along the continental shelf on Australia's south-east coast between May and September (Nicol, 1987; Bannister *et al*., 1999). False killer whales utilise deep offshore waters and sometimes deep coastal waters where the continental shelf is narrow (Culik, 2005).

False killer whales are extremely vocal with a diverse repertoire consisting of click trains, burst-pulse sounds, and whistles. Peak frequencies of false killer whale sounds recorded from captive animals ranged from 3 to 22 kHz (Murray *et al*., 1998).

No biologically important habitat has been reported in proximity of the Operational Area, therefore the likelihood of encounter of false killer whales during the Otway Basin 2DMC MSS has been assessed as '**low**'. Furthermore, the proposed timing of the Otway Basin 2DMC MSS does not significantly overlap with the suggested seasonality of false killer whales in south-east Australia; false killer whales are most likely present between May and September while the survey is proposed for October through to March.

False killer whales are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for false killer whales.

5.2.6.2.13 Common bottlenose dolphin (*Tursiops truncatus*)

Common bottlenose dolphins occur globally in cold temperate and tropical seas, where they inhabit a range of habitats including bays, lagoons, estuaries, open coasts and pelagic waters (as referenced in Möller *et al.,* 2002). In Australian waters they are usually found in depths >30 m (Hale *et al*., 2000; Kemper, 2004). Bilgmann *et al*. (2007) suggests that female common bottlenose dolphins tend to be resident to particular areas, while males' range further. High numbers of common bottlenose dolphin strandings have occurred in the South-east Marine Region, suggesting that regionally significant populations may exist in this marine region (Commonwealth of Australia, 2015. Common bottlenose dolphins have a summer breeding season (Möller *et al.,* 2002).

Common bottlenose dolphins produce 'clicks' which are used for echolocation purposes (0.8 – 24 kHz) and 'whistles' which are used as a form of communication (40 – 130 kHz).

The Operational Area of the Otway Basin 2DMC MSS spatially overlaps with the preferred water depths of bottlenose dolphins and the survey will occur over the summer months which coincide with the breeding season of this species; therefore, the likelihood of encounter of bottlenose dolphins during the survey has been assessed as '**moderate**'.

Bottlenose dolphins are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for bottlenose dolphins.

5.2.6.2.14 Indian Ocean bottlenose dolphin/Spotted bottlenose dolphin (*Tursiops aduncus*)

Indian Ocean bottlenose dolphins are restricted to coastal waters of the Indo-Pacific, Indian and Western Pacific Oceans, including southeast Australia (as referenced in Möller *et al.,* 2002), where they are most commonly found in water depths less than 100 m (Wang, 2018). Within Australia they are distributed contiguously around the Australian mainland (although the taxonomic status of many populations is unknown), where they have been confirmed to occur in bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters off eastern, western, and northern Australia (Hale *et al.,* 2000; Möller & Beherehiray, 2001). Genetic data of animals found in southern Australia suggest that inshore animals may belong to another, un-described species of *Tursiops* (Möller *et al.,* 2008).

The vocalisations of Indian Ocean bottlenose dolphins are likely to be similar to those of common bottlenose dolphins.

As Indian Ocean bottlenose dolphins are a coastal species, the likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**low**'.

Indian Ocean bottlenose dolphins are listed as *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for Indian Ocean bottlenose dolphins.

5.2.6.2.15 Spectacled porpoise (*Phocoena dioptrica*)

Spectacled porpoises occur only in cold temperate waters (Hammond *et al.*, 2008), with their distribution thought to be restricted to the circumpolar sub-Antarctic (Baker, 1999; Goodall, 2002). Although identified as potentially present within the South-east Marine Region (Commonwealth of Australia, 2015), the Australian distribution of spectacled porpoises appears to be south of Tasmania, therefore this species is unlikely to occur in the Operational Area.

The Operational Area does not overlap with the reported distribution of spectacled porpoises. As a result, the likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**low**'.

Spectacled porpoises are listed as *migratory* and *cetacean* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for spectacled porpoises.

5.2.7 Pinnipeds

Six species of pinniped (i.e. seals and sea lions) have been recorded in the South-east Marine Region and therefore have the potential to be present within the Operational Area: Australian sea lion, Sub-Antarctic fur seal, Antarctic fur seal, Australian fur seal, New Zealand fur seal, and southern elephant seal (Commonwealth of Australia, 2015). Australian sea lions, Australian fur seals, and New Zealand fur seals are the most likely pinnipeds to occur in the Operational Area. An assessment of the likely timing of pinniped presence within the Operational Area has been undertaken (**Table 21**).

A brief description of each species is provided in the following sections.

Table 21 Timing of Pinniped Presence within Operational Area

Species	January	February	March	April	May	June	July	August	September	October	November	December
Pinnipeds												
Australian sea lion												
Sub-Antarctic fur seal	Seasonality unknown											
Antarctic fur seal												
Australian fur seal												
New Zealand fur seal												
Southern elephant seal	Seasonality unknown											

Key:			
Breeding/pupping		Peak breeding/pupping	
Presence during migrations/movements		Resident population	
Feeding		Peak feeding	
Most likely time of presence with unspecified activity – most likely feeding			

5.2.7.1.1 Australian sea lion (*Neophoca cinerea*)

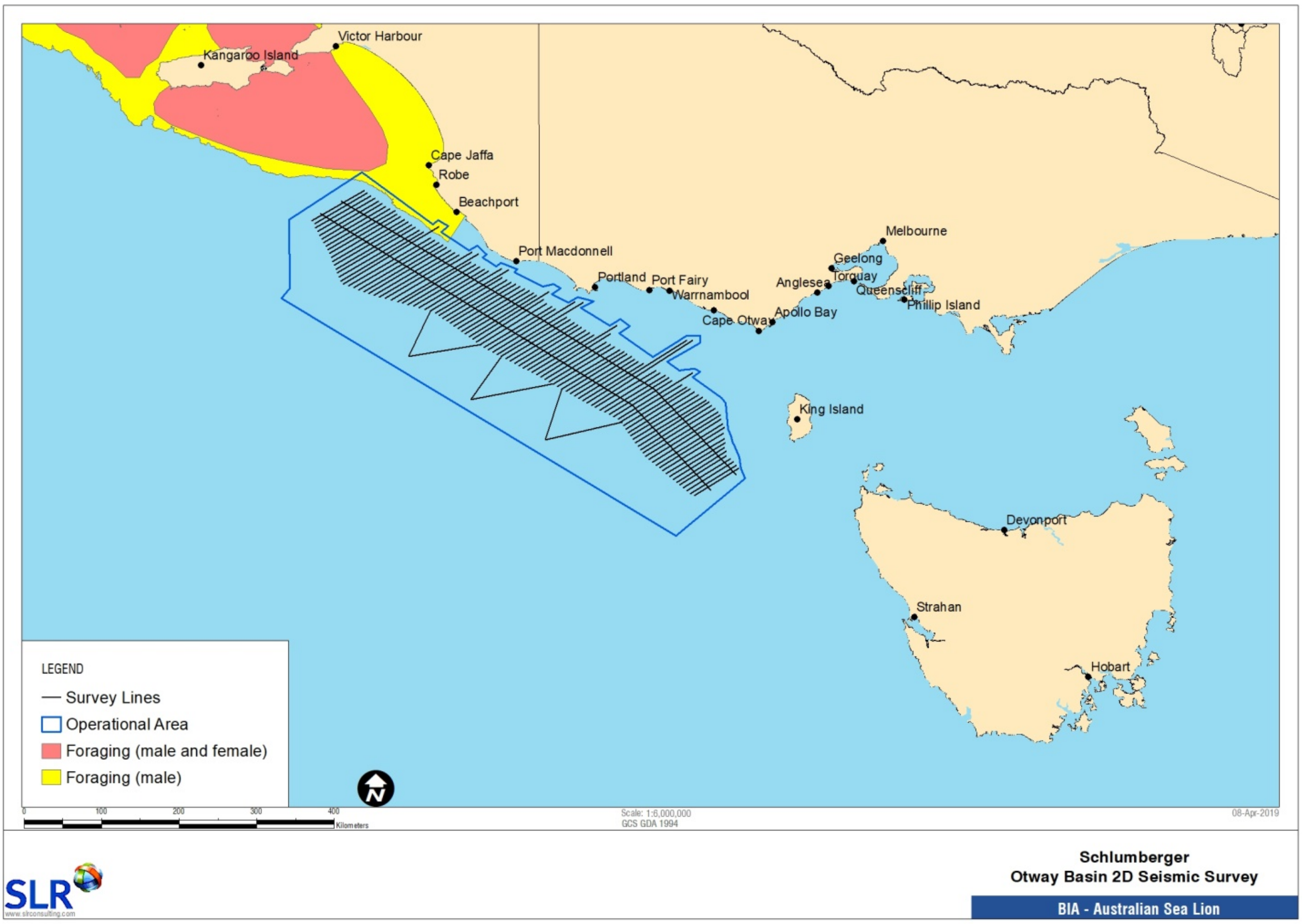
The range of the endemic Australian sea lion was severely restricted following commercial sealing in the late eighteenth and early nineteenth century, with the historical range thought to have extended into Bass Strait (Ling, 1999). Current populations are restricted to Southern and Western Australia (Shaughnessy *et al*., 2011); the Operational Area lies in the eastern extreme of the Australian sea lion's range. A BIA for the Australian sea lion overlaps with the northwest corner of the Operational Area as this area is used for foraging by male Australian sea lions (**Figure 29**). Females move no greater than 60 km from their natal site, while males disperse approximately 200 km from natal sites (Campbell, 2003). The closest breeding colony to the Operational Area is located on The Pages islands, over 150 km north (DoEE, 2018n).

Australian sea lions are benthic foragers, primarily feeding on the seabed (Commonwealth of Australia, 2013). Their diet is varied, and includes fish, cephalopods, sharks, rock lobster, and sea birds (Shaughnessy, 1999). Australian sea lions feed on the continental shelf in depths of 20 – 100 m (Shaughnessy, 1999). Adults usually travel up to 60 km from their breeding colony on each foraging trip, although may travel up to 160 km over shelf waters (Hamer *et al.,* 2011).

Although a BIA has been identified for foraging male (and to a lesser extent female) Australian sea lions, the majority of the Operational Area lies outside of the boundaries of the BIA (**Figure 29**); however, due to the presence of the BIA in the northwest of the Operational Area, the likelihood of encountering Australian sea lions during the Otway Basin 2DMC MSS has been assessed as '**moderate**'.

Australian sea lions are listed as *vulnerable* and *marine* under the EPBC Act. Due to their 'vulnerable' listing, Australian sea lions are managed under the 2013 'Recovery Plan for the Australian sea lion (*Neophoca cinerea*)' (Commonwealth of Australia, 2013). Within the supporting 'Issues Paper for the Australian Sea Lion (*Neophoca cinerea*), noise disturbance, including emissions from seismic surveys, was identified as a 'secondary threat' to Australian sea lions. There are no specific recommendations within the recovery plan with regard to mitigating against noise from seismic surveys.

Figure 29 Male and Female Australian Sea Lion Biologically Important Areas of Relevance to the Operational Area



5.2.7.1.2 Sub-Antarctic fur seal (*Arctocephalus tropicalis*)

Sub-Antarctic fur seals are found on rocky shores, with the only Australian breeding colony occurring outside of the Operational Area on subantarctic Macquarie Island (Shaughnessy, 1999), approximately 1,500 km southeast of Tasmania. They have a wide range, and occasionally reach Tasmania and mainland Australia while foraging along oceanographic frontal zones (Commonwealth of Australia, 2015).

The Operational Area represents an unlikely foraging area of sub-Antarctic fur seals, therefore the likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**low**'.

Sub-Antarctic fur seals are listed as *vulnerable* and *marine* under the EPBC Act. Sub-Antarctic fur seals were jointly managed with southern elephant seals under the 'Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan 2004-2009'; however, following a review of this plan in 2015 it was determined that a recovery plan was not required. A revised Conservation Advice for sub-Antarctic fur seals was subsequently released and approved on 7 December 2016. Noise disturbance, including seismic surveys, have not been identified within the Conservation Advice as a threat to sub-Antarctic fur seals.

5.2.7.1.3 Antarctic fur seal (*Arctocephalus gazella*)

Antarctic fur seals breed outside of the Operational Area on Australian sub-Antarctic islands, such as Macquarie Island, more than 1,500 km southeast of Tasmania. Although they are capable of travelling large distances, records of Antarctic fur seals around mainland Australia are rare; a single record exists for an observation at Kangaroo Island (Shaughnessy, 1999). Antarctic fur seal colonies are almost deserted from April – November (Shaughnessy, 1999), making this the most likely period for this species to occur around mainland Australia. However, on account of the low number of sighting records it is unlikely that Antarctic fur seals will be present in the Operational Area.

The Operational Area represents an unlikely foraging area of Antarctic fur seals, therefore the likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**low**'.

Antarctic fur seals are listed as *marine* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for Antarctic fur seals.

5.2.7.1.4 Australian fur seal (*Arctocephalus pusillus*)

The population of Australian fur seals was severely reduced during commercial sealing operations in the 1800s and early 1900s (Warneke & Shaughnessy, 1985). Since the 1980s, pup production has been concentrated in northern Bass Strait (Kirkwood *et al*., 2010); six of the ten established breeding colonies are located along the Victorian coastline, with the remaining four colonies located off the coast of Tasmania (Kirkwood *et al*., 2010). The largest established breeding colonies are found on Lady Julia Percy Island (approximately 34 km west of the Operational Area) and at Seal Rocks (213 km east of the Operational Area) (Kirkwood *et al*., 2010). Australian fur seals migrate north over winter, returning to Bass Strait breeding colonies in late spring (Shaughnessy *et al*., 2001).

Breeding colonies are occupied year-round, with activity peaking during the summer breeding season (Shaughnessy, 1999). Following the birth of their pups, females' alternate periods feeding at sea with periods at shore to suckle their pups. Pups begin to forage in June and July, with the majority fully weaned by September – October (Shaughnessy, 1999).

Australian fur seals prefer rocky parts of islands with flat, open terrain, and occupy flatter areas than New Zealand fur seals. The diet of Australian fur seals consists primarily of fish (mainly redbait, leatherjacket, and jack mackerel) and cephalopods, with seabirds also taken (Warneke & Shaughnessy, 1985). Fish comprise the majority of the diet in winter, with cephalopods dominating in summer (Shaughnessy, 1999).

The Operational Area is spatially proximate to aggregation/breeding areas of Australian fur seals, particularly towards the east. Furthermore, Littnan & Arnould (2002) have suggested that Australian fur seals may occur in areas up to 500 km from colonies. Taking this into account, the likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**moderate**'.

Australian fur seals are listed as *marine* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for Australian fur seals.

5.2.7.1.5 New Zealand fur seals (*Arctocephalus forsteri*)

New Zealand fur seals occur in New Zealand and Australian waters, with Australian breeding colonies located on Kangaroo Island, 162 km west of the Operational Area. Colonies are occupied year-round, with activity peaking during the summer breeding season (Shaughnessy, 1999). New Zealand fur seals are typically found along the coast on rocky parts of islands (Shaughnessy, 1999). Adult males begin defending coastal territories in late November, with on-shore numbers peaking in early January (Goldsworthy & Shaughnessy, 1994). Adult females come to shore in early December and give birth soon after. Females continue to suckle their pups for several months, alternating between periods at sea and on-shore feeding of pups (Shaughnessy, 1999).

New Zealand fur seals forage along the continental shelf for fish and squid, with males foraging in deeper waters than females (Goldsworthy & Page, 2009).

The Operational Area is spatially proximate to aggregation/breeding areas of New Zealand fur seals and covers potential feeding areas. The likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**moderate**'.

New Zealand fur seals are listed as *marine* under the EPBC Act. There is no approved Conservation Advice or adopted Management Plan or Recovery Plan for New Zealand fur seals.

5.2.7.1.6 Southern elephant seal (*Mirounga leonina*)

Although southern elephant seals do not breed on mainland Australia, due to their wide range they are occasionally observed on beaches in Tasmania and on the mainland. Historic records show a number of births along the coast of Victoria and Tasmania (Commonwealth of Australia, 2015). Although records show southern elephant seals on occasion utilise waters around the Operational Area, they are unlikely visitors.

The Operational Area represents an unlikely foraging area of southern elephant seals, therefore the likelihood of encounter during the Otway Basin 2DMC MSS has been assessed as '**low**'.

Southern elephant seals are listed as *vulnerable* and *marine* under the EPBC Act. Southern elephant seals were jointly managed with sub-Antarctic fur seals under the 'Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan 2004 – 2009'; however, following a review of this plan in 2015 it was determined that a recovery plan was not required. A revised Conservation Advice for southern elephant seals was subsequently released and approved on 7 December 2016. Noise disturbance, including from seismic surveys, has not been identified within the Conservation Advice as a threat to southern elephant seals.

5.2.8 Seabirds

'Seabirds' are those species that derive most of their energy requirements from marine habitats (Serventy *et al*., 1971); this is compared to 'waders' that feed in the intertidal (Taylor, 2000). Most seabirds spend the majority of their lives at sea, returning to land only for breeding (Spear, 2001). For the purpose of this EP, birds have been classified as either 'seabirds' or 'shorebirds', with shorebirds feeding in the intertidal or within a few hundred meters of the shore.

A number of seabirds have been identified as potentially present within the Operational Area, 17 of which have BIAs that overlap with the Operational Area (DoEE, 2018o). **Table 22** lists those species which have a BIA within the Operational Area. Other seabirds that have been identified as potentially present within the Operational Area (Commonwealth of Australia, 2015) are listed in **Table 23**.

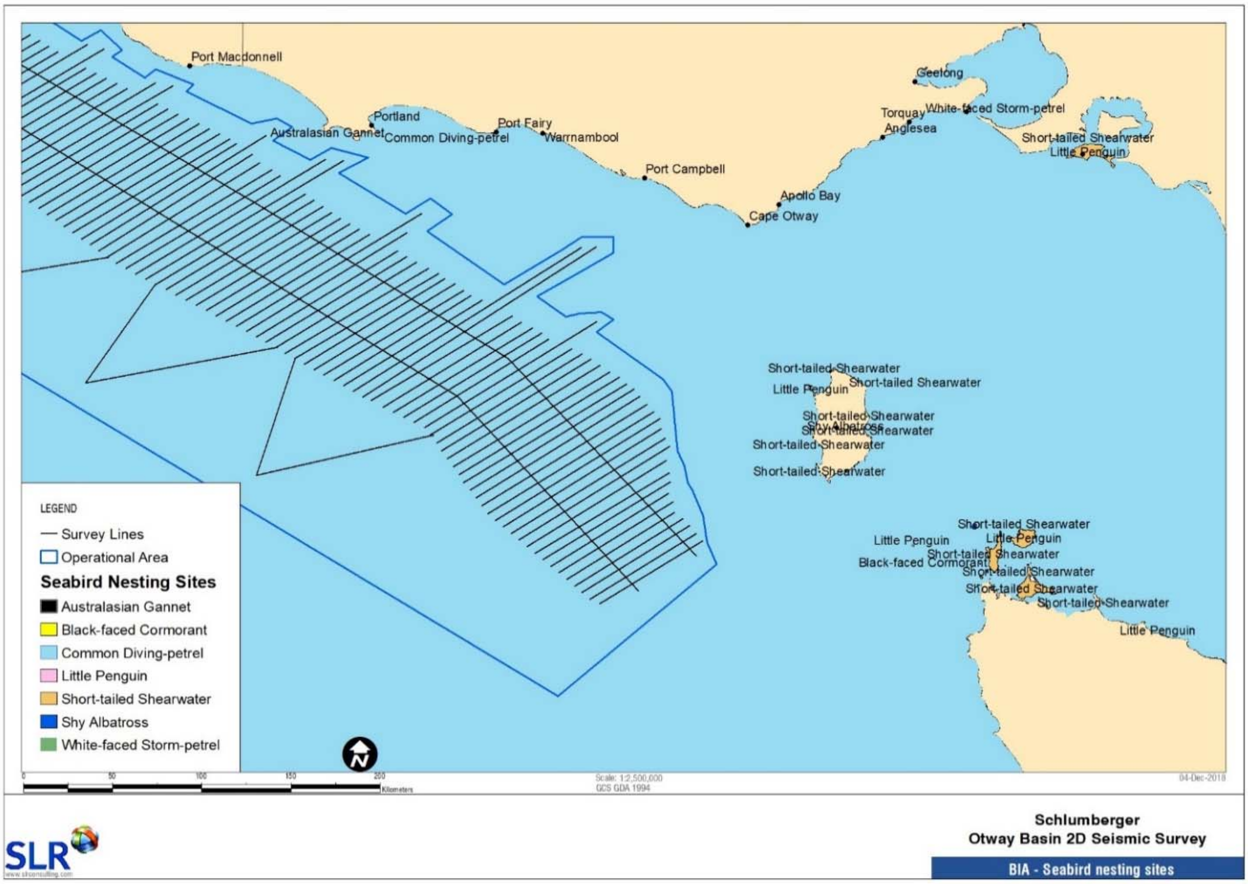
The offshore distribution of seabirds is patchy, with birds congregating in areas where food is abundant (Reid *et al*., 2002). As a number of the seabirds identified as potentially present do not breed on land in close proximity to the Operational Area, breeding season will also determine the presence of seabirds. Therefore not all the species identified in **Table 22** and **Table 23** may be present during the Otway Basin 2DMC MSS and, where possible, an indication of seasonality has been provided.

Of the 17 seabirds identified with BIAs within the Operational Area, seven have known breeding sites inshore of, and in close proximity to the Operational Area (**Figure 30**): Australasian gannet, black-faced cormorant, common-diving petrel, little penguin, short-tailed shearwater, shy albatross, white-faced storm petrel. Known breeding locations (Commonwealth of Australia, 2015) within the BIAs and of relevance to the Operational Area are as follows:

- Australasian gannet - Important breeding locations of relevance to the Operational Area include Black Pyramid Rock (Tasmania) and Lawrence Rock (Victoria). These locations are 84 km and 13 km, respectively, from the Operational Area;
- Black-faced cormorant – There are 40 known significant breeding sites (defined as having more than 10 breeding pairs) for black-faced cormorant in the South-east Marine Region; the areas where this species may occur in relation to the Operational Area includes the coastline of Port Campbell, the tip of Portland and on islands at the northern tip of Tasmania;
- Common-diving petrel – There are 30 sites with significant breeding colonies known from Tasmania with those on Hunter Island (115 km from Operational Area), Three Hummock Island (126 km from Operational Area), Robbins Island (129 km from Operational Area) and the most northern tip of Tasmania (approximately 116 km from Operational Area) of relevance to the Otway Basin 2DMC MSS. There are 12 breeding sites in Victoria, with Lady Julia Percy Island (34 km from Operational Area) and Lawrence Rocks (13 km from Operational Area) the closest to the Operational Area;
- Little penguin – Bass Strait is the stronghold for little penguins in Australia and supports 37 colonies with over 1,000 breeding pairs. These breeding locations are not listed but foraging birds are likely to utilise waters of the Operational Area;
- Short-tailed shearwater – Breeds on a number of the islands off Victoria and Tasmania;
- Shy albatross – The only endemic Australian albatross with colonies at Albatross Island, Mewstone, and Pedra Branca (Tasmania). Albatross Island is the closest to the Operational Area at a distance of approximately 112 km, while Mewstone and Pedra Branca are 419 km and 465 km respectively from the closest boundary of the Operational Area; and

- White-faced storm petrel – relevant breeding locations include Mud and South Channel Islands (215 km from Operational Area) in Port Phillip Bay (Victoria), while 15 significant colonies are located in Tasmania, with those around Robbins (129 km from Operational Area), Hunter (115 km from Operational Area), and Albatross (112 km from Operational Area) Islands of relevance to the Operational Area.

Figure 30 Known Seabird Breeding Locations in the Vicinity of the Operational Area



The Agreement on the Conservation of Albatrosses and Petrels (**ACAP**) is a multilateral agreement which seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to their populations. ACAP focuses mainly on the threat from fishing and seabird bycatch, which is outside the scope for this EP. The Bonn Convention on Migratory Species (**CMS**) also lists some species of seabird (mainly albatross, petrels and terns) as warranting conservation, with CMS parties tasked with, amongst other things, 'controlling other factors that might endanger them'. CMS links conservation efforts for seabirds to the ACAP.

The 'National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011 – 2016' replaces the 2001 Recovery Plan for albatrosses and giant petrels. The first recovery plan was prepared in recognition of the need to develop a co-ordinated conservation strategy for albatrosses and giant petrels listed as threatened under the EPBC Act (DoSEWPC, 2011). Two species of giant petrels and 19 species of albatross are covered under this plan. The species covered under this plan and of relevance to the Operational Area are: southern and northern giant petrels, and the Antipodean, Campbell, Buller's, Indian yellow-nosed, shy, wandering, and Gibson's albatrosses. Conservation Advices for blue petrels and soft-plumaged petrels were approved on 1 October 2015. With the exception of the previously mentioned species, no other seabird species potentially present within the Operational Area have an approved Conservation Advice or adopted Management Plan or Recovery Plan.

Table 22 Seabirds with BIA's within the Operational Area

Common name	Scientific name	Type of presence	Seasonality	EPBC Act listing status
Antipodean albatross	*Diomedea antipodensis*	Foraging, feeding or related behaviour likely to occur	Potentially present year-round as forage large distances during chick rearing[2]	Vulnerable, migratory, marine
Australasian Gannet	*Morus serrator*	Breeding, foraging	Present year-round, breeds July – March[1]	Marine
Black-browed albatross	*Thalassarche melanophris*	Foraging	Present April – September[2]	Vulnerable, migratory, marine
Black-faced cormorant	*Phalacrocorax fuscescens*	Breeding, foraging	Endemic – present year-round[3]	Marine
Buller's albatross	*Thalassarche bulleri*	Foraging	Present January – July[3]	Vulnerable, migratory, marine
Campbell albatross	*Thalassarche melanophris impavida*	Foraging	Present April – August[2]	Vulnerable, migratory, marine
Common diving-petrel	*Pelecanoides urinatrix*	Breeding, foraging	Present year-round, breeds July – January[1]	Marine
Fairy tern	*Sternula nereis*	Foraging	Present year-round[1]	Marine
Indian yellow-nosed albatross	*Thalassarche chlororhynchos bassi/ Thalassarche carteri*	Foraging	Present June – August[3]	Vulnerable, migratory, marine
Little penguin	*Eudyptula minor*	Breeding, Foraging	Present year-round, breeds September – February[1]	Marine
Short-tailed shearwater	*Ardenna tenuirostris*	Foraging, breeding	Present September – May, breeds October – May[1]	Migratory, marine
Shy albatross	*Thalassarche cauta*	Breeding, Foraging	Present year-round, Breeds September[3]	Vulnerable, migratory, marine
Soft-plumaged petrel	*Pterodroma mollis*	Foraging	Breeds September – April[1]	Vulnerable, marine.
Wandering albatross	*Diomedea exulans*	Foraging	Potentially present year-round[3]	Vulnerable, migratory, marine
Wedge-tailed shearwater	*Ardenna pacifica*	Foraging	Migrates to tropics in winter[2]	Migratory, marine
White-capped albatross	*Thalassarche cauta steadi*	Foraging	Present March – October[3]	Vulnerable, migratory, marine
White-faced storm-petrel	*Pelagodroma marina*	Breeding, Foraging	Present September – February, egg laying occurs early summer[3]	Marine

1 DoEE, 2018o.
2 DoEE, 2018p.
3 Commonwealth of Australia, 2015.

Table 23 'Other' Seabirds Potentially Present within the Operational Area

Common name	Scientific name	Distribution in Operational Area	Seasonality	EPBC Act Listing Status
Blue petrel	*Halobaena caerulea*	Species/habitat may occur	Present July – September[1]	Vulnerable, marine
Cape gannet	*Morus capensis*	Breeding known to occur		Marine
Fairy prion (southern)	*Pachyptila turtur*	Species/habitat may occur	Present year-round, breeds September[2]	Vulnerable, marine
Flesh-footed shearwater	*Ardenna carneipes*	Species/habitat known to occur	September – May[1]	Marine, migratory
Gibson's albatross	*Diomedea antipodensis gibsoni*	Species/habitat likely to occur	Potentially present year-round as forage large distances during chick rearing[1]	Vulnerable, marine
Gould's Petrel	*Pterodroma leucoptera leucoptera*	Species/habitat may occur	Mainly present December – April[1]	Endangered, marine
Great skua	*Catharacta skua*	Species/habitat may occur		Marine
Grey-headed albatross	*Thalassarche chrysostoma*	Species/habitat may occur	Potentially present year-round as forage large distances during chick rearing[1]	Endangered, migratory, marine
Northern giant petrel	*Macronectes halli*	Species/habitat may occur	Present May – October[2]	Vulnerable, migratory, marine
Northern royal albatross	*Diomedea sanfordi*	Foraging, feeding or related behaviour likely to occur	Potentially present year-round as forage large distances during chick rearing[1]	Endangered, migratory, marine
Salvin's albatross	*Thalassarche salvini*	Foraging, feeding or related behaviour likely to occur	Potentially present year-round as forage large distances during chick rearing[1]	Vulnerable, migratory, marine
Soft-plumaged petrel	*Pterodroma mollis*	Species/habitat may occur	Most likely present September – April[1]	Vulnerable, marine
Sooty albatross	*Phoebetria fusca*	Species/habitat likely to occur	Present in autumn and winter months (March – August)[1]	Vulnerable, migratory, marine
Southern giant petrel	*Macronectes giganteus*	Foraging, feeding or related behaviour likely to occur	Present in winter months (June – August)[1]	Endangered, migratory, marine
Southern royal albatross	*Diomedea epomophora*	Foraging, feeding or related behaviour likely to occur	Potentially present year-round as forage large distances during chick rearing	Vulnerable, migratory, marine
Wandering albatross	*Diomedea exulans*	Foraging, feeding or related behaviour likely to occur	July – November[1]	Vulnerable, migratory, marine

1 DoEE, 2018q.
2 Commonwealth of Australia, 2015.

Shorebirds potentially present inshore of the Operational Area (DoEE, 2018q) include a number of species of tern, prion, godwit, plover, and sandpiper that utilise coastal areas such as estuaries, beaches, and salt marshes for foraging, nesting and roosting, with many of these species classified as migratory (**Table 24**). These species have been included for completeness given their potential to occur inshore of the Operational Area in the coastal environment.

Table 24 Shorebirds Potentially Present within the Operational Area

Common name	Scientific name	Type of Presence	EPBC Act Listing Status
Australian painted-snipe	*Rostratula australis*	Species/habitat likely	Endangered, marine
Bar-tailed godwit	*Limosa lapponica baueri*	Species/habitat known	Vulnerable, migratory, marine
Black-tailed godwit	*Limosa limosa*	Roosting known	Migratory, marine
Bridled tern	*Onychoprion anaethetus*	Species/habitat may occur	Marine
Caspian tern	*Sterna caspia*	Breeding known	Migratory, marine
Cattle egret	*Ardea ibis*	Breeding likely	Marine
Common greenshank	*Tringa nebularia*	Species/habitat known	Migratory, marine
Common noddy	*Anous stolidus*	Species/habitat likely	Marine
Common sandpiper	*Actitis hypoleucos*	Species/habitat known	Migratory, marine
Crested tern	*Thalasseus bergii*	Breeding known	Migratory, marine
Curlew sandpiper	*Calidris ferruginea*	Species/habitat known	Critically Endangered, migratory, marine
Double-banded plover	*Charadrius bicinctus*	Roosting known	Migratory, marine
Eastern curlew	*Numenius madagascariensis*	Species/habitat known	Critically Endangered, marine
Great knot	*Calidris tenuirostris*	Roosting known	Critically Endangered, marine
Greater sand plover	*Charadrius leschenaultii*	Roosting known	Vulnerable, marine
Grey plover	*Pluvialis squatarola*	Roosting known	Migratory, marine
Grey-tailed tattler	*Tringa brevipes*	Roosting known	Migratory, marine
Fairy tern	*Sterna nereis*	Breeding known	Marine
Hooded plover	*Thinornis rubricollis rubricollis*	Species/habitat known	Vulnerable, marine
Latham's snipe	*Gallinago hardwickii*	Roosting known	Migratory, marine
Lesser sand plover	*Charadrius mongolus*	Roosting known	Endangered, marine
Little curlew	*Numenius minutus*	Roosting likely	Migratory, marine
Little tern	*Sternula albifrons*	Breeding known	Marine
Marsh sandpiper	*Tringa stagnatilis*	Roosting known	Migratory, marine
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbieri*	Species/habitat may occur	Critically Endangered, marine
Oriental plover	*Charadrius veredus*	Foraging, feeding or related behaviour known	Migratory, marine

Common name	Scientific name	Type of Presence	EPBC Act Listing Status
Osprey	*Pandion haliaetus*	Species/habitat known	Migratory, marine
Pacific golden plover	*Pluvialis fulva*	Roosting known	Migratory, marine
Pacific gull	*Larus pacificus*	Breeding known	Marine
Pectoral sandpiper	*Calidris melanotos*	Species/habitat known	Migratory, marine
Pied stilt	*Himantopus himantopus*	Roosting known	Marine
Pin-tailed snipe	*Gallinago stenura*	Roosting likely	Migratory, marine
Red knot	*Calidris canutus*	Species/habitat known	Endangered, Migratory, marine
Red-capped plover	*Charadrius ruficapillus*	Roosting known	Marine
Red-necked phalarope	*Phalaropus lobatus*	Foraging, feeding or related behaviour known	Migratory, marine
Red-necked stint	*Calidris ruficollis*	Roosting known	Migratory, marine
Ruddy turnstone	*Arenaria interpres*	Roosting known	Migratory, marine
Ruff	*Philomachus pugnax*	Roosting known	Migratory, marine
Sanderling	*Calidris alba*	Roosting known	Migratory, marine
Sharp-tailed sandpiper	*Calidris acuminata*	Roosting known	Migratory, marine
Silver gull	*Larus novaehollandiae*	Breeding known	Marine
Sooty tern	*Sterna fuscata*	Breeding known	Marine
Swinhoe's snipe	*Gallinago megala*	Roosting likely	Migratory, marine
Tasmanian wedge-tailed eagle	*Botaurus poiciloptilus*	Breeding likely	Endangered, marine
Terek sandpiper	*Xenus cinereus*	Roosting known	Migratory, marine
Whimbrel	*Mumenius phaeopus*	Roosting known	Migratory, marine
White-bellied sea-eagle	*Haliaeetus leucogaster*	Breeding known	Marine
Wood sandpiper	*Tringa glareola*	Roosting known	Migratory, marine

5.3 Coastal Environment – Marine Protected and Sensitive Areas

5.3.1 Provincial Bioregions

The Otway Basin 2DMC MSS Operational Area is located within Australia's South-east Marine Region (**Figure 12**).

Spanning the transition from deep ocean seabed to continental shelf, the South-east Marine Region consists of a wide variety of water depths, geomorphic features, currents and temperatures (Commonwealth of Australia, 2015), which supports a diverse range of marine species. The *Integrated Marine and Coastal Regionalisation of Australia - Provincial Bioregions (IMCRA v4.0)* is a spatial framework for classifying Australia's marine environment into ecological provincial bioregions at a scale that can be used in regional planning. It categorises Australia's marine regions into 41 on-shelf and off-shelf provincial bioregions (Department of the Environment and Heritage, 2006). The identified provincial bioregions from the basis for the development of Australia's National Representative System of Marine Protected Areas, with the aim of establishing a comprehensive and representative system of marine protected areas that focuses on habitat and biodiversity distribution rather than jurisdictional boundaries (Heap *et al*., 2005).

There are seven provincial bioregions within the Operational Area and wider environment. Although the Operational Area encroaches slightly into the Spencer Gulf Shelf Province and the Western Bass Strait Shelf Transition, it is primarily located within the West Tasmania Transition (**Figure 31**). **Table 25** summarises each provincial bioregion with basic descriptors (Australian Marine Parks, 2018), and the presence of any smaller-scale bioregions ('meso-scale regions').

Figure 31 Marine Provincial Bioregions relevant to the Otway Basin 2DMC MSS Operational Area

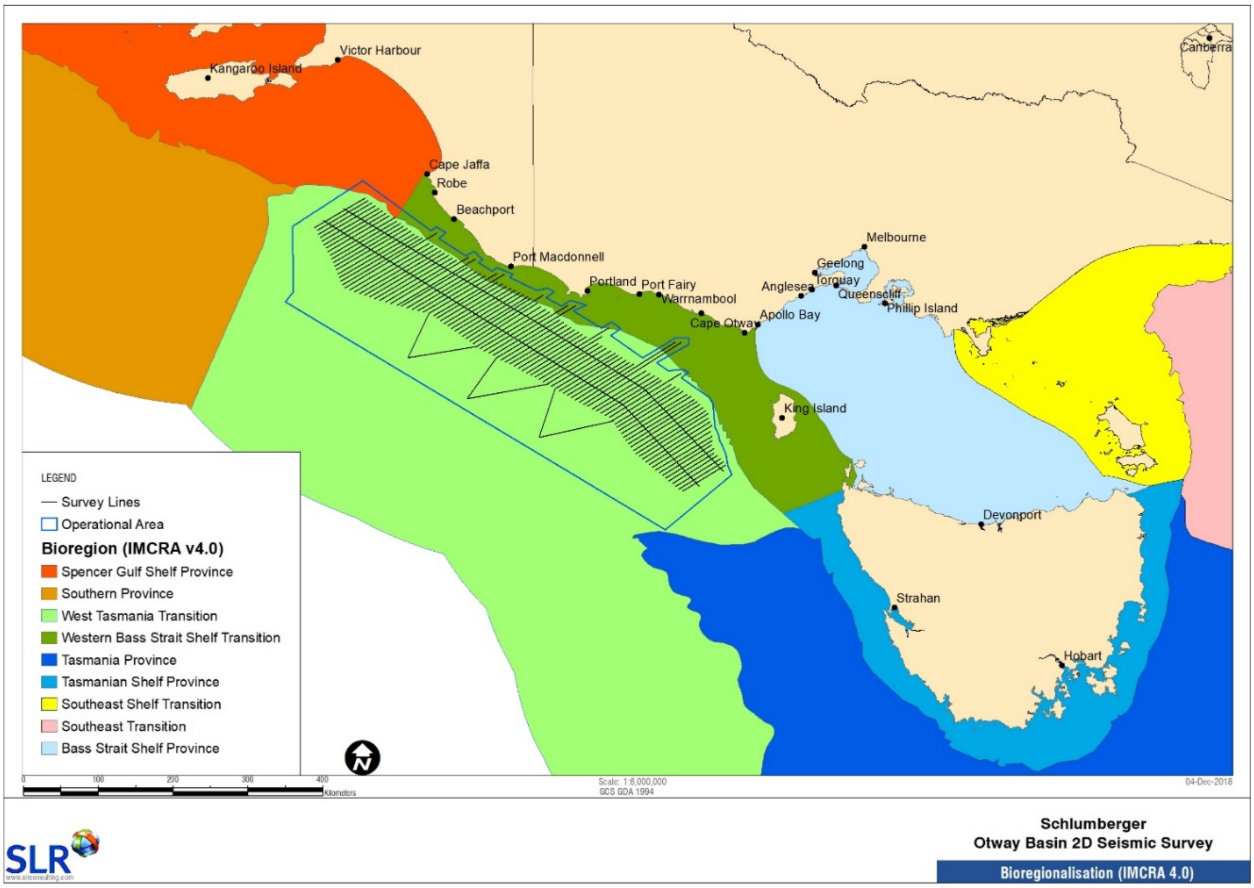


Table 25 Provincial Bioregions Overlapping the Operational Area and Wider Environment

IMCRA Bioregion	Brief Description	Area (km2)	Max. depth (m)	Water type	Meso-scale Bioregions
Spencer Gulf Province	Located on nearshore regions of Spencer Gulf, along the coastal margin of South Australia on the Continental Shelf, where water is typically less than 200 m deep. Geomorphic units within this provincial bioregion are: bank, sandbank; basin, terrace, plateau; deep, escarpment; knoll; shelf, abyssal plain; and slope.	132,860	603	Warm Temperate Waters	Coorong
Southern Province	Located off the south coast of South Australia and Western Australia along the continental slope and rise from the Southern Ocean, out to the EEZ limit. This provincial bioregion contains all of the biome types, and also covers the abyssal plain/deep ocean floor; it contains the second largest areas of abyssal plain/deep ocean floor of all bioregions. It contains the Diamantina Fracture Zone; a region of very rugged seabed comprising numerous deep-sea ridges and troughs representing a unique region of deep-sea habitats. There are 463 demersal fish species and 26 endemic species within this provincial bioregion. Key indicator demersal fish species are: *Bathyraja* sp.; *Centroberyx* sp.; *Dicrolene* sp.; *Notoraja* sp.; *Nybelinella* sp.; *Paraliparis australiensis*; *Paraliparis avellaneus*; and *Pavoraja* sp. Geomorphic units include: basin, terrace, plateau; rise; deep, escarpment; knoll; pinnacle; ridge, sill; shelf, abyssal plain; slope; and trench, saddle units.	774,120	Not calculated	Warm Temperate Waters	
Western Bass Strait Shelf Transition	Located along the coastal margin of South Australia and Victoria, on the Continental Shelf where water is typically less than 200 m deep. The continental shelf is as narrow as 25 km within this provincial bioregion. Geomorphic units include: bank, sandbank; basin, terrace, plateau; deep, escarpment; knoll; ridge, sill; shelf, abyssal plain; and slope units.	37,130	272	Transitional Waters	Otway
West Tasmania Transition	Located off the south coast of South Australia and Victoria along the continental slope and rise from the Southern Ocean, out to the EEZ limit. Includes deep ocean areas west of Tasmania.	289,850	5,645	Transitional Waters	

	There are 456 species of demersal fish found within this provincial bioregion. Biomes within this provincial bioregion include: shelf; slope; rise; abyssal plain/deep ocean floor; upper slope; mid-upper slope; mid slope; and biotope. Geomorphic units include: bank, sandbank; basin, terrace, plateau; deep, escarpment; knoll; ridge, sill; shelf, abyssal plain; slope; and trench, saddle.				
Tasmania Province	Located off the west, south and east coasts of Tasmania along the continental slope and rise from the Southern Ocean, out to the EEZ limit. It has 486 demersal fish species, with 52 endemic species. This provincial bioregion is characterised by many seamounts that attract endemic fish, particularly the Cascade Seamount. Key indicator demersal fish species are: *Cataetyx* spp., *Guttigadus* sp., *Monomitopus cf kumae*, *Paraliparis anthracinus*, *Paraliparis ater*, and *Rhinochimaera africana*. Geomorphic units within this provincial bioregion include: bank, sandbank; basin, terrace, plateau; canyon; deep, escarpment; knoll; ridge, sill; seamount; shelf, abyssal plain; slope; and trench, saddle	300,190	5,584	Cold Temperate Waters	
Tasmanian Shelf Province	Located along the coastal margin of west, south and east Tasmania where water is typically less than 200 m deep. Geomorphic units within this provincial bioregion include: bank, sandbank; basin, terrace, plateau; deep, escarpment; knoll; ridge, sill; shelf, abyssal plain; slope; and trench, saddle units.	59,300	834	Cold Temperate Waters	Franklin; Davey; Bruny; Freycinet
Bass Strait Shelf Province	Located on the shelf region of northern Tasmania and the Bass Strait. Geomorphic units within this provincial bioregion include: bank, sandbank; basin, terrace, plateau; deep, escarpment; ridge, sill; shelf, abyssal plain; and slope units.	96,670	90	Cold Temperate Waters	Boags; Central Bass Straight; Central Victoria; Victorian Embayments

5.3.2 Onshore Protected Areas

While no Onshore Protected Areas exist within the Otway Basin 2DMC MSS Operational Area, there are 84 bordering the coast within the wider environment, though some of these are further than 100 km from the Operational Area (**Appendix L**).

All Onshore Protected Areas have conservation designations affiliated with the IUCN Protected Area Categories. These categories range from the highest level of nature reserve (Category IA – 'Strict Nature Reserve') through to lower level reserves (Category VI – 'Protected area with sustainable use of natural resources'). Of the 84 Onshore Protected Areas identified, approximately a quarter are IUCN Category IA, 1B or II, and just over half are IUCN Category V or VI (**Appendix L**).

Figure 32 shows the locations of the coastal Onshore Protected Areas listed within **Appendix L.** Most of the highest value (IUCN Category IA) protected areas are too small to be displayed on this map; however, these protected areas are typically small islands located close to the north-west tip of Tasmania or east of Discovery Bay Coastal Park, Victoria.

Figure 32 Onshore Protected Areas Bordering Coastline, categorised by IUCN Conservation Status

Note: NP – National Park; CA – Conservation Area; CP – Conservation Park; RR – Regional Reserve; SR – State Reserve.

5.3.3 Australian Marine Parks

Australian marine parks (formerly Commonwealth Marine Reserves) are marine protected areas that are located within Australian waters, extending from 3 NM to 200 NM offshore and are managed by the Australian Government.

The Otway Basin 2DMC MSS Operational Area lies within the South-east Network of Marine Parks which was established to protect examples of biodiversity and seafloor features of Commonwealth waters of the South-east Region and are managed under the South-east Commonwealth Marine Reserves Network Management Plan 2012-23 (Directory of National Parks, 2013). The management plan sets out the zoning which defines what activities can or cannot occur in the Marine Parks, and the associated rules allocated to each of the different activities. This management plan was implemented to provide clear direction for effective management of the Marine Park network in the southeast region until 2023.

The Environmental Protection and Biodiversity Conservation Amendment (Commonwealth Marine Reserves Renaming) Proclamation 2017 dated October 2017 omitted the former term 'Commonwealth Marine Reserve', which is used in the Network Management Plan, and substituted 'Marine Park'. The boundaries and zoning of the areas have not changed.

There are two main objectives of the management plan:

- Provide for the protection and conservation of biodiversity and other natural and cultural values of the South-east network of Marine Parks; and
- Provide for ecologically sustainable use of the natural resources within the South-east network of Marine Parks where this is consistent with the above objective.

5.3.3.1 IUCN Categories

Within the South-east Network of Marine Parks, 14 Marine Parks were gazetted to provide examples of ecosystems of the southeast marine region. In relation to the Otway Basin 2DMC MSS Operational Area there are two Marine Parks within the Operational Area, and four within the wider environment (**Table 26** and **Figure 33**). All but one of these zones affiliated with the Marine Parks are classified as 'IUCN VI', meaning that they are a 'Protected area with sustainable use of natural resources'. However, one of the zones within the Murray Marine Park has the higher designation of Marine National Park (IUCN II).

Table 26 Australian Marine Parks within the wider environment

Feature	Within Operational Area	Within Wider Environment (<100km)
Australian Marine Parks	Nelson – Special Purpose Zone (IUCN VI); Zeehan – Special Purpose Zone (IUCN VI); and Zeehan – Multiple Use Zone (IUCN VI).	Murray - Marine Park (IUCN II); Murray - Multiple Use Zone (IUCN VI); Murray - Special Purpose Zone (IUCN VI); Apollo - Multiple Use Zone (IUCN VI); Boags - Multiple Use Zone (IUCN VI); and Franklin - Multiple Use Zone (IUCN VI)

Note: IUCN Categories: II - National Park; VI - Managed Resource Protected Area.

5.3.3.1.1 Category II – National Park

IUCN Category II Protected Areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

The key management principle for these Protected Areas are that they should be protected and managed to conserve their natural condition, based on the same management principles as IUCN Category VI listed in **Section 5.3.3.1.2**. Mining, which includes seismic surveys, is prohibited in a Protected Area with an IUCN II designation (i.e. National Park).

5.3.3.1.2 Category VI – Protected Area with Sustainable Use of Resources

The IUCN definition of Category VI is "… *areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resources use compatible with nature conservation is seen as one of the main aims of the area*" (Director of National Parks, 2013).

IUCN Category VI areas are managed mainly for the ecologically sustainable use of natural ecosystems based on the following principles (Director of National Parks, 2013):

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

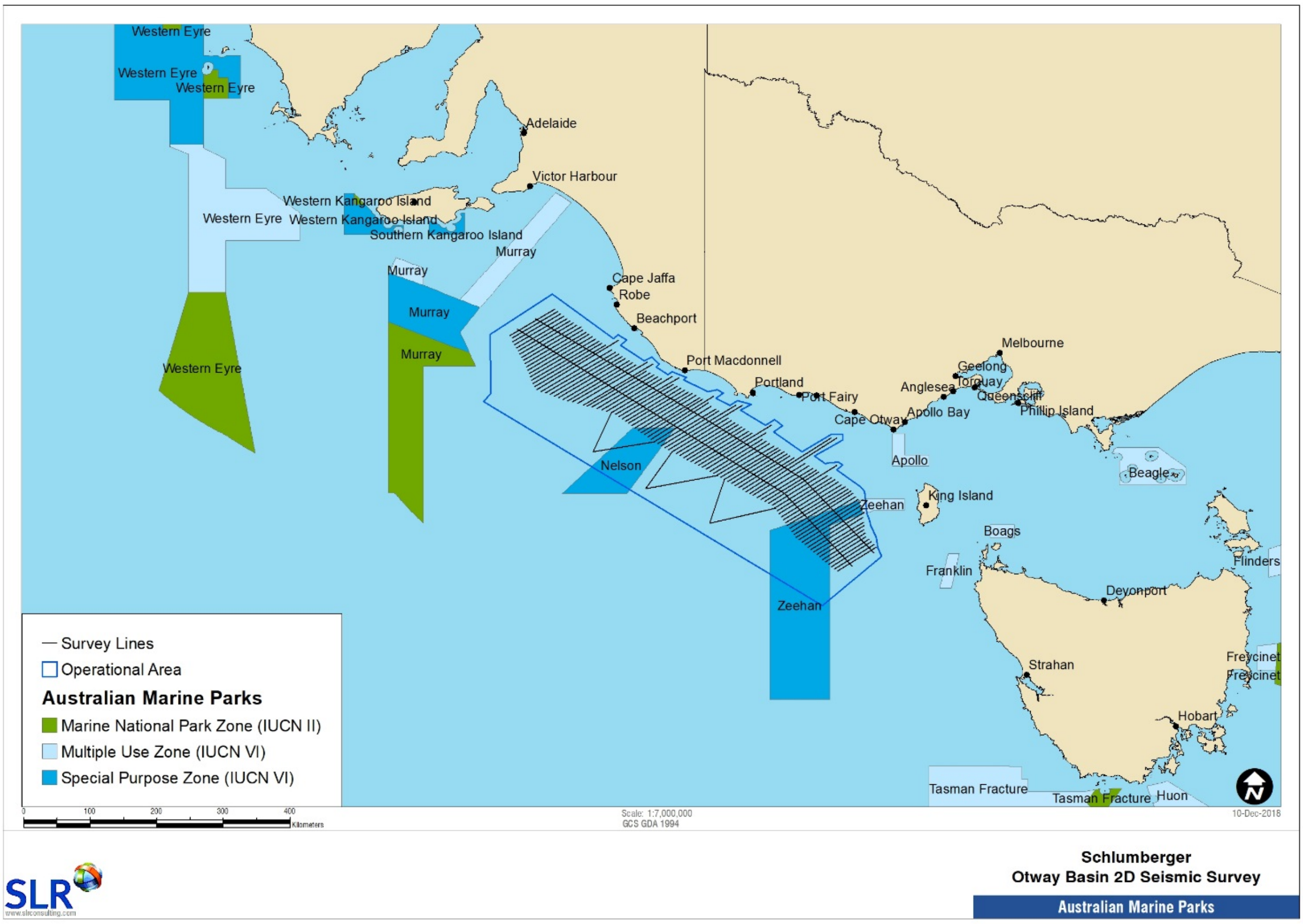
A wide range of activities are allowed or may be authorised within a Managed Resource Protected Area as long as the activities are consistent with the IUCN management principles and will not have an unacceptable impact on the values of the area.

The UNCN Category VI is split into two designations:

- Multiple Use Zones – provide for a general sustainable use by allowing activities that do not significantly impact on benthic habitats; and
- Special Purpose Zone – provides for limited natural resource use by limiting access to mining and low-level extractive activities.

Two Marine Parks are located within the Otway Basin 2DMC MSS Operational Area and further descriptions of the habitats and associated marine fauna with these parks are provided below. The Zeehan Marine Park has a special purpose zone and a multiple use zone as part of its classification (**Figure 33**).

Figure 33 Australian Marine Parks within the Operational Area and Wider Environment



Note: II - National Park; VI - Managed Resource Protected Area.

5.3.3.2 Australian Marine Parks within the Otway Basin 2DMC MSS Operational Area

Both the Nelson and Zeehan Australian Marine Parks within the Otway Basin 2DMC MSS Operational Area are classified as IUCN Category VI, which are categorised as 'Managed Resource Protected Areas'.

Mining operations (including seismic surveys) are permitted within Australian Marine Parks in accordance with a Mining Class Approval, issued by the Director of National Parks under s359B of the EPBC Act. Marine Park Zones that are listed as 'Approved' within the Class Approval include all zones located within the Operational Area (Nelson and Zeehan), as well as four of the six zones located within the wider environment (Murray – Special Purpose, Apollo, Boags and Franklin). The 'Murray – Marine National Park' and 'Murray Multiple Use' zones are not listed as approved, so have been assessed further within **Section 7.2.2.4.1**.

The Class Approval requires the proposed application (i.e. this EP) to be subject to the processes under the OPGGS Act and the Offshore Minerals Act, 1994, as well as being assessed under Chapter 4 of the EPBC Act; where any assessment by the Director of National Parks regarding impacts on Marine Park values is not required (Director of National Parks, 2013).

As such NOPSEMA will be assessing the activities included within this EP to ensure they are consistent with the Management Plan for these Marine Parks.

5.3.3.2.1 Nelson Marine Park – Special Purpose Zone

The Nelson Marine Park covers 6,123 km^2 and spans the deepwater ecosystems below 3,000 m from South Australia to west of Tasmania (**Figure 33**). The Marine Park includes a number of geological features such as plateaus, rocky knolls, canyons and the abyssal plains.

There is little known about the benthic diversity in this Marine Park; however, it is known to be an important migration area for humpback whales, and blue, fin and sei whales are also likely to migrate through this area.

5.3.3.2.2 Zeehan Marine Park – Special Purpose Zone and Multiple Use Zone

The Zeehan Marine Park is located 118 km northwest of Tasmania and is split into two zones; 95% is categorised as 'Special Purpose Zone' and 5% as Multiple Use Zone (**Figure 33**). The Zeehan Marine Park covers an area of 19,897 km^2, with water depths ranging from the shallow continental shelf (~50 m) down to the abyssal plain (over 3,000 m). The Marine Park has ecosystems, habitats and communities that are associated with the West Tasmania Transition (**Table 25**), Western Bass Strait Shelf Transition (**Table 25**) and associated sea-floor features such as abyssal plains and deep ocean floors, and also includes four submarine canyons that incise the continental slope from the shelf edge down the abyssal plain.

Biodiversity and productivity in this region are influenced by the Zeehan current.

The Marine Park includes a variety of seabed habitats on the continental shelf, such as exposed limestone, that support a range of animal communities including large sponges and other sessile invertebrates. On the continental slope, thickets of low invertebrates such as lace corals and sponges are present.

The area is an important migration area for blue and humpback whales, and also provides important foraging habitat for black-browed, wandering and shy albatross, and great-winged and cape petrels.

Commercially fished species found within this Marine Park include Tasmanian giant crabs. It also provides a nursery ground for blue warehou and ocean perch. Although not commercially fished, white sharks are also known to use this area to forage.

5.3.3.3 Within the Wider Environment

Of the four Marine Parks located in the wider environment, three are classified as IUCN Category VI and one (Murray Marine National Park) is IUCN Category II.

5.3.3.3.1 Murray Marine Park – Marine National Park Zone, Special Purpose Zone and Multiple Use Zone

The Murray Marine Park is located south of the Murray River Mouth and stretches out to the EEZ, over 400 km offshore, covering a total area of 25,803 km^2 (DoEE, 2018r). Nearly half of the park (12,749 km^2) is IUCN Category II (Marine National Park), with 7,147 km^2 of Category VI (Special Purpose Zone), and 5,907 km^2 of Category VI (Special Purpose Zone) (**Figure 33**). The Murray Marine National Park (Category II) is 17.5 km from the Operational Area and 54 km from the closest survey line.

This Marine Park covers a wide range of different habitats and communities and spans the Lacepede Shelf, continental slope and deeper water ecosystems that extend from South Australia to Tasmania. Within the Marine Park is the Murray Canyon; considered to be one of the most spectacular geological formations on the Australian continent margin. It descends to 4,600 m below sea level and stretches for more than 150 km (DoEE, 2018r).

The Murray Marine Park protects samples of representative key features in the area associated with the continental shelf and slope, abyssal plain and the Sprigg Canyon.

The inshore waters of the Murray Marine Park are important for those marine species that are on migratory routes and in particular, southern right whale uses the inshore area to nurse their young (**Figure 22**). In the offshore waters of the Marine Park, many species of seabird utilise the area foraging.

Upwelling within the Marine Park is known to occur; however, these upwelling events are less strong than what occurs further to the east in association with the Bonney Upwelling (**Section 5.3.8.1**). There have been several sightings of blue whales in the Marine Park but this does not indicate it is a high use area for this species of whale; however, control measures are in place to prevent acoustic disturbance to whales (**Table 66**). Similar to the other Marine Parks in the area, white sharks are also known to forage through the area.

To summarise, the major conservation values within the Murray Marine Park include:

- Examples of ecosystems, habitats and communities associated with the Spencer Gulf Shelf Province, Southern Province and the West Tasmanian Transition and associated sea-floor features (i.e. abyssal plain/deep ocean floor, canyons, escarpment, knoll/abyssal hill, shelf, slope and terrace);
- Features with high biodiversity and productivity: Bonney coast upwelling, shelf rocky reefs and hard substrate;
- Important foraging areas for blue, sei and fin whales, Australian sea lions, wandering, black-browed, yellow-nosed and shy albatross, great-winged petrels, flesh-footed and short-tailed shearwaters, and white-faced storm petrels;
- Important breeding area for southern right whales; and
- An important migration pathway for humpback whales (DoEE, 2018r).

5.3.3.3.2 Apollo Marine Park – Multiple Use Zone

With a total area of 1,184 km^2, the Apollo Marine Park is located 6 km south of Cape Otway and 47 km northeast of the Operational Area. It has ecosystems, habitats and communities that are associated with the Western Bass Strait Shelf Transition and the Bass Strait Province (**Table 25**), as well as sea floor features such as deep/hole/valley and shelf environments.

Major conservation values of the Apollo Marine Park include (Director of National Parks, 2013):

- Examples of ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province, including associated sea-floor features (i.e. deep/hole/valley and shelf environments);
- Important migration area for blue, sei and humpback whales;
- Important migration area for black-browed and shy albatross, Australasian gannet, short-tailed shearwater and crested tern; and
- An important heritage site – wreck of the MV *City of Rayville* (located approximately 14 km off Cape Otway, 66 km from the nearest survey line, in 70 m of water).

5.3.3.3.3 Boags Marine Park – Multiple Use Zone

With a total area of 537 km^2, the Boags Marine Park is located 37 km north of the northern tip of Tasmania, 127 km east of the Operational Area. It has ecosystems, habitats and communities that are associated with the Bass Strait Shelf Province (**Table 25**), and contains sea floor features that include plateau, and tidal sand-wave/sandbank environments. Marine environments here are thought to contain a rich array of life, particularly soft-bottom benthic organisms including polychaete worms, molluscs and crustaceans.

Major conservation values of the Boags Marine Park include (Director of National Parks, 2013):

- Examples of ecosystems, habitats and communities associated with the Bass Strait Shelf Province, including associated sea-floor features (plateau, tidal sand-wave/sandbank environments); and
- Important foraging areas for shy albatross, Australasian gannet, short-tailed shearwater, fairy prion, black face cormorant, common diving petrel and little penguin.

5.3.3.3.4 Franklin Marine Park – Multiple Use Zone

With a total area of 621 km^2, the Franklin Marine Park is located 26 km west of the northern tip of Tasmania, 75 km east of the Operational Area. It has ecosystems, habitats and communities that are associated with the Western Bass Strait Shelf Transition and the Tasmanian Shelf Province (**Table 25**), as well as sea floor features such as deep/hole/valley and shelf environments, escarpment and plateau. Water depth varies between 40 and 150 m, with the sloping sea floor covered by both fine and coarse sediments. The reserve provides a feeding ground for the many seabirds that populate the islands off the northern tip of Tasmania.

Major conservation values of the Franklin Marine Park include (Director of National Parks, 2013):

- Examples of ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Tasmanian Shelf Province, including associated sea-floor features (i.e. deep/hole/valley, shelf, escarpment and plateau environments); and
- Important foraging areas for shy albatross, Australasian gannet, short-tailed shearwater, fairy prion, little penguin, common diving petrel, black faced cormorant and silver gull.

5.3.4 State Marine Parks Marine National Parks, Marine Sanctuaries, Marine Reserves, and Fisheries Research Areas

There are ten areas located near the Operational Area (i.e. within 100 km) that are classified as either State Marine Parks, Marine National Parks, Marine Sanctuaries, and Marine Reserves, and 12 locations further afield from the Operation Area, with most within the coastal waters of South Australia and Victoria (**Table 27** and **Figure 34**). Further afield Protected Areas include Conservation Parks, Marine Parks, Marine National Parks, Marine Sanctuaries, Marine Nature Reserves, Recreation Reserves, and Fisheries Research Areas.

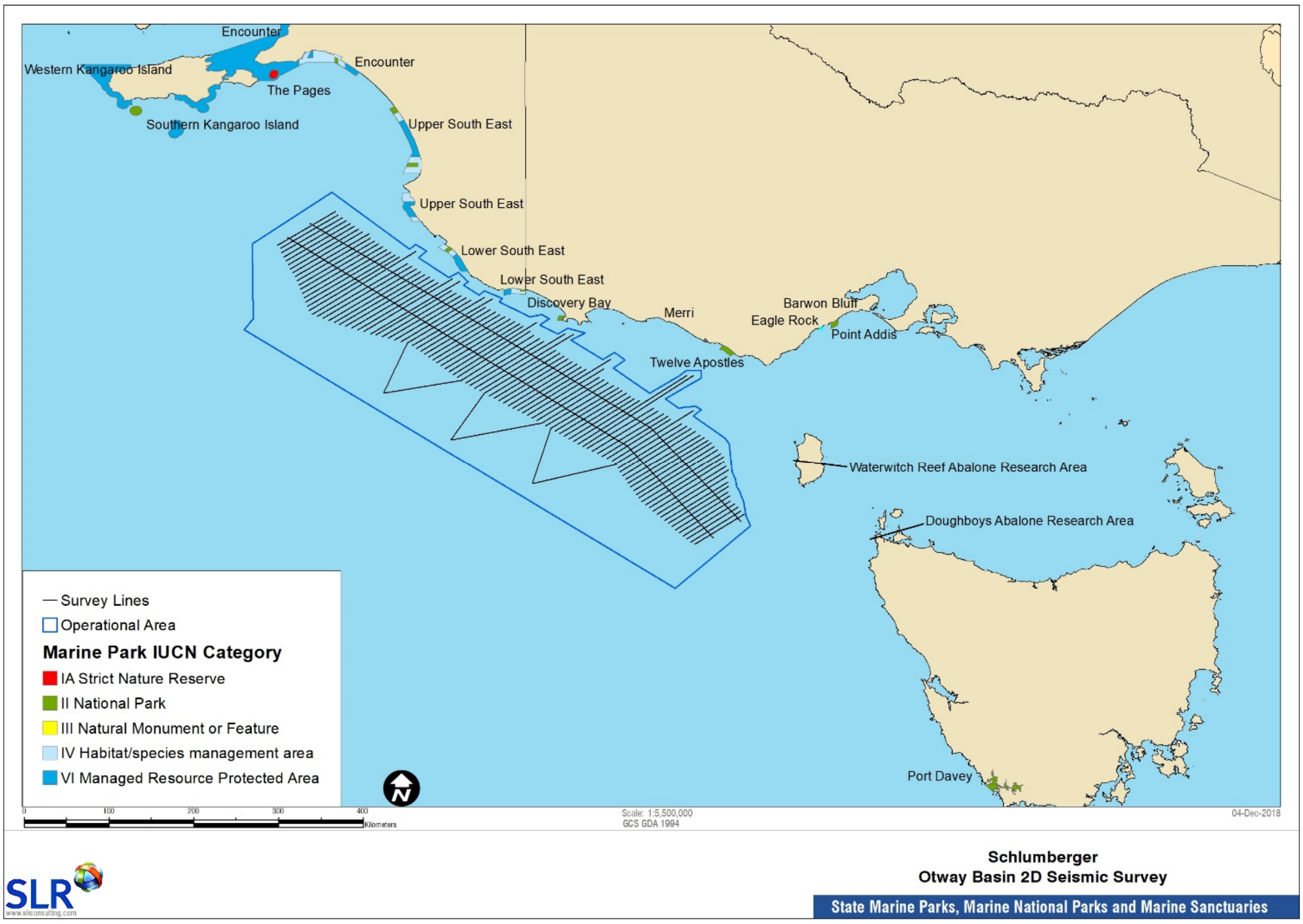
The western coast of Tasmania has additional zones of Protected Coastal Waters. These are encompassed within the State's onshore Conservation Areas, State Reserves, and Nature Reserves, many of which extend offshore approximately 300 m and are further detailed in **Section 5.3.4.4**.

Table 27 State Marine Parks, Marine National Parks, Marine Reserves, Marine Sanctuaries, Conservation Parks, and Fisheries Research Areas near the Otway Basin 2DMC MSS Operational Area

State	Feature	Name	IUCN Category	Distance from Operational Area
South Australia	Marine Park	Lower South East	II IV VI	3 and 4 km
South Australia	Marine Park	Upper South East	II IV VI	26 and 62 km
South Australia	Marine Park	Encounter	II IV VI	138 km
South Australia	Marine Park	Southern Kangaroo Island	VI	142 km
South Australia	Conservation Park	The Pages	1A	146 km
South Australia	Marine Park	Western Kangaroo Island	II and VI	186 km
Victoria	Marine National Park	Discovery Bay	II	8 km
Victoria	Marine National Park	Twelve Apostles	II	30 km
Victoria	Marine Sanctuary	The Arches	III	35 km
Victoria	Marine Sanctuary	Merri	III	60 km
Victoria	Marine Sanctuary	Marengo Reef	III	95 km
Victoria	Marine Sanctuary	Eagle Rock	III	146 km
Victoria	Marine Sanctuary	Point Danger	III	154 km
Victoria	Marine Sanctuary	Barwon Bluff	III	161 km
Victoria	Marine Sanctuary	Point Addis	III	162 km
Victoria	Recreation Reserve	Ex-HMAS Canberra	Not listed	188 km
Victoria	Marine National Park	Port Phillip Heads	II	192 km
Tasmania	Fisheries Research Area	Waterwitch Reef Abalone Research Area	N/A	59 km
Tasmania	Fisheries Research Area	Doughboys Abalone Research Area	N/A	112 km
Tasmania	Marine Nature Reserve	Port Davey	II	356 km

Note: IUCN Categories: IA - Strict nature reserve; II - National Park; III - Natural Monument or Feature; IV - Habitat/species management area; VI - Managed Resource Protected Area.

Figure 34 State Marine Parks, Marine National Parks, Marine Reserves, Marine Sanctuaries, Conservation Parks, and Fisheries Research Areas within the wider environment, Categorised by IUCN Conservation Status



5.3.4.1 South Australia Conservation and Marine Parks

There are eight South Australian Protected Areas of relevance to the Operational Area; one Conservation Park and seven Marine Parks. Conservation Parks are established for the purpose of conserving wildlife or the natural or historic features of the land. South Australian Marine Parks have been zoned for multiple uses that provide varying levels of conservation, recreational and commercial use. Assigned zones depend on the intended outcome and include: general managed use zones, habitat protection zones, sanctuary zones, and restricted access zones (National Parks SA, 2018). The legislative basis for Victorian Marine Parks is provided in the Marine Parks Act 2007, with Management Plans providing the statutory basis for the management of each Marine Park. Management plans for South Australian Marine Parks have been developed around four management priorities and associated strategies in order to meet the objectives of the Marine Parks Act 2007. Management priorities are: protection, stewardship through community involvement, performance assessment, knowledge and review, and compliance (DEWNR, 2012).

5.3.4.1.1 Pages Conservation Park

The Pages Conservation Park lies 146 km to the west of the Operational Area, south-east of Cape Jervis, and consists of The Pages Island Group (i.e. North Page Island and South Page Island) and surrounding waters. This Conservation Park was established in order to protect the breeding areas of Australian sea lions and seabirds. The Australian sea lion breeding colony supported on The Pages Islands is the world's second largest (DEWNR, 2012). Due to their steep cliff sides, access to these islands is usually only possible via helicopter.

5.3.4.1.2 Encounter Marine Park

The Encounter Marine Park covers approximately 3,119 km^2 and lies 138 km to the west of the Operational Area. It covers the waters off southern metropolitan Adelaide and the Fleurieu Peninsula and continues past the Murray Mouth to the Coorong Coast. The Marine Park extends around the north-eastern coastline of Kangaroo Island and partially, or completely, overlaps a number of other Protected Areas, including the Pages Conservation Park. Habitats within the Encounter Marine Park include sheltered and high energy sandy beaches and dune systems, coastal cliffs and rocky headlands, intertidal, shallow and deep-water reefs, islands, estuaries, saltmarshes, seagrass meadows, and deep-water trenches. Southern right whales breed and calve within Encounter Bay, while Australian sea lions breed on the Pages Islands. Tidal flows through Backstairs Passage distribute nutrients between regions. Giant sponges and gorgonian corals are found in the deep trenches. A number of commercial and recreational fisheries operate within the park, while tourism operations such as charter fishing, diving, and marine mammal watching also occur.

The Encounter Marine Park is managed under the '*Encounter Marine Park Management Plan 2012*' which provides for the protection of marine and coastal biodiversity and life-sustaining ecological processes, the protection of natural, European and Aboriginal cultural heritage, and provides for ongoing ecologically sustainable development and use (DEWNR, 2012).

5.3.4.1.3 Southern Kangaroo Island Marine Park

Southern Kangaroo Island Marine Park covers 673 km^2 and abuts the southern coast of Kangaroo Island between D'Estrees Bay and the western end of Seal Bay Conservation Park, and includes the offshore Young Rocks, North Rock, and South West Rock. The park lies 142 km from the boundary of the Operational Area. The Southern Kangaroo Island Marine Park is fully exposed to Southern Ocean winds and swells, with exposed cliffs, rocky headlands, and wave-cut platforms dominating the park. Fringing and deep-water reefs are interspersed by sandy seafloor, while significant seagrass beds can be found in the more sheltered waters of D'Estrees Bay. A breeding colony for Australian sea lions at Seal Bay is the most iconic feature of the park, with New Zealand fur seal colonies also found here. The exposed coastline supports nesting habitat for osprey and white-bellied sea eagles, while beaches support shorebirds such as hooded plover. The Marine Park is a popular tourist destination while commercial and recreational fisheries operate within the park's waters. European sealing and whaling occurred within the Marine Park.

The Southern Kangaroo Island Marine Park is managed under the '*Southern Kangaroo Island Marine Park Management Plan 2012*' (DEWNR, 2012a).

5.3.4.1.4 Western Kangaroo Island Marine Park

The Western Kangaroo Island Marine Park lies 186 km north-west of the Operational Area and covers 1,020 km^2 between Cape Forbin and Sanderson Bay. The Marine Park includes the North and Casuarina Islets and Lipson Reef. The southern and western coasts of the Marine Park are exposed to strong winds, large swells, and seasonal nutrient-rich upwelling. The coast is comprised of rugged, exposed cliffs and headlands interspersed by beaches, with reefs found along most of the coastline which transition to sandy seafloor habitats towards deeper waters. The park supports the second largest concentration of New Zealand fur seals on Kangaroo Island, a significant breeding site for Australian fur seals, and is a haul out area and occasional breeding site for Australian sea lions. Fish species of conservation concern include western blue groper, harlequin fish, and western blue devil. There are notable tourist destinations adjacent to the park, while commercial fisheries operate within its boundaries.

The Western Kangaroo Island Marine Park has a rich European exploration and settlement history, with a number of protected shipwreck sites, and State and Commonwealth Heritage listed lighthouses and associated jetty, store, and landing sites also occurring within its boundaries.

The '*Western Kangaroo Island Marine Park Management Plan 2012*' provides the statutory basis for the management of the Western Kangaroo Island Marine Park (DEWNR, 2012b).

5.3.4.1.5 Upper South East Marine Park

The Upper South East Marine Park covers 906 km^2 and is divided into two sections; from 11 km north of Tea Tree Crossing on the Coorong Ocean Beach to Maria Creek at Kingston SE, and from Wright Bay to the northern-most point of Stinky Bay. These two sections are 26 and 62 km, respectively, from the Operational Area.

Habitats within the Upper South East Marine Park include high-energy dune-backed sandy beaches, reefs, seagrass beds, and kelp forests, and are strongly influenced by the Bonney Upwelling. These habitats support a variety of flora and fauna of conservation importance. For example, Baudin Rocks supports breeding and haul-out areas for Australian sea lions and fur seals, as well as roosting and breeding sites for seabirds and coastal species, while seagrass meadows at Lacepede Bay provide nursery areas for fish and invertebrates.

The Marine Park supports commercial and recreational fisheries and includes the Limestone Coast; an important tourism destination. The Ngarrindjeri and Buangid people have traditional associations with areas within the park, and many European shipwrecks can be found within the park's boundaries. The Upper South East Marine Park is managed under the '*Upper South East Marine Park Management Plan 2012*' (DEWNR, 2012c).

5.3.4.1.6 Lower South East Marine Park

At approximately 4 km from the Operational Area, the Lower South East Marine Park is the closest Marine Park of relevance to the Otway Basin 2DMC MSS and lies within the Otway Bioregion. This Marine Park covers an area of 360 km^2 and is divided into two sections; adjacent to Canunda National Park, and the area extending from Port MacDonnell Bay to the South Australia/Victoria border.

Habitats covered under this Marine Park include high-energy sandy beaches, freshwater springs, reefs, kelp forests and algal communities. The Bonney Upwelling is a strong influence within the park, with blue whales taking advantage of the high biological productivity. Within Lower South East Marine Park are various sites that are important for seabirds and shorebirds. Commercial and recreational fishing occurs within the park, while tourism operations based on diving and cruise ships are major economic activities within the wider region. The Buandig Aboriginal people have traditional associations within the park, while the rocky coast from Cape Buffon to McIntyre Beach is among the highest ranked areas of coastal scenic quality in South Australia.

This park is managed under the '*Lower South East Marine Park Management Plan 2012*' (DEWNR, 2012d).

5.3.4.2 Victoria Marine National Parks, Marine Sanctuaries and Recreation Reserves

There are four Marine National Parks and six Marine Sanctuaries within Victorian jurisdiction that are of relevance to the Operational Area. Victoria's Marine National Parks and Marine Sanctuaries were established in 2002 and are highly protected, no-take areas. Management Zones have not been defined for Victorian Marine National Parks and Marine Sanctuaries. The Victoria Marine National Parks and Marine Sanctuaries of relevance to the Operational Area are described below. A Recreation Reserve has also been established around the ex-HMAS *Canberra* shipwreck and is also described below.

5.3.4.2.1 Discovery Bay Marine National Park

Discovery Bay Marine National Park lies 20 km west of Portland and is 8 km directly inshore of the Operational Area. Protected within the 27.7 km^2 park is the largest coastal basalt formation in western Victoria, and some of the highest wave energy environments in the state (Barton *et al*., 2012). Main habitats protected include subtidal reefs, and soft sediments, with a small number of intertidal reefs and soft sediment habitat. In deep waters (33 – 55 m), calcarenite reefs support thick cover of sessile invertebrates (e.g. sponges, ascidians, bryozoans and gorgonians), with shallower basaltic reefs covered with large kelps such as *Ecklonia radiata*. Ridges of fine sand separate the reefs. Within the water column is a variety of planktonic and pelagic organisms, supported by the cold, nutrient rich waters. Specific species and communities of conservation significance within Discovery Bay Marine National Park include the endemic southern hooded shrimp, western blue groper, southern bluefin tuna, grey nurse shark, white shark, Australian and New Zealand fur seals, blue whale, southern elephant seal, wandering albatross, and southern giant petrel (ParksVIC, 2018). Aboriginal tradition indicates that the Marine National Park is part of Gunditjmara Country (Barton *et al*., 2012).

Management of the Discovery Bay Marine National Park is under the '*Ngootyoong Gunditj Ngootyoong Mara South West Management Plan'* (NGNM, 2015).

5.3.4.2.2 Twelve Apostles Marine National Park

The Twelve Apostles Marine National Park is located 30 km inshore of the Operational Area and covers 75.1 km^2 adjacent to Broken Head along the coast to Pebble Point, offshore to 3 NM (Barton *et al*., 2012). The majority of the park lies below the high tide mark; however, additional land above this mark includes Mutton Bird Island and offshore rock stacks such as the Twelve Apostles. In winter the park is exposed to south-westerly Southern Ocean winds and swells and in spring/summer by those arising from the south-east in Bass Strait. Main habitats protected include limestone cliffs, intertidal reef platforms, high profile subtidal rocky reefs, limited intertidal soft sediments and beaches, extensive sandy subtidal soft sediment and the water column. The Twelve Apostles Marine National Park is regarded as having the highest diversity of intertidal invertebrates on limestone reefs in Victoria. Specific species and communities of conservation significance include southern bluefin tuna, grey nurse shark, white shark, wandering albatross, little egret, Australian bittern, little penguin, hooded plover, short-tailed shearwater, southern right whales, humpback whales, and New Zealand and Australian fur seals (ParksVIC, 2018a). Indigenous tradition indicates that this park is part of Kirrae Whurrong and Gadubanud Country. The Twelve Apostles is one of the key attractions on the Great Ocean Road, and although much of the park is inaccessible due to rough sea conditions, lookouts along the coastline provide a number of valuable viewing platforms (ParksVIC, 2006).

The joint '*Twelve Apostles Marine National Park and The Arches Marine Sanctuary Management Plan'* provides a strategic guide for management of the Twelve Apostles Marine National Park (ParksVIC, 2006).

5.3.4.2.3 Point Addis Marine National Park

Point Addis Marine National Park covers an area of 46 $km^2$from the high-water mark to 3 NM offshore (ParksVIC, 2005) and is located 162 km north-east of the Operational Area. The coastline within the park is exposed and subject to high wave energy and includes the famous surf beach Bells Beach. Main habitats protected are beaches (including intertidal soft sediment), intertidal and subtidal reefs, subtidal soft sediments (including unusually large rhodolith beds in deeper waters (25 – 39 m)), and the water column (ParksVIC, 2018b). Specific species and communities of conservation significance within the park include fairy tern, common tern, Caspian tern, hooded plover, wandering albatross, shy albatross, yellow-nosed albatross, black-browed albatross, fairy prion, blue whale, southern right whale, killer whale, Australian fur seals, pacific ridley turtle, the red algae *Rhodymenia verrucosa* and *Webervanbossea splachnoides*, the chiton *Ischnochiton versicolor*, and the green alage *Caulerpa catoides* (ParksVIC, 2018b). Indigenous tradition indicates that this park is part of Wadda wurrung Country (ParksVIC, 2018b).

The Point Addis Marine National Park is managed under the joint '*Point Addis Marine National Park, Point Danger Marine Sanctuary, and Eagle Rock Marine Sanctuary Management Plan 2005'* (ParksVIC, 2005).

5.3.4.2.4 Port Phillip Heads Marine National Park

The Port Phillip Heads Marine National Park covers a total of 34.75 km^2 and is made up of six separate marine areas around the southern end of Port Phillip; Swan Bay (20.83 km^2), Mud Islands (6.25 km^2), Point Lonsdale (3.77 km^2), Point Nepean (3.77 km^2), Popes Eye (0.031 km^2), and Portsea Hole (0.098 km^2). With the exception of part of the Point Lonsdale and Point Nepean areas, the majority of the park is within the confines of Port Phillip Bay. The outer southern coasts of Point Lonsdale and Point Nepean are exposed to south-westerly swells from Bass Strait, with waves averaging 1.7 m breaking on the outer reef flats. Between the heads lies a narrow and turbulent 100 m deep stretch of water. The reefs of Point Lonsdale and Point Nepean support high algal, invertebrate, and fish diversity and abundance. Specific species and communities of conservation significance include southern right whale, humpback whale, southern elephant seal, Australian fur seal, southern bluefin tuna, grey nurse shark, white shark, and 58 threatened bird species. Indigenous tradition indicates that the park is part of Country of Wathaurung in the west, and Country of Boonwurrung in the east (ParksVIC, 2018c).

The Port Phillip Heads Marine National Park is managed under the '*Port Phillip Heads Marine National Park Management Plan 2006'* (ParksVIC, 2006a).

5.3.4.2.5 Merri Marine Sanctuary

The 0.25 km^2 Merri Marine Sanctuary (ParksVIC, 2007) lies 60 km inshore of the Operational Area near Warrnambool, with its boundaries extending between Thunder Point in the west and Breakwater Rock in the east and offshore around Merri and Middle Islands (ParksVIC, 2007; Barton *et al*., 2012). In winter the sanctuary is exposed to large Southern Ocean swells and south-westerly winds, with the Bonney Upwelling bringing cold, nutrient-rich water in spring and summer. The Merri River Estuary flows into the sanctuary. Main habitats protected are intertidal and subtidal soft sediments (mainly fine sand), intertidal and subtidal reefs made of calcarenite, and the water column (ParksVIC, 2018d). Intertidal soft sediments are mainly found at the mouth of the Merri River and although this area has a low macroinvertebrate diversity (ParksVIC, 2018d), it provides important feeding habitat for a range of shorebirds, including 51 threatened species (Barton *et al*., 2012). Subtidal reefs are the dominant habitat, and are patchy and interspersed with sand, or consolidated hard reef cut by deep depressions and crevices. Specific species and communities of conservation significance within the Merri Marine Sanctuary include the pot-bellied seahorse, Australasian bittern, fairy tern, gull-billed tern, little egret, wandering albatross, southern giant petrel, southern elephant seal, Australian fur seal, Australian sea lion, and leopard seal. Indigenous tradition indicates that the sanctuary is part of Kirrae Whurrong and Gunditjmara Country (ParksVIC, 2018d).

The '*Merri Marine Sanctuary Management Plan 2007'* provides the basis for the management of the Sanctuary (ParksVIC, 2007).

5.3.4.2.6 Eagle Rock Marine Sanctuary

Eagle Rock Marine Sanctuary covers 0.179 km^2, with its boundaries extending from the high-water mark around the base of Split Point between Castle Rock and Sentinel Rock, and offshore for approximately 300 m. The high wave energy along the coastline results in sand movement from the south-west in winter and south-east in spring/summer. Main habitats protected include intertidal and subtidal soft sediments, intertidal and subtidal reefs, and the water column. The reefs within the sanctuary are support a relatively diverse algal community. Specific species and communities of conservation significance include Caspian tern, white bellied sea eagle, sooty shearwater, Pacific gull, black faced cormorant, common diving petrel, Australian fur seal, the crab *Amarinus paralacustris*, marine snail *Belloliva leucozona*, and the red algae species *Muellerana wattsii, Psilothallia siliculose, Lesueuria mindeniana, Ahnfeltiopsis humilis,* and *Rhodopeltis australis*. Indigenous tradition indicates that the sanctuary is part of Wadda wurrung Country (ParksVIC, 2018e).

The Eagle Rock Marine Sanctuary is managed under the joint '*Point Addis Marine National Park, Point Danger Marine Sanctuary, and Eagle Rock Marine Sanctuary Management Plan 2005'* (ParksVIC, 2005).

5.3.4.2.7 Barwon Bluff Marine Sanctuary

Barwon Bluff Marine Sanctuary sits 161 km from the Operational Area and protects 0.17 km^2 of intertidal and subtidal reefs and beach areas from the base of the Barwon Bluff where the Barwon River meets Bass Strait. Water to the east of Point Flinders is relatively calm and influenced by tidal currents and the Barwon River, while to the west of Point Flinders, the intertidal platforms are exposed to high-energy south-westerly swells from Bass Strait. The main habitats protected by the sanctuary include intertidal and subtidal soft sediment and reefs, and the water column (ParksVIC, 2007a). Neptune's necklace (*Hormosira banksii*) is a key habitat forming algae species on the intertidal reefs, with the many invertebrate species found in the intertidal and subtidal reef systems providing feeding opportunities for migratory and threatened seabirds and shorebirds. Specific species and communities of conservation significance include a number of seabirds such as petrels, shy albatross, knot, egrets, terns, as well as two fish species of conservation significance; the dusky morwong and the longsnout boarfish (ParksVIC, 2018f). Marine mammals that pass through the sanctuary include various dolphins, killer whales, Australian fur seals, humpback whales and southern right whales (ParksVIC, 2007a). The subtidal reefs are easily accessible from the shore, providing opportunities for snorkelling, diving and educational field trips. Indigenous tradition indicates that Barwon Bluff Marine Sanctuary is part of Wathaurong Country (ParksVIC, 2018f).

The '*Barwon Bluff Marine Sanctuary Management Plan 2007'* provides the basis for the management of the Barwon Bluff Marine Sanctuary (ParksVIC, 2007a).

5.3.4.2.8 Port Danger Marine Sanctuary

The Port Danger Marine Sanctuary covers 0.217 km^2, extending from the high-water mark around the Point Danger headland and offshore for approximately 600 m to the east and 400 m to the south. It lies 154 km to the north-east of the Operational Area between the townships of Torquay and Jan Juc. The exposed coastline of the sanctuary is subject to strong winds and large swells from the south and south-west. Main habitats within the boundaries of the sanctuary are intertidal and subtidal soft sediments, intertidal and subtidal reefs, and the water column. Neptune's necklace is a key habitat forming algae on the intertidal reefs. The Port Danger Marine Sanctuary is particularly recognised the sea slug fauna found on intertidal and subtidal reefs, with 96 species recorded, many of which are endemic. Specific species and communities of conservation significance include 18 conservation listed species of seabird such as wandering albatross, Caspian tern, sooty shearwater, Pacific gull, common diving petrel, the crab *Hexapus granuliferus*, and marine snail *Tubercliopsis septapila*. Indigenous tradition indicates that the sanctuary is part of Country of Wadda wurrung (ParksVIC, 2018g).

The sanctuary is managed under the joint '*Point Addis Marine National Park, Point Danger Marine Sanctuary, and Eagle Rock Marine Sanctuary Management Plan 2005'* (ParksVIC, 2005).

5.3.4.2.9 Marengo Reef Marine Sanctuary

The 0.12 km^2 Marengo Reef Marine Sanctuary is approximately 150 m offshore and surrounds and includes the Little Henty Reef system. It is 95 km from the Operational Area. Two sections of the reef, the Inner Reef and Outer Reef, are usually exposed, and are separated by a narrow channel; 'the Gap' (ParksVIC, 2007b). Access to Outer Reef is restricted due to its importance as a haul out area for Australian fur seals, with the reef also declared a Special Protection Area and biotic site of state significance on account of the seal habitat. Large south-westerly swells affect Outer Reef, while inshore processes within Mounts Bay affect Inner Reef. Main habitats within the sanctuary include subtidal soft sediment, intertidal and subtidal reefs, and the water column. Specific species and communities of conservation significance include 13 conservation listed seabirds and shorebirds such as Australasian bittern, eastern great egret, common sandpiper, shy albatross, marine mammals such as Australian fur seals and elephant seals, and six fish species of conservation significance including barracouda, common gurnard perch, and dusky morwong. Indigenous tradition indicates that the sanctuary is part of Country of Gabubanud, with other aboriginal communities including the Kirrae Warrung, Framlingham Aboriginal Trust, Wathaurung Aboriginal Cooperative, and the Southern Otways Indigenous Group also having an association with the coastal region of the area (ParksVIC, 2018h).

The '*Marengo Reefs Marine Sanctuary Management Plan 2007'* provides the basis for the management of this Marine Sanctuary (ParksVIC, 2007b).

5.3.4.2.10 Arches Marine Sanctuary

The Arches Marine Sanctuary lies 35 km from the Operational Area. It covers an area of 0.48 km^2 and is situated 600 m offshore from Port Campbell (ParksVIC, 2018i). The sanctuary is open to south-west winds and swells from the Southern Ocean in winter, and south-east winds and swells in spring and summer. Main habitats protected include subtidal soft sediments, and subtidal limestone reefs in water depths between 19 and 25 m that consist of canyons, tunnels, arches, caverns, ledges and vertical sing holes. Subtidal reefs support diverse algae, sponge, bryozoan, hydroid, gorgonian, and sea star communities that are characteristic of deeper Bass Strait waters. Specific species and communities of conservation significance include southern bluefin tuna, grey nurse shark, white shark, southern right whale, humpback whale, southern elephant seal, Australian fur seal, leatherback turtle, shy albatross, black-browed albatross, short-tailed shearwater, pied cormorant, and black-faced cormorant. Indigenous tradition indicates that the Arches Marine Sanctuary is part of Country of Kirrae Whurrong and Country of Gadubanud (ParksVIC, 2018i).

The joint '*Twelve Apostles Marine National Park and The Arches Marine Sanctuary Management Plan'* provides a strategic guide for management of the Arches Marine Sanctuary (ParksVIC, 2006).

5.3.4.3 Ex-HMAS Canberra Recreation Reserve

The Ex-HMAS Canberra Recreation Reserve lies offshore from Ocean Grove in Bass Strait, 188 km from the Operational Area in waters 28 m deep. The ex-HMAS *Canberra* was a former warship in the Australian Navy that was scuttled in 2009 to become the first artificial dive reef in Victoria. The dive site provides wreck diving on the Canberra's flight decks, bridge, engine rooms, and galley and accommodation quarters. Access to the dive site within the Recreation Reserve is limited to those participating in diving or snorkelling activities and is only available through booking a permit to access the public mooring (ParksVIC, 2018j).

5.3.4.4 Tasmania Marine Nature Reserves and Fisheries Research Areas

Tasmania's west coast contains one Marine Nature Reserve and two Fisheries Research Areas of relevance to the Operational Area. These areas are further described below.

5.3.4.4.1 Port Davey Marine Nature Reserve

Port Davey Marine Nature Reserve is the only Marine Nature Reserve on the western coast of Tasmania and lies 356 km from the Operational Area. The 177.53 km^2 reserve is contained within the enclosed waters of Port Davy and includes Bathurst Channel and Bathurst Harbour, and extends inland for more than 20 km up to the high-water mark of all rivers, bays and estuaries. The reserve protects a range of habitats including open ocean, exposed reefs, steep gorges, bays and inlets, kelp forests, seagrass meadows, and muddy and gravelly sediments. It is accessible only by boat, light plane or on foot via a 5 – 7 day walk, with visitors requiring a park entry pass. Several hundred boat-based visitors visit the reserve each year, with commercial and recreational fisherman utilising the more sheltered waters within the reserve in periods of adverse weather (ParksTAS, 2018).

5.3.4.4.2 Fisheries Research Areas - Abalone

Fisheries Research Areas may have restrictions imposed on some types of recreational and commercial fishing depending on the research being conducted within the area. There are two Fisheries Research Areas on the west coast of Tasmania; the Waterwitch Reef Abalone Research Area 59 km from the Operational Area off King Island, and the Doughboys Abalone Research Area 112 km from the Operational Area off Cape Grim on the Tasmanian mainland. The taking of any fish by diving within these designated areas is prohibited, as is entering the research area for the purpose of diving or swimming beneath the surface (TASGov, 2009).

5.3.5 Wetlands of International Importance (Ramsar)

The Convention on Wetlands of International Importance (the **Ramsar Convention**) was inaugurated in Ramsar, Iran on 2 February 1971. The Ramsar Convention aims to stop international wetland loss and to conserve those that remain. The Convention encourages member countries to nominate sites containing representative, rare or unique wetlands to the List of Wetlands of International Importance ('Ramsar sites').

There are four near-coast Ramsar sites within the wider environment, and one further afield (**Table 28**, **Figure 35**). The closest, Piccaninnie Ponds Karst Wetlands and Glenelg Estuary/Discovery Bay, consist of wetlands situated in freshwater, estuarine and beach environments, sometimes running parallel to the coast within the dune systems. Some areas are tidal and provide habitat for a number of nationally and globally threatened bird species such as the orange–bellied parrot, the great knot, the far eastern curlew and the Australasian bittern (Ramsar, 2018). They also provided breeding/spawning habitat for native fish species including Yarra pygmy perch, the eastern little galaxias and the dwarf galaxias.

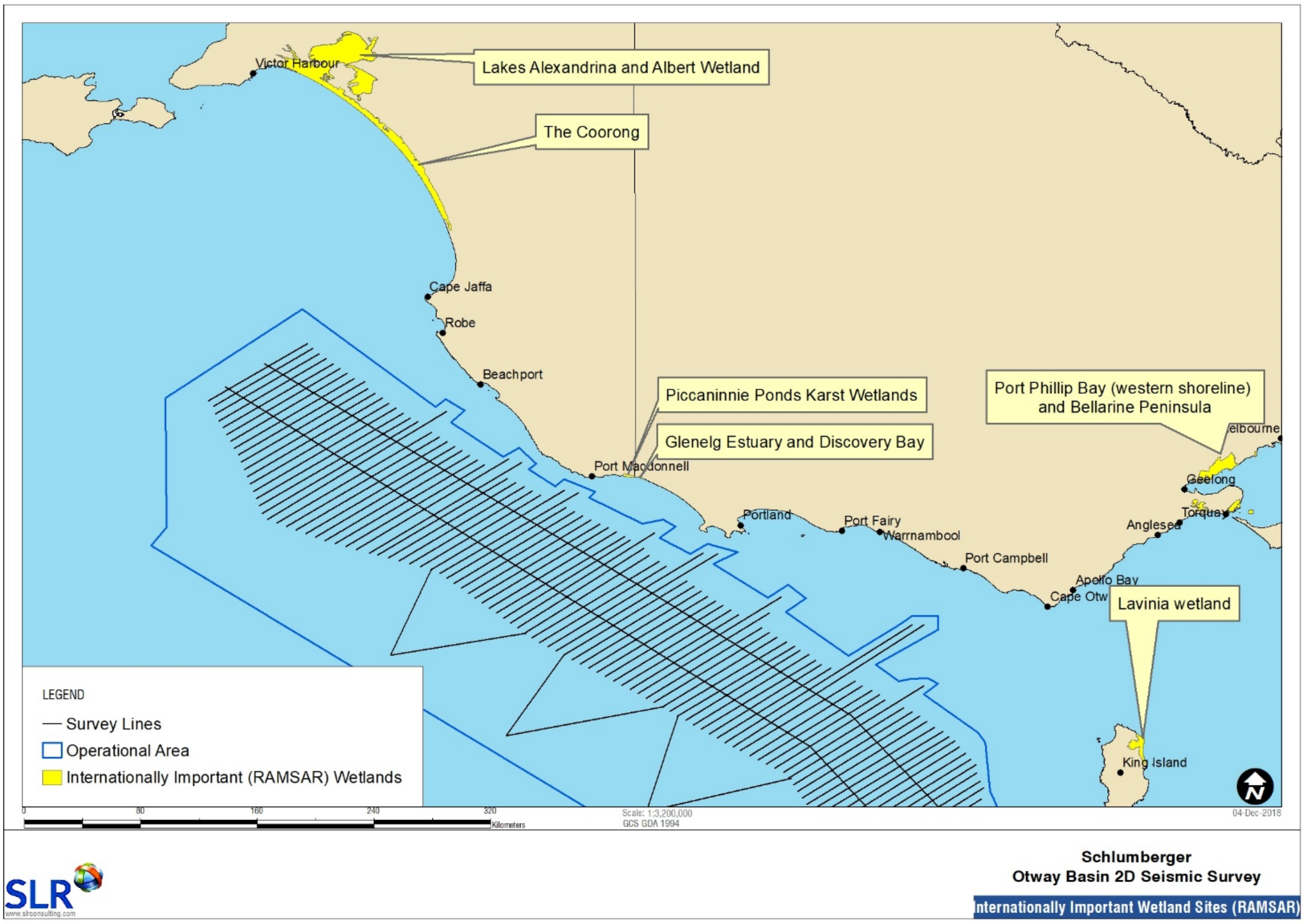
Lavinia Wetland is located on the north east coast of King Island, covering an area of 7,034 ha. This wetland includes a large estuary and saltmarsh, coastal lagoons, perched lakes, swamp forest and other smaller wetland areas (Newall & Lloyd, 2012). Significant values include around 200 ha of feeding habitat for the nationally endangered orange–bellied parrot, nationally and regionally rare plant species, habitat for nationally rare and threatened fauna (e.g. King Island scrubtit, green and gold frog), and nesting for water fowl and sea birds (including the fairy tern).

The largest Ramsar site, which encompasses the Coorong and Lakes Alexandrina and Albert Wetlands, covers a combined area of more than 1,400 km^2, stretching along the coast of South Australia east of Kangaroo Island at the mouth of the Murray River. The Coorong is an elongated saline lagoon that extends 100 km along the coast, separated from the sea by a narrow dune (DoEE, 2018s). Lake Alexandrina and Albert wetlands are fresh/brackish water. The sites provide important habitat for waterfowl including curlew sandpiper, banded stilt, red-capped plover, masked lapwing, redkneed dotterel, black swan, cape barren goose, musk duck, straw-necked ibis, royal spoonbill, rufus night heron and Australian pelican. The area is home to the threatened 'gahnia sedgeland' ecosystem and forms part of the endangered 'Swamps of the Fleurieu Peninsula'. The area is used for fishing, camping, boating, walking, wildlife observation and research.

Table 28 Coastal Wetlands of International Importance (Ramsar Sites) within Wider Environment

Ramsar Sites – Coastal Wetlands	Distance from Operational Area
Piccaninnie Ponds Karst Wetlands	19 km
Glenelg Estuary and Discovery Bay	26 km
Lavinia wetland	75 km
The Coorong, Lakes Alexandrina and Albert Wetlands	100 km
Port Phillip Bay (western shoreline) and Bellarine Peninsula	188 km

Figure 35 Near-coast Ramsar Sites within the Wider Environment



5.3.6 Nationally Important Wetlands

The spatial database titled *Directory of Important Wetlands in Australia* (DoEE, 2018t) identifies 15 coastal wetlands within the wider environment (**Table 29** and **Figure 36**) surrounding the Otway Basin 2DMC MSS Operational Area. This data set was collated by the Department of the Environment and Energy from various datasets including those supplied by relevant State agencies.

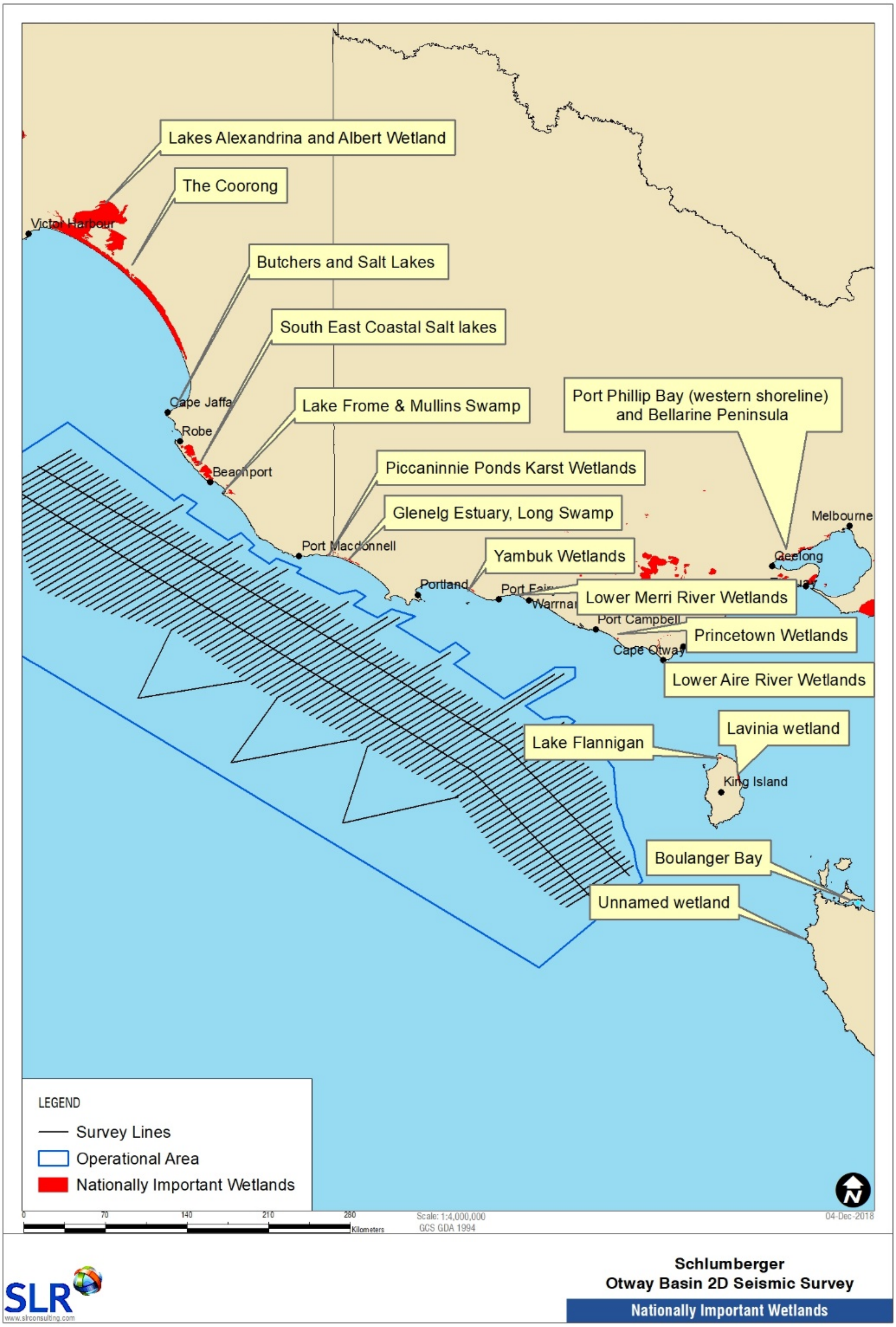
Coastal wetlands typically form in the lower reaches of river valleys where they meet estuarine habitat, sometimes forming elongated lakes parallel to the coast and separated from the ocean by dunes. Therefore, water is often brackish in the seaward extents, influenced by the tide and river flows. Some are seasonal, but all provide habitat for numerous species of flora and fauna, particularly waterfowl.

Some areas provide habitat for a number of nationally and globally threatened bird species such as the orange–bellied parrot, great knot, far eastern curlew, Australasian bittern, curlew sandpiper, banded stilt, red-capped plover, double banded plover, red necked stint, masked lapwing, redkneed dotterel, black swan, cape barren goose, pacific golden plover, musk duck, ruddy turnstone, straw-necked ibis, royal spoonbill, banded stilt, red necked avocet, rufus night heron, grey plover, marsh sandpiper and Australian pelican (DSE, 2003; Ramsar, 2018).

Table 29 Nationally Important Coastal Wetlands within the Wider Environment

Nationally Important Wetlands	Distance from Operational Area
Piccaninnie Ponds Karst Wetlands	19 km
Glenelg Estuary, Long Swamp and Discovery Bay	26 km
South East Coastal Salt Lakes	22 km
Lake Frome and Mulins Swamp	22 km
Yambuk Wetlands	46 km
Lower Merri River Wetlands	57 km
Unnamed Wetland (Tasmania)	118 km
Princetown Wetlands	38 km
Lower Aire River Wetlands	55 km
Butchers and Salt Lakes	64 km
Lake Flannigan	66 km
Lavinia wetland	75 km
Lakes Alexandrina and Albert Wetlands, The Coorong	100 km
Boulanger Bay – Robins Passage	138 km
Port Phillip Bay (western shoreline) and Bellarine Peninsula	197 km

Figure 36 Nationally Important Coastal Wetlands within the Wider Environment



5.3.7 Threatened Ecological Communities

A Threatened Ecological Community (**TEC**) is a group of native plants, animals and other organisms that naturally occur together and interact in a unique habitat, and are recognised as being *critically endangered*, *endangered* or *vulnerable* under the EPBC Act.

Four TEC's are located within the wider environment surrounding the Otway Basin 2DMC MSS Operational Area:

- Giant Kelp Forests of South East Australia (listed as '*Endangered'*);
- Subtropical and Temperate Coastal Saltmarsh (listed as '*Vulnerable'*);
- River Murray and associated wetlands (160 km from the Operational Area). Floodplains and groundwater systems from the junction of Darling River to the sea (listed as '*Approval Disallowed'*); and
- Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community (listed as '*Endangered'*).

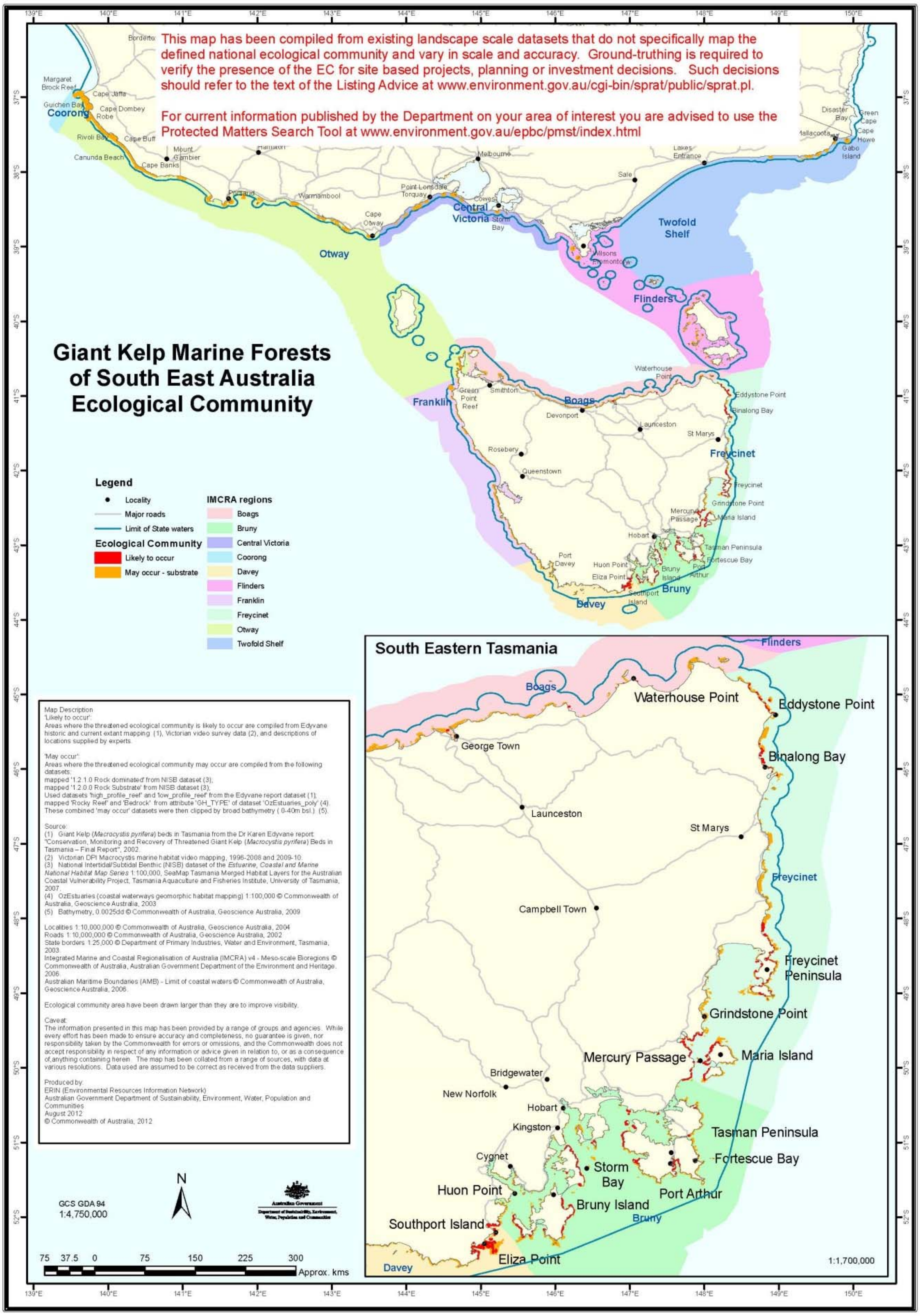
5.3.7.1 Giant Kelp Forests of South East Australia

Giant kelp (*Macrocystis pyrifera*) is a large brown algae that populates temperate rocky reefs in water depths of more than 8 m (DoSEWPC, 2012). The kelp grows vertically forming a forest with a closed or semi-closed canopy. This creates an understory and relatively sheltered seafloor with vast areas of habitat for other marine species such as fish, molluscs, bryozoans, polychaetes, crustaceans, echinoderms and sponges.

Giant kelp forests have undergone a gradual demise due largely to changing oceanographic conditions driven by climate change (DoSEWPC, 2012). Kelp forest loss is particularly evident on the eastern coast of Tasmania. The kelp forest areas that remain in Victoria, South Australia and Tasmania are protected under the EPBC Act as a TEC.

According to the giant kelp forest distribution map (**Figure 37**), there are no giant kelp forests "*Likely to occur*" within the Operational Area. However, kelp forests "*May occur*" on inshore rocky reefs between Cape Jaffa and Cape Otway, and along the western coast of Tasmania.

Figure 37 Giant Kelp Marine Forests of South East Australia Ecological Community



Source: DoSEWPC, 2018

5.3.7.2 Sub-tropical and Temperate Coastal Saltmarsh

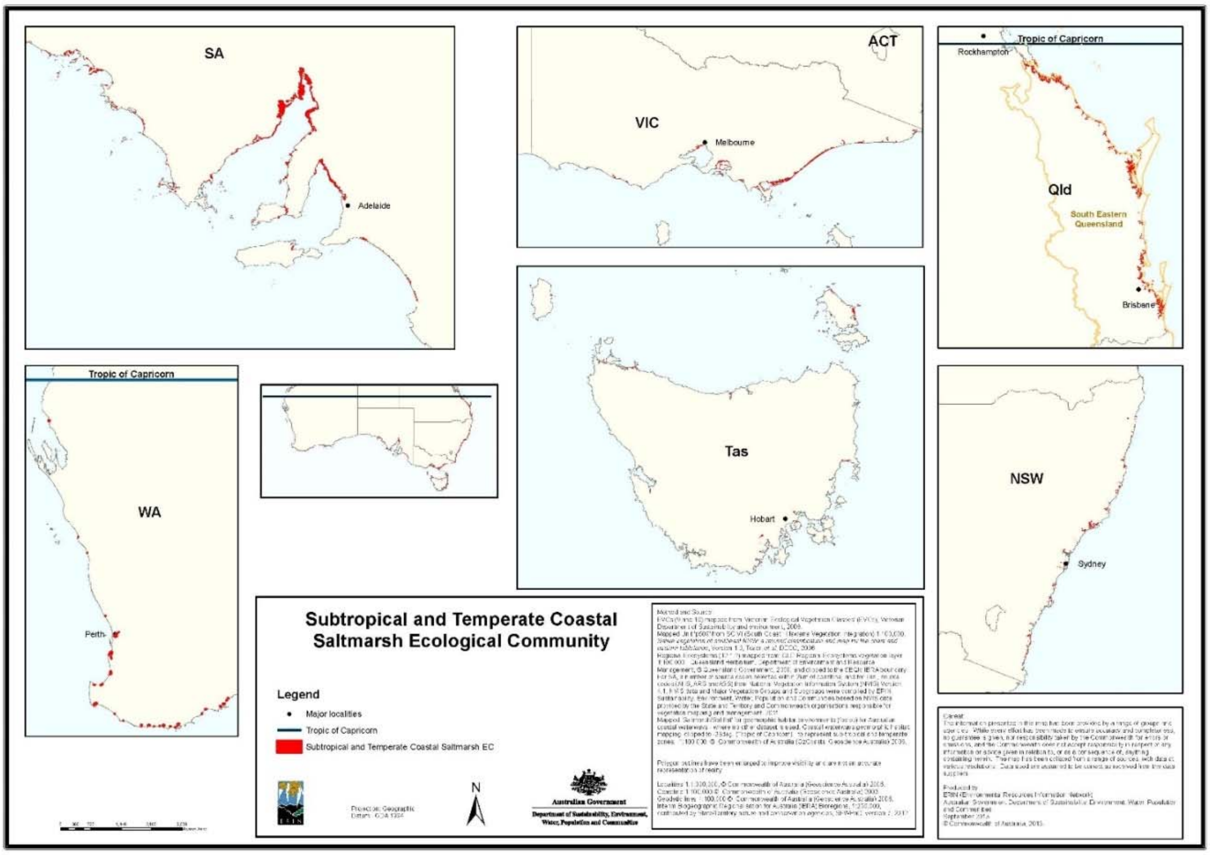
Coastal saltmarshes occur along the sub-tropical and temperate Australian coastline (DoEE, 2018u). They are usually located between the mean high and mean spring tide elevations, or in areas where there is regular or intermittent tidal influence. Saltmarshes are mainly associated with soft substrate shores in estuaries and sheltered bays (i.e. sandy and/or muddy), but also on open coasts where there is low wave energy (Adam, 2009).

Saltmarshes provide a variety of important ecological roles. These include, but are not limited to, provision of nursery and recruitment habitat of key native species, cover, refuge or pathway provision for listed threatened species, areas of high species richness, as shown by the variety and proportion of native flora and the diversity of fauna species present (DoEE, 2018u). They also provide ecosystem services such as the filtering of surface water prior to it entering the sea, carbon sequestration, provision of food and nutrients for a wide range of adjacent marine and estuarine communities (e.g. shorebirds) and stabilising the coastline and providing a buffer from waves/storms.

Coastal saltmarshes are considered vulnerable because of their very restricted distribution, ongoing fragmentation due to anthropogenic clearing and infilling, invasion of exotic plants and mangroves, and rising sea level.

There are multiple saltmarsh areas identified within the wider environment, particularly in The Coorong area of South Australia, the north-western tip of Tasmania, and in a few pockets along the coast of Victoria, west of Cape Otway (**Figure 38**).

Figure 38 Subtropical and Temperate Coastal Saltmarsh Ecological Communities



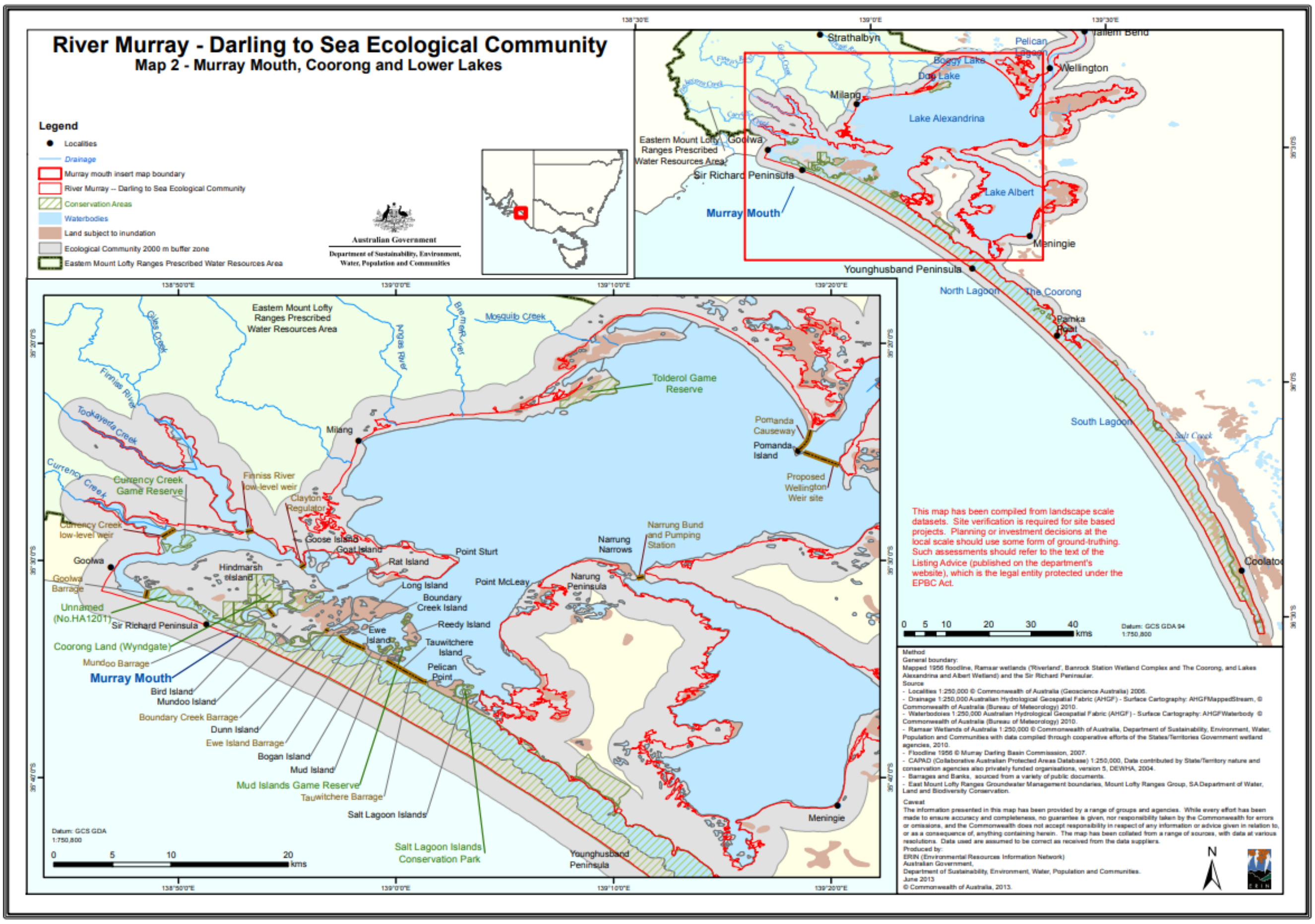
Source: DoSEWPC, 2018a.

5.3.7.3 River Murray and Associated Wetlands

This TEC was briefly listed as critically endangered for four months in 2013 until the listing was disallowed by the Minister for the Environment, Heritage and Water. Now listed as 'Approval Disallowed', it is no longer a matter of National Environmental Significance under the EPBC Act.

Despite this, it is acknowledged the communities highlighted within the literature of the 2013 submission hold significant ecological value (**Figure 39**). It is considered that communities that may be relevant to the Otway Basin 2DMC MSS are addressed in other parts of this report. For example, the entire Coorong and Lakes Alexandrina and Albert Wetland is a wetland recognised as being of both national and international importance, and is described as such in **Sections 5.3.4** and **5.3.5**.

Figure 39 River Murray and Associated Wetlands



Source: TSSC, 2013

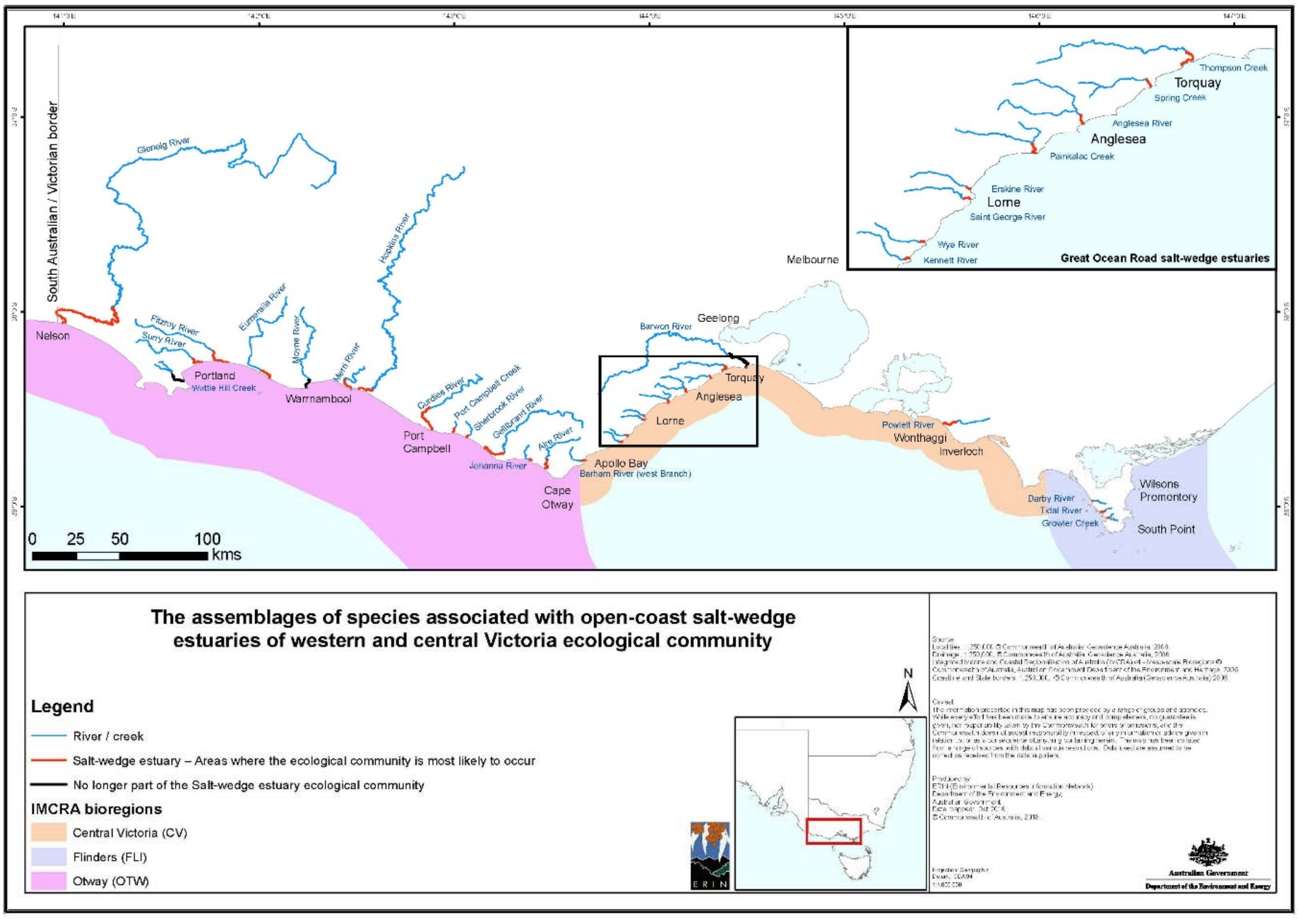
5.3.7.4 Assemblages of Species associated with Open Coast Salt-Wedge Estuaries of Western and Central Victoria Ecological Community

This TEC includes a total of 25 estuaries located along the western and central coast of Victoria (**Figure 40**). Each community is comprised of an assemblage of native plants, animals and micro-organisms associated with salt-wedge estuaries that are found along this high-energy wave dominated coastline.

Salt wedge estuaries are dynamic systems, with associated variation in physical and chemical characteristics. The biological implications of this varying environment are considerable, with some plant's dependent on the dynamics for their existence, refuge, increased productivity and reproductive success. Coastal, estuarine, brackish and freshwater taxa may reside in the estuary for reproduction, feeding, refuge or migration. The community composition at any one time is dependent on the current state of flux within the salt-wedge system.

Threats include climate change, water quality decline associated with land use, anthropogenic changes to the flow regime, invasive species and disease, and human activity such as recreational activities, mining and sand extraction.

Figure 40 Open Coast Salt-Wedge Estuaries of Western and Central Victoria Ecological Community



Source: DoEE, 2019

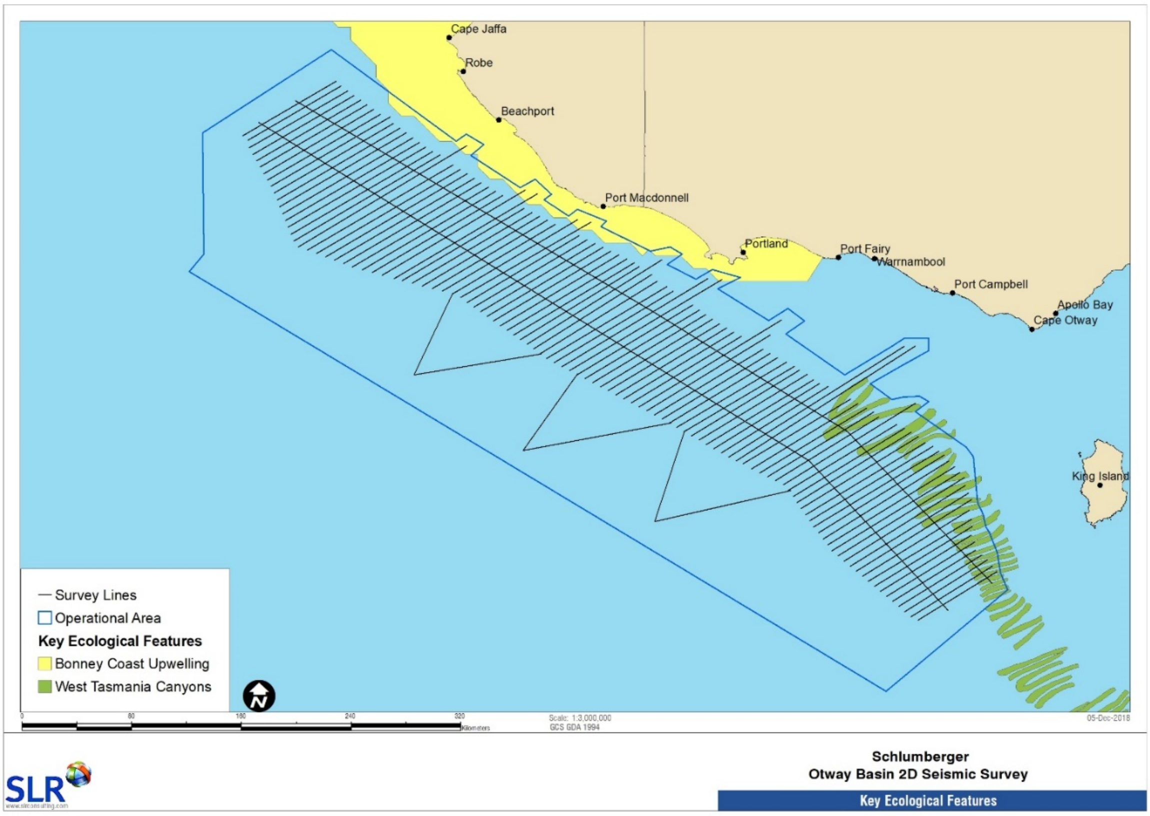
5.3.8 Key Ecological Features

KEF are features of the Australian commonwealth marine environment that are recognised to be of regional importance for either biodiversity or ecosystem function and integrity. The criteria used to identify KEFs in the region are (Commonwealth of Australia, 2015):

- A species, group of species or community with a regionally important ecological role, where there is specific knowledge about why the species or species group is important to the ecology of the region, and the spatial and temporal occurrence of the species or species group is known;
- A species, group of species or community that is nationally or regionally important for biodiversity, where there is specific knowledge about why the species or species group is regionally or nationally important for biodiversity, and the spatial and temporal occurrence of the species or species group is known;
- An area or habitat that is nationally or regionally important for:
  - Enhanced or high biological productivity;
  - Aggregations of marine life;
  - Biodiversity and endemism; and
- A unique seafloor feature with ecological properties of regional significance.

Three KEFs are present in the Operational Area and wider environment. Two of these, the Bonney Coast Upwelling and the West Tasmania Canyons (**Figure 41**) are spatially defined while the other one, the shelf rocky reefs and hard substrates is not, and therefore cannot be mapped.

Figure 41 Key Ecological Features present in the Operational Area and Wider Environment



5.3.8.1 Bonney Coast Upwelling

Upwelling events in southern Australian waters occur when seasonal south-easterly winds blow parallel to the shoreline, moving coastal waters offshore primarily between November and March. The displaced coastal water is replaced by cold nutrient-rich waters that rise from depths exceeding 3,000 m to the surface via a series of submarine canyons (Butler *et al*., 2002). The orientation of certain sections of the southern shelf makes them susceptible to south-easterly winds that encourage upwelling to occur. These areas include Eyre Peninsula, Kangaroo Island, the Bonney Coast (Robe to Portland) and eastern Victoria (Lakes Entrance to Croajingalong) (Butler *et al*., 2002). The Bonney Coast upwelling is the most prominent of these and occurs as a surface plume along the coast of South Australia and Victoria where the continental slope is very close to shore (~20 km) (**Figure 41**). It is noteworthy that this plume is a surface expression of a larger (and largely subsurface) upwelling system extending from western Tasmania to the eastern Great Australian Bight (Kämpf *et al.* 2004); hence, large predictable seasonal upwelling plumes are regularly observed within this region (Schahinger, 1987). For further details on the physical processes involved with Bonney Coast Upwelling see **Section 5.1.3**.

Biologically, the Bonney Coast Upwelling region supports high productivity and high species diversity in comparison to the surrounding southern Australian waters. A chain effect occurs whereby the cold nutrient rich waters of the upwelling result in increased phytoplankton abundance (represented by high levels of chlorophyll-α); in turn, this attracts zooplankton such as krill (*Nyctiphanes australis*) which feeds on the phytoplankton. Consequently, higher organisms such as fish, seabirds, little penguins (Collins *et al*., 1999), Australian fur seals and blue whales (*Balaenoptera musculus*) are attracted to the area. Other attributes of the area linked to the Bonney Coast Upwelling include its unique algal diversity (Womersley, 1984) and its productivity as a fishery.

N. australis is abundant in southeast Australian shelf waters with high abundances driven by the Bonney Coast Upwelling. This krill species forms swarm aggregations in surface waters predominately during summer months, in response to increased productivity. Blue whales are attracted to the area to feed on the krill, particularly on the continental shelf of Australia between Port Campbell, Victoria, and Robe, South Australia — i.e. the Bonney Coast — from December to April/May (Gill, 2001; 2002). This region includes the inshore portion of the Operational Area; however, there is very little overlap with the survey line plan. The relationship between the upwelling and blue whales' presence has resulted in the Bonney Upwelling being listed as one of the 11 unique marine areas in Commonwealth waters. Furthermore, the Bonney Upwelling is one of 12 widely recognised and well-known blue whale feeding sites worldwide where the whales are known to frequent and feed in relatively high numbers. The Bonney Coast is also recognised as a feeding ground of an endangered species under the EPBC Act. Some authors have indicated that the Bonney Upwelling may be a possible blue whale breeding area although this is not widely agreed upon.

Butler *et al.* (2002) notes that 78 species occurring in the Bonney Upwelling area are covered by one or more of the provisions of the EPBC Act. *'….. Of these, 8 species (5 whales, 2 sharks and 1 bony fish) are not listed marine species but they are listed threatened species under the EPBC Act. The Bonney Upwelling area harbours, in total, 26 listed threatened species: one shark is listed as critically endangered; 5 birds and 2 whales are listed as endangered; and 11 birds, 1 shark, 3 whales and 1 bony fish are listed as vulnerable. The listed marine migratory species include 18 birds and 3 whales*.'

Descriptions of a number of the species associated with the Bonney Upwelling, including the threatened species, have been provided throughout **Section 5.2.**

5.3.8.2 West Tasmania Canyons

As with the Bonney Upwelling, the West Tasmania Canyons (**Figure 41**) facilitate high productivity, large aggregations of marine life and high biodiversity. The canyons are located along the shelf margin, northwest of Tasmania.

The canyons can influence ocean currents, facilitating both upwellings that act as a source of nutrients around the canyon heads, and as a sink for rich organic sediments (Commonwealth of Australia, 2015). This results in higher productivity and biodiversity than surrounding waters, with sponges attaching to rocky reefs around the canyon heads. The greatest diversity occurs at a depth of 200 – 350 m, with abundant fish life.

With the revision to the survey plan in December 2018, SLB reduced the size of the Operational Area, in particular around the southern and eastern extent. This reduction has now excluded a significant portion of the West Tasmanian Canyons from the Operational Area, and this survey reduction is highlighted in **Figure 60**. The total area classified as the West Tasmanian Canyons equates to 13,550 km^2 and following the reduction of the Operational Area, there is an overlap of 2,627 km^2 or 20% with this KEF. The reduction to the Operational Area in December 2018 reduced the overlap with the West Tasmanian Canyons by 5,000 km^2.

5.3.8.3 Shelf Rocky Reefs and Hard Substrates

This KEF can be found scattered around all areas of the South-east Marine Region and as such have not been spatially defined in the Conservation Values Atlas. They occur around the continental shelf edge, but above the shelf break, between 50 m and 220 m (Hosack & Dambacher, 2012). These rocky reefs provide habitat for macroalgae and sessile invertebrates, increasing the structural diversity of shelf ecosystems (Commonwealth of Australia, 2015). Dominated by sponges, bioturbators, sea pens, and molluscs, the biogenic habitat structures established on the reefs provides habitat for fish and are important areas for biodiversity and high productivity.

5.3.9 Biologically Important Areas

BIAs are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration. There are several BIAs for EPBC Act-listed species overlapping the Operational Area and wider environment (**Table 30**). Maps displaying the BIA for each seabird species are provided in **Appendix M,** while cetacean, pinniped and white shark BIA maps are provided in the relevant species discussions throughout **Sections 5.2.6, 5.2.7**, and **5.2.3.2.1** respectively.

Of the 19 species listed within the EPBC Act that have BIAs overlapping the Operational Area or located in the wider surrounding environment, 14 of which are birds (**Table 30**). Listed whale species include pygmy blue whale, southern right whale, and sperm whale (although the sperm whale BIA does not overlap with the Operational Area). A BIA for white sharks also overlaps with the Operational Area.

No marine mammal or seabird breeding areas are known to occur within the Otway Basin 2DMC MSS Operational Area for the 19 listed species in **Table 30**. However, breeding areas overlap with the wider environment for seven species of seabird (as seen in **Figure 30** and **Table 30**).

Table 30 Biologically Important Areas for EPBC Act-listed Marine Species that Overlap with the Operational Area or Wider Environment

Species	Activity within Operational Area	Activity within Wider Environment	Reference in EP
Pygmy Blue Whales	Foraging (high annual use area)	Foraging (high annual use area)	**Figure 27**
Sperm Whale	None	Foraging likely	**Figure 23**
Southern Right Whale	Known core range, aggregation, connecting habitat, migration and resting	Known core range, aggregation, connecting habitat, migration and resting, breeding	**Figure 23**
White Shark	Foraging and distribution	Foraging and distribution	**Figure 21**
Australian Sea Lion	Foraging	Foraging	**Figure 29**
Antipodean Albatross	Foraging	Foraging	**Appendix M**
Black-browed Albatross	Foraging	Foraging	**Appendix M**
Campbell Albatross	Foraging	Foraging	**Appendix M**
Indian Yellow-nosed Albatross	Foraging	Foraging	**Appendix M**
Wandering Albatross	Foraging	Foraging	**Appendix M**
Bullers Albatross	Foraging	Foraging	**Appendix M**
Shy Albatross	Foraging	Foraging and breeding	**Appendix M**
Black-faced Cormorant	None	Foraging and breeding	**Appendix M**
Australasian Gannet	Foraging	Foraging and aggregation	**Appendix M**
Common Diving Petrel	Foraging	Foraging and breeding	**Appendix M**
Soft-plumage Petrel	Foraging	Foraging and breeding	**Appendix M**
Little Penguin	Foraging	Foraging and breeding	**Appendix M**
White-faced storm Petrel	Foraging	Foraging and breeding	**Appendix M**
Short-tailed Shearwater	Foraging	Foraging and breeding	**Appendix M**

Source: DoEE, 2018o

5.3.10 The Australian Whale Sanctuary

The Australian Whale Sanctuary was established in 2000 to help protect whales, dolphins and porpoises within the Commonwealth marine area. It includes all marine areas beyond the Coastal Waters of each state (beyond 3 NM) out to the edge of Australia's EEZ (to 200 NM), including external territories and the Australian Antarctic Territory (DoEE, 2018v). All states and territories provide similar protection for cetaceans within Coastal Waters (up to 3 NM), and it is the responsibility of the state and territory governments to protect whales and dolphins.

It is an offence to kill, injure or interfere with cetaceans within the sanctuary, and activities that will take, keep, move, interfere with (including to harass, chase, herd, tag, mark or brand) a cetacean require a permit (e.g. whale watching or research activities). The EPBC Act regulates activities that are likely to have an impact on all listed threatened and migratory species. Any such proposed activity should therefore be referred to the Minister for the Environment and Heritage for assessment.

Migratory species within the EPBC Act are those that are listed under international agreements as species whose protection requires or would significantly benefit from international cooperation. Australia is a signatory to the International Convention for the Regulation of Whaling. Obligations under this Convention include provision for the conservation of whales through the complete protection of select species, and the designation of whale sanctuaries (Director of National Parks, 2013).

5.4 Cultural and Heritage Values

In the southeast marine region around the Otway Basin 2DMC MSS Operational Area, cultural and heritage features such as sites of aboriginal significance and built European heritage are important. Most of these features are located close along the shoreline and coastal margins and fall within the State's jurisdiction (Director of National Parks, 2013).

The world, national and marine heritage properties of all the surrounding areas in relation the Operational Area are also considered below; however, as above most of these are largely terrestrial based along coastal margins.

5.4.1 Aboriginal Heritage

Native Title is the recognition in Australian Law that indigenous people had a system of law and ownership of their lands before European settlement. In 2001, the High Court of Australia held that Native Title can exist offshore within the limits of Australia's territorial sea (12 NM) although offshore Native Title can only be non-exclusive, meaning that native titleholders will not have the right to exclude others from accessing the sea or seabed in the waters where native title exists.

Victoria, South Australia and Tasmania have a rich Aboriginal history. The coasts adjacent to the proposed Operational Area are claimed as part of traditional lands by a number of Aboriginal groups, with Native Title Consent Determination Areas registered for the following traditional owners (from west to east):

- Ngarrindjeri and Others (South Australia);
- First Nations of the South East (South Australia);
- Gunditj Mirring (Victoria); and
- Eastern Maar (Victoria).

Native Title Claims adjacent to the proposed Operational Area in Victoria include the sea for 3 NM from the high-water mark on the mainland and offshore islands (e.g. Deen Maar, also known as Lady Julia Percy Island).

The Kirrae Wurrung, Gunditjmara and Gadabanud, collectively known as Maar (the people), are the first people of South-west Victoria (Smyth & Bahrdt Consultants, 2004). The Maar developed the Kooyang Sea Country Plan in response to Action 3.11.2 of the South-east Regional Marine Plan. The Sea Country Plan refers to indigenous cultural and archaeological values of marine areas, including the current ocean floor.

The *South Australian Fisheries Management Act 2007* recognises Aboriginal traditional fishing as a separate and unique fishing sector alongside commercial and recreational fishing. Under the Act, the Minister and a Native Title Group that is party to an Indigenous Land Use Agreement may make an Aboriginal Traditional Fishing Management Plan for the management of specified Aboriginal traditional fishing activities in a specified area of waters.

An online search of the Indigenous Land Use Agreement Register (NNTT, 2018) did not identify any claims involving marine resources or offshore areas of South Australia, Victoria or Tasmania.

The Otway Basin 2DMC MSS Operational Area is in waters deeper than 50 m, where 89% is in waters deeper than 1,000 m, with no part of the Operational Area boundary approaching the coastline at any point closer than 3 NM. Therefore, the intertidal areas along the seaward boundary of the Native Title claims are well inshore of the Operational Area and with the way that the properties of sound travelling up into the shallower regions dissipate much quicker than down slope or along a flat seabed, these areas will not be significantly disturbed by the Otway Basin 2DMC MSS.

5.4.2 European and Marine Heritage

5.4.2.1 World and National Heritage Properties

World Heritage Properties or Sites are landmarks or areas that have been selected by the United Nations Educational, Scientific and Cultural Organisation (**UNESCO**) as having cultural, historical, scientific, or other forms of significance. Chosen sites are legally protected by international treaties and are considered to be important to the collective interests of humanity. Properties/Sites are nominated for World Heritage status, with only those countries that have signed the World Heritage Convention pledging to protect their natural and cultural heritage able to submit nomination proposals for properties in their territory.

The following criteria are considered when establishing a World Heritage Property or Site (WHC, 2018):

- Represents a masterpiece of human creative genius;
- Exhibits an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;
- Bears a unique or at least exceptional testimony to a cultural tradition or to a civilisation which is living, or which has disappeared;
- An outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates significant stage(s) in human history;
- An outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;
- Directly or tangibly associated with events or living traditions, with ideas, or beliefs, with artistic and literary works of outstanding universal significance;
- Contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
- Outstanding examples representing major stages of earth's history, including the records of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
- Outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals; and
- Contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

There are three UNESCO World Heritage Sites across the South Australia, Victoria and Tasmania regions: Naracoorte Caves National Park Australian Fossil Mammal Site (South Australia), Royal Exhibition Building and Carlton Gardens (Victoria), and Tasmanian Wilderness (Tasmania) (**Figure 42**). However, these UNESCO World Heritage Sites are terrestrial and will not be affected by the Otway Basin 2DMC MSS. There are no marine-based UNESCO World Heritage Sites of relevance to the Operational Area.

Australia's National Heritage List is made up of places that have exceptional natural, historic and cultural value that contribute to Australia's national identity (Australian Heritage Council, 2009). These symbols of National Heritage showcase Australia's development as a nation, and reflect achievements, joys and sorrows in the lives of Australians. Also listed are places that portray the richness of Australia's extraordinarily diverse natural heritage.

For a place to be included in the National Heritage List, it must meet one or more of the following National Heritage Criteria:

- Outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history;
- Outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history;
- Outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history;
- Outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:
    - A class of Australia's natural or cultural places;
    - A class of Australia's natural or cultural environments;
- Outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
- Outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period;
- Outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
- Outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history; and
- Outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.

Note: the cultural aspect of a criterion means the indigenous cultural aspect, the non-Indigenous cultural aspect, or both.

There are eight National Heritage Sites in the wider vicinity of the Otway Basin 2DMC MSS Operational Area (**Figure 42**), two of which are terrestrial (Budj Bim National Heritage Landscape – Mt Eccles and Budj Bim National Heritage Landscape – Tyrendarra), so will not be affected by the Otway Basin 2DMC MSS.

The remaining six National Heritage Sites are also land-based but lie adjacent to the coastal margin. Four of these, Point Lonsdale Lighthouse Reserve and Environs; Quarantine Station and Surrounds; Point Nepean Defence Sites and Quarantine Station Area; Shortland Bluff and Environs and Queenscliff Foreshore Reserve are located approximately 200 km from the Otway Basin 2DMC MSS Operational Area (**Figure 42**), and based on the values that these sites are recognised for and the distance they are located away, they will not be affected by the activities conducted during the Otway Basin 2DMC MSS.

There are two National Heritage Sites which are closer to the Otway Basin 2DMC MSS Operational Area (**Figure 42**), which extend up to a few hundred metres into the sea. These sites are listed below with the distance to the nearest boundary of the Operational Area:

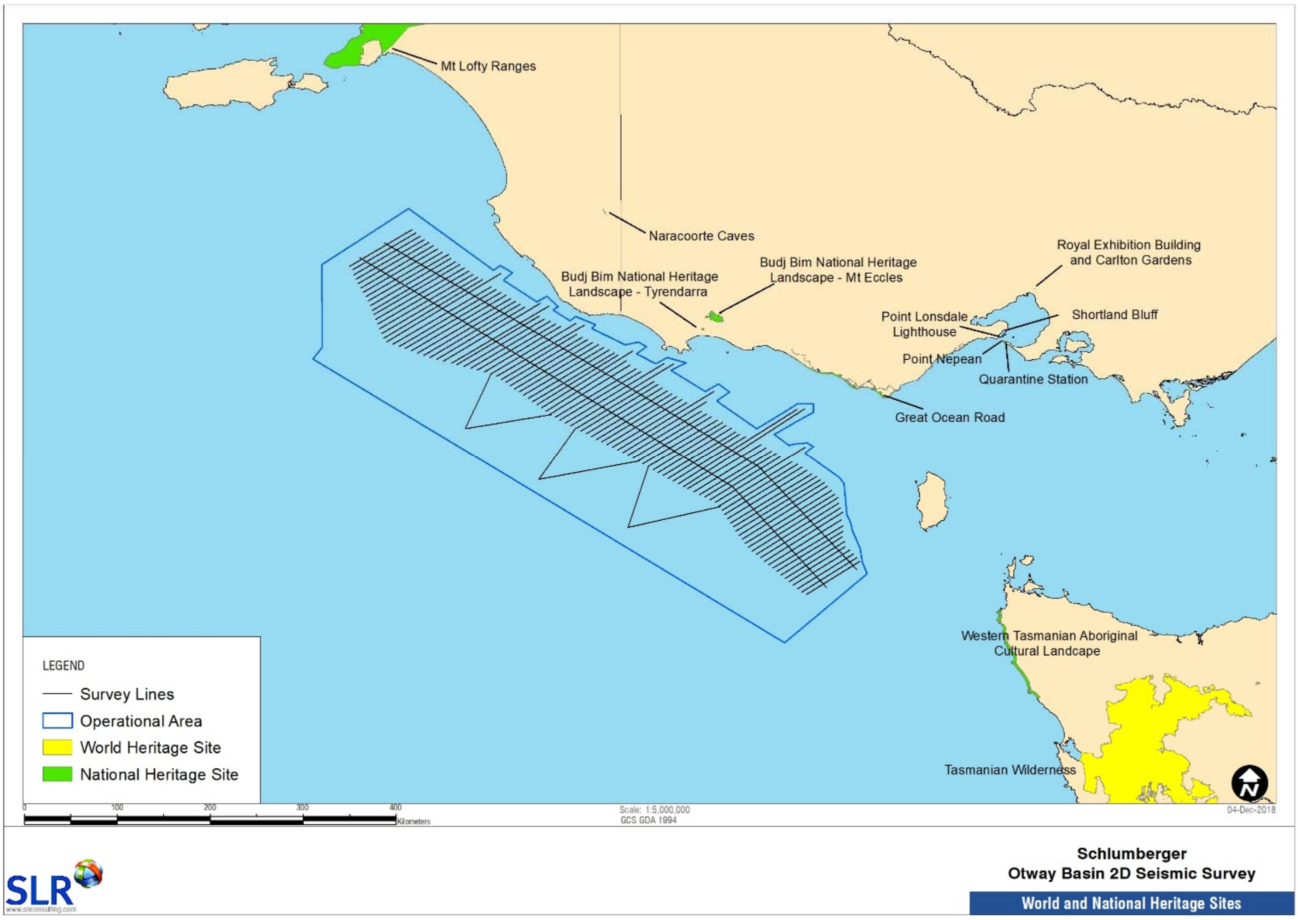
- Great Ocean Road and Scenic Environs – 36 km; and
- Western Tasmania Aboriginal Cultural Landscape – 114 km.

The Great Ocean Road is the only coastal feature in western Victoria listed on the National Heritage Register. The Great Ocean Road is 242 km long, runs east from Warrnambool and is defined as an 'iconic coastal journey'. The road is above high-water mark and therefore will not be affected by the Otway Basin 2DMC MSS.

Scenic values and visual amenities from the Great Ocean Road will not be affected by the Otway Basin 2DMC MSS simply due to the fact that the seismic vessel will be located over 36 km away and over the horizon and not visible from the coastline. Based on calculations around distance to the horizon, to gain a 36 km horizon, the height above sea level has to be 100 m. It is only a very small part of the survey that the vessel is in such a location, therefore this iconic road will not be affected in any way for its amenity values.

The Western Tasmania Aboriginal Cultural Landscape is the only feature in western Tasmania listed on the National Heritage Register. This landscape extends along the northern half of the west coast of Tasmania and contains stone artefact scatters, hut depressions, stone arrangements, rock engravings and shelters and human burials. Circular pits in cobble beaches are believed to be remnants of seal hunting hides. All known elements of the landscape are above low water mark and therefore will not be affected in any way by the Otway Basin 2DMC MSS activities.

Figure 42 World and National Heritage Property Locations



5.4.2.2 Marine Heritage Listed Properties

Under the Historic Shipwrecks Act 1976 (Commonwealth), all historic wrecks and associated relics older than 75 years are protected if located in waters from the low water mark out to the continental shelf edge.

A search of the Australian National Shipwreck Database (DoEE, 2018w) indicated 108 wrecks in south-east South Australia, two wrecks in west Victoria, 76 wrecks in west Bass Strait and 146 wrecks off the west coast of Tasmania, most of which date from the early 1800s to present, most are found in shallow waters on reefs or in bays along the coast, on King Island, or on beaches in exposed coastal areas. These areas are invariably shallower than the depth of the shallowest part of the Otway Basin 2DMC MSS Operational Area (i.e. 50 m), and the MSS will have no impact on the wrecks. The effect of recreational diving that may occur on some of these wrecks and the associated noise impacts on recreational divers has been considered within **Section 7.2.4** of this EP.

The only database listed exceptions in or adjacent to the proposed Operational Area are:

- '*British Admiral*' which hit a reef west of King Island in 1874; the listed location is -39.9°, 140.96°, which is approximately 247 km west of King Island in deep water off the shelf. The circumstances leading to the wreck's position in deep water so far from the reef where it first grounded is unclear, and the coordinates may be incorrect;
- '*George Home*', a wooden barque sprang a leak and sank 150 NM SSE of Kangaroo Island in 1851. The listed location is -37.899°, 139.451° but the wreck has not been found;

- '*Lemael*', a wooden schooner battered by storms and hit reef 3 NM south of Millicent, West Cape Banks in 1921. The listed location is -38.749°, 140.285° but the wreck has not been found;
- '*Nora Creina*', a wooden brigantine struck an uncharted rock 17 NM west of Cape Martin (Beachport) and sank in 1859. The listed location is -37.499°, 139.668° but the wreck has not been found;
- '*Emu*', a wooden schooner 'driven to sea and sunk' between Port MacDonnell and Lacepede Bays in 1861. The listed location is -37.499°, 139.751° but the wreck has not been found; and
- '*Nyora*', a tug foundered in a gale while towing a schooner 12 NM south-west of Cape Jaffa in 1917. The listed location is -36.865°, 138.835° but the wreck has not been found.

As indicated, the vast majority of wrecks are in shallow water outside the Otway Basin 2DMC MSS Operational Area.

5.4.2.3 Commonwealth Heritage Listed Places

There are three areas classified as Commonwealth Heritage places that are adjacent to the Otway Basin 2DMC MSS Operational Area. These include:

- Cape Northumberland Lighthouse (South Australia) – located 7 km from the Operational Area;
- Cape Sorell Lighthouse (Tasmania) – located 234 km from the Operational Area; and
- Cape Wickham Lighthouse (King island, Tasmania) – located 72 km from the Operational Area.

Each lighthouse is located on elevated coastal land, well above high tide mark and will not be affected by the Otway Basin 2DMC MSS activities.

5.5 Socio-Economic Environment

For more than 200 years the southeast region of Australia has supported a number of marine industries which make significant contributions to the economic activity to the region's economy. These industries include:

- Commercial fishing – more than 30 fisheries operate in the southeast region and are managed by the Commonwealth, State or are jointly managed. Significant infrastructure and facilities are required onshore to support the extensive fishing in each region;
- Commercial shipping – one of Australia's busiest shipping routes, which includes international and coastal cargo trade, passenger, and vehicle ferry;
- Oil and gas production – there are four hydrocarbon basins: Gippsland, Otway, Bass and Sorrell; and
- Commercial tourism – there is a diverse range of tourism activities including charter fishing, nature and whale watching, and other related activities.

5.5.1 Coastal Settlements

The Operational Area spans the coastal areas of South Australia, Victoria and Tasmania. These coastal areas are sparsely developed, and the population is concentrated in small towns of typically less than 1,400 people, with several larger towns of between 3,000 people (Port Fairy, Victoria) and 50,000 people (Warrnambool, Victoria) (Australian Bureau of Statistics, 2018). The west coast of Tasmania is notably unpopulated, with only two coastal settlements - Arthur River (57 people) and Strahan (658 people).

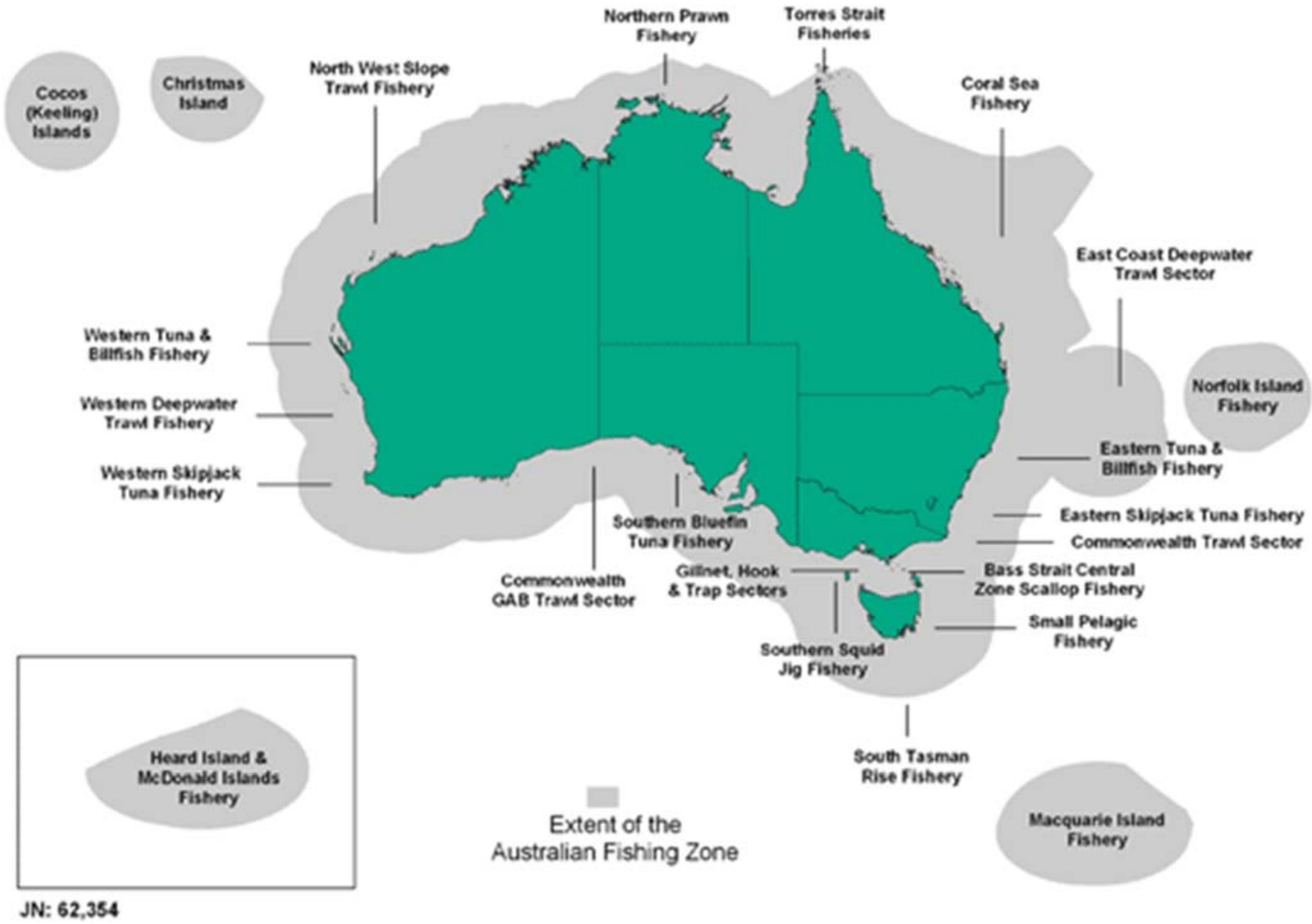
Many of the coastal settlements have a harbour and/or marina that host commercial and recreational fishing, diving and/or sailing vessels. The following list includes those settlements adjacent to the Operational Area which have a direct association with the marine environment through commercial and/or recreational activities:

- Kingston SE (population: 1,393);
- Robe (population: 1,378);
- Beachport (population: 652);
- Port MacDonnell (population: 847);
- Portland (population: 10,800);
- Port Fairy (population: 3,340);
- Warrnambool (population: 50,099);
- Port Campbell (population: 267);
- Apollo Bay (population: 1,366);
- Currie (King Island) (population: 665);
- Arthur River (population: 57); and
- Port Macquarie / Strahan (population: 658).

5.5.2 Commercial Fisheries

Australia's fisheries are those that occur within the Australian EEZ (waters out to 200 NM from coastal baselines). Boundaries within Australia's fisheries have been established in order to simplify jurisdiction (DoAWR, 2002). Inshore waters out to 3 NM represent State waters, with jurisdiction of these waters vested in the adjacent State or Territory (Geoscience Australia, 2018b). The Commonwealth has jurisdiction over fisheries occurring in Commonwealth waters; those between 3 NM and 200 NM from the coastline (DoAWR, 2002). Commonwealth waters are covered by the Australian Fishing Zone (**Figure 43**) (DoAWR, 2018) and are managed through the AFMA. Where a fishery falls within multiple jurisdictions, an Offshore Constitutional Settlement arrangement is generally developed, whereby sole responsibility is passed to one jurisdiction. Alternatively, a Joint Authority may be formed, allowing for the co-management of the fishery through the legislation of one jurisdiction (DoAWR, 2002).

Figure 43 Australian Fishing Zone and Location of Commonwealth Fisheries



Source: DoAWR, 2018

The offshore waters of South Australia, Victoria and Tasmania are rich in marine resources and include the fishing grounds of a variety of commercial fisheries. The Otway Basin 2DMC MSS Operational Area encompasses some Commonwealth and State managed commercial fisheries. **Table 31** shows the open (shaded blue) season for the various commercial fisheries surrounding the Operational Area.

Table 31 Commercial Fishing Seasons within the Operational Area

Fishery	January	February	March	April	May	June	July	August	September	October	November	December
Commonwealth Managed Fisheries:												
Bass Strait Central Scallop[a]												
Small Pelagic[b]												
Southern/Eastern Scalefish & Shark[c]												
Southern Squid Jig[d]												
Southern Bluefin Tuna[e]												
Victoria Managed Fisheries:												
Abalone (daylight hours only)[f]												
Rock Lobster - males[g]												
Rock Lobster - females[g]												
Giant Crab - males[h]												
Giant Crab - females[h]												
South Australia Managed Fisheries:												
Abalone (Southern Zone)[i]												
Rock Lobster (Southern Zone)[j]												
Tasmania Managed Fisheries:												
Abalone Greenlip – North-west[k]												
Abalone Blacklip - North-west and West[k]												
Rock Lobster - males[l]												
Rock Lobster - females[l]												
Giant Crab - males[m]												
Giant Crab - females[m]												
Scallops[n]												
Squid[o]												

Note: light blue shaded months indicate the fishing season is open

a opens 1 July - https://www.afma.gov.au/fisheries/bass-strait-central-zone-scallop-fishery/bass-strait-central-zone-scallop-fishery-2018-fishing-season

b opens 1 May - https://www.afma.gov.au/fisheries/small-pelagic-fishery

c opens 1 May - https://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery

d opens 1 January - https://www.afma.gov.au/fisheries/southern-squid-jig-fishery

e opens 1 December - https://www.afma.gov.au/fisheries/southern-bluefin-tuna-fishery

f opens 1 April - https://vfa.vic.gov.au/commercial-fishing/abalone

g opens 1 July - https://vfa.vic.gov.au/commercial-fishing/rock-lobster/fishery-overview

h opens 1 July - https://vfa.vic.gov.au/commercial-fishing/giant-crab/fishery-overview

i all year - http://www.pir.sa.gov.au/fishing/commercial_fishing/fisheries/abalone_fishery#toc6

[j] opens 1 October - http://www.pir.sa.gov.au/fishing/commercial_fishing/fisheries/rock_lobster_fishery

[k] https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/abalone-fishery/abalone-closures

[l] opens 1 March - https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/rock-lobster-fishery/rock-lobster-fishing-seasons

[m] opens 1 March - https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/commercial-fishing-licences-and-seasons/commercial-fishing-seasons

[n] closed in 2018 - https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/commercial-fishing-licences-and-seasons/commercial-fishing-seasons

[o] closed during Oct 2018 - https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/commercial-fishing-licences-and-seasons/commercial-fishing-seasons

5.5.2.1 Commonwealth Managed Fisheries – The Regulator

AFMA is the Government agency responsible for the management and sustainable use of Australia's Commonwealth fisheries (those from 3 NM out to the extent of the Australian Fishing Zone). AFMA was established under the Fisheries Administration Act 1991, and it is under this Act, as well as the Fisheries Management Act 1991, that AFMA is invested with its objectives, functions and powers.

AFMA looks after Commonwealth fisheries through:

- Research and science which provides the information to manage fisheries, such as the setting of quota levels;
- Management and regulation that develops and makes the rules for fisheries (e.g. quota and gear restrictions, and issuing of permits); and
- Monitoring and enforcement of rules and regulations.

The aim of AFMA is to keep fish species, and the marine environment as a whole, in good health for the future. In order to achieve this, they work together with Australian State agencies, international counterparts, industry, scientists, and recreational and environmental fishery stakeholders (AFMA, 2018a).

AFMA ensures that impacts on commercial fisheries from petroleum activities, including seismic surveys, are considered by providing comment directly to the Department of Industry, Innovation and Science on annual acreage releases, and by providing comment to petroleum companies on proposals that may have significant impacts on fisheries. AFMA expects petroleum operators to consult directly with fishing operators about proposed petroleum activities. Note that in some fisheries there are no associations (AFMA, 2018b).

Consultation with commercial fishers that may be affected by the Otway Basin 2DMC MSS has been guided by AFMA recommendations and expectations. See **Section 4** and **Appendix F** for details on consultation with AFMA and the commercial fishing sector.

5.5.2.2 Commonwealth Managed Fisheries – The Representative Bodies

The interests of a number of Commonwealth-managed fisheries are represented by peak industry bodies. Details on industry bodies (where available) are provided below, with a record of all consultation carried out by SLB provided in **Section 4** and full transcripts in **Appendix F** of this EP.

5.5.2.2.1 South East Trawl Fishing Industry Association

Based in Lakes Entrance (Victoria), SETFIA is the peak industry body representing the interests of commercial fishers in the South East Trawl Fishery and East Coast Deepwater Trawl sectors. SETFIA is a 30+ year-old not-for-profit, tax exempt entity incorporated under the Commonwealth Corporations Act. They cannot distribute profits to members and cannot aim to make a profit.

SETFIA are an industry association that represents 80% quota owners, fishermen, and sellers in the South East Trawl Fishery; also known as the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery. Membership is voluntary, with membership costing $3,000 – 6,000 per operator.

The fishery covered by SETFIA extends south from Barranjoey Point (north of Sydney), around Tasmania to Cape Jervis (South Australia), where it joins the Great Australian Bight Trawl Sector. Fishing methods within the South East Trawl Fishery include Danish seining and trawling (SETFIA, 2019).

SETFIA were engaged by SLB to prepare an assessment of the fisheries operating within the Operational Area. This assessment provides:

- Identification of fisheries operating in Operational Area;
- Details of the tonnage, value and % of each fishery extracted by these fisheries from the Operational Area;
- Other information on seasonality, fishing methods, ports of operation, number of operators etc.;
- Identification of fisheries not operating in the Operational Area but are entitled to;
- List of associations representing the affected fisheries; and
- Contact details of individual fishers affected.

Within this report, 'impact' was calculated as the overlap of the Operational Area with the landed commercial catch (and revenue) taken within that same area. SETFIA did not consider potential impacts of the MSS beyond the Operational Area, or on other life history stages of commercially fished species. Using SETFIAs definition of impact, for the fisheries that overlap with the Operational Area, the order of impact, by highest overlap is: South Australian Southern Zone Rock Lobster, Victorian Western Zone Rock Lobster, Otterboard Trawl, Tasmanian Rock Lobster, Victorian Giant Crab, South Australian Marine Scalefish, Scalefish Hook, and Shark Hook and Shark Gillnet Fisheries.

SETFIA provided SLB with a list of associations representing potentially affected fisheries during the initial stages of the development of the assessment, allowing initial high-level consultation between SLB and the identified associations. The fisheries assessment report was incorporated into the ongoing consultation strategy, with SLB continuing to engage and update those fisheries identified within the assessment.

Information provided to SLB by SETFIA in the fisheries assessment report was incorporated into this EP to provide an overview of fisheries that fish within the Operational Area and have been included into determining the potential effects to commercial fisheries from the proposed Otway Basin 2DMC MSS. Based on the results of SETFIA's analysis, there are 18 active fisheries within the Otway Basin 2DMC MSS Operational Area to some extent, with the nine biggest fisheries including; Rock Lobster (Tasmanian, Victorian Southern and South Australian Western Zones), CTS Otterboard Trawl, Giant Crab, Tasmanian Marine Scalefish, GHaT Scalefish Hook, and GHaT Shark Hook and Shark Gillnet Fisheries.

SETFIA's fisheries assessment further notes that half of the proposed survey occurs in depths too deep for fishing and that the fishing industry is generally less concerned about 2D surveys compared to 3D surveys based on the larger line spacing, reduced intensity, and decreased duration of 2D surveys. A full copy of SETFIA's fisheries assessment report is provided in **Appendix G**.

SETFIA have also been engaged by SLB to provide and operate an SMS alert system to alert those fishers that may be impacted by the Otway Basin 2DMC MSS. This system will allow fishers to plan their activities so as to avoid fishing in the path of the MSS and will help to limit any potential impacts to the fishing industry. The SMS alert system will be implemented once the EP has been approved.

5.5.2.2.2 Seafood Industry Australia

Seafood Industry Australia (**SIA**) was created in 2017 following the allocation of funding from the Australian Government. SIA was established as the new national peak body representing the Australian seafood industry as a whole, including members from wild catch, aquaculture, and post-harvest sectors. SIA provides services to ensure fisheries are adequately represented in regard to Government decisions, to act as a national industry voice, and to encourage the growth of the Australian seafood industry.

Pledged members of SIA that are of relevance to the Operational Area include the Tasmanian Rock Lobster Fishermen's Association, SIV, TSIC, Wildcatch Fisheries South Australian, Southern Rock lobster Ltd., and the Australian Southern Bluefin Tuna Industry Association (**ASBTIA**) (SIA, 2018). Consultation has occurred with these members (see **Section 4** and **Appendix F**).

5.5.2.2.3 Other Representative Bodies

ASBTIA is the peak body representing southern bluefin tuna ranching companies in Australia and is made up of eight-member companies representing 100% of the local industry (ASBTIA, 2018). The Association represents 73 southern bluefin tuna quota owners and ranching companies (FoodSA, 2018), and was formerly referred to as the Tuna Boat Owners Association of Australia (ASBTIA, 2018). ASBTIA coordinates research for the bluefin industry through the ASBTIA/FRDA SBT Research Programme.

Representative bodies of the Southern and Eastern Scalefish and Shark Fishery include the Great Australian Bight Fishing Industry Association (**GABIA**), SETFIA (see above), Sustainable Shark Fishing Inc., and Southern Shark Industry Alliance Inc. GABIA works with Commonwealth and State governments, researchers, and other stakeholders to sustainably manage and control the trawl fisheries' use of the Great Australian Bight. GABIA's vision is for '*a sustainably managed and profitable demersal and midwater trawl fishery, supplying high quality fresh and frozen product to domestic and overseas markets and built through a co-management approach with all stakeholders*' (GABIA, 2018). Members of the Commonwealth-licenced shark gillnet and shark hook members in the Gillnet Hook and Trap Fishery are represented by the Southern Shark Industry Alliance and the Sustainable Shark Fishing Association.

Founded in 2014, the Small Pelagic Fishery Industry Association Inc. represents the interests of Commonwealth-licenced operators of Australia's Small Pelagic Fishery.

5.5.2.3 State-managed Fisheries – The Regulators

Each State within Australia has jurisdiction over their State marine waters. Descriptions on each fisheries regulator in the States of relevance to the Operational Area are provided below.

5.5.2.3.1 Department of Primary Industries and Regions, South Australia

Commercial fisheries within South Australian State waters are regulated by the Fisheries and Aquaculture division of the Department of Primary Industries and Regions, South Australia (**PIRSA**). The purpose of PIRSA is to grow primary industries and drive regional development. Management of South Australian fisheries are achieved through the administration of the Fisheries Management Act 2007, the management of licences and registrations, preparation of fisheries management plans (thought collaboration with industry and other stakeholders), and support of scientific research and innovation through the South Australian Research and Development Institute (**SARDI**) (PIRSA, 2018).

SARDI is the South Australian Government's principal primary industries research institute, providing policy-driven applied research. Research carried out by SARDI has supported PIRSA's fisheries management decisions for ongoing ecological sustainability of South Australian commercial fisheries and has resulted in higher economic returns (SARDI, 2017).

5.5.2.3.2 Victorian Fisheries Authority

The Victorian Fisheries Authority (**VFA**) is an independent statutory authority that was established to manage Victorian fisheries resources. By working with stakeholders, the VFA aims to deliver on three main outcomes: sustainable fishing and aquaculture, clear resource access and sharing arrangements, and increased economic, social and cultural value. The VFA manages commercial fisheries through licencing and quota management, enforcement of the provisions of the Fisheries Act 1995, support of sustainable and responsible fishing and aquaculture, and research and fishery monitoring and assessments (VFA, 2018).

In 2017, the VFA released a consultation policy to provide clarity about their role in assisting proponents seeking approval to undertake seismic surveys in Victorian managed waters, or fishers operating in waters in which a seismic survey is planned. The VFA advocates that plans to undertake seismic surveys in areas fished by Victorian fishers should consider the objectives of the Fisheries Act 1995, and address impacts and mitigation strategies as part of the EP preparation. Relevant objectives of the Fisheries Act 1995 include:

- To provide for the management, development and use of Victorian fisheries, aquaculture industries and associated aquatic biological resources in an efficient, effective and ecologically sustainable manner;
- To protect and conserve fisheries resources, habitats and ecosystems including the maintenance of aquatic ecological processes and genetic diversity;
- To promote sustainable commercial fishing and viable aquaculture industries and quality recreational fishing opportunities for the benefit of present and future generations; and
- To facilitate access to fisheries resources for commercial, recreational, traditional, and non-consumptive uses.

Within the consultation policy are a number of ecological, economic and social impacts that the VFA expects proponents to address such as cumulative impacts on fish, fish habitat, and fishing activity, likelihood of displacement of fishers, and overlap in timing of the proposed survey with peak fishing periods, commercial closures, and reproduction and moulting phases of potentially affected species. In order to assist proponents in addressing these impacts, VFA will (upon request and where possible) provide fishing catch and effort data, provide a list of key fisheries contacts (excluding personal contact information of licence holders) within the survey area for consultation purposes, advocate for further data collection regarding the impact of seismic surveys on key Victorian marine species, assist proponents to ensure that appropriate Victorian fishing interests are consulted in a targeted and constructive way, and suggest mitigation strategies to manage specific risks to key species (VFA, 2018a).

The VFA expects that consultation on a proposed seismic survey will apply the following principles (VFA, 2018a):

- Consultation will adhere to the principles of natural justice to those who may be adversely affected by a proposed activity, and will allow them to have their views heard before a regulatory decision is made;
- Consultation should be targeted and reflect the possible impact of the survey on relevant persons and fisheries resources;
- Consultation will be made in a timely manner to allow genuine concerns to be raised;
- Proponents will make reasonable efforts to determine who may be affected by the survey;
- The consultation process will enable all relevant views to be heard and will contribute to the proponent's understanding of the management of impacts and risks of the activity to those affected;
- Consultation will include sufficient information about how the survey may impact stakeholder interests, activities, or functions;
- Consultation will be undertaken with a genuine desire to further understand the surrounding environment;
- Consultation will inform the activity such that any survey will not interfere with fishing, fisheries, or fisheries habitat to a greater extent than is necessary for the reasonable exercise of the proponent's rights and performance;
- Outcomes will be transparent, accurately documented, and provided to the resource's regulator for consideration;
- All issues raised will be clearly documented in the EP, and each objection or claim raised is to be reasonably addressed; and
- The consultation process must consider expert advice, and consideration must be given to recent relevant scientific studies regarding affected species or fisheries.

SLB has undertaken consultation with Victorian commercial fishers in accordance with the VFA Consultation Policy (see **Section 4** and **Appendix F**) and their recommendations were incorporated into the stakeholder engagement approach.

5.5.2.3.3 Department of Primary Industries, Parks, Water and Environment

The Department of Primary Industries, Parks, Water and Environment (**DPIPWE**) are the regulatory body responsible for the sustainable management and protection of all Tasmanian natural and cultural assets, including fisheries and aquaculture. DPIPWE manages Tasmanian fisheries under the Living Marine Resources Management Act 1995 through the setting of quota and fisheries-specific restrictions, issuing of fishing licences, and implementation of open and closed seasons (DPIPWE, 2018).

5.5.2.4 State-Managed Fisheries – The Representative Bodies

In addition to the regulators, each State has a peak body that represents a range of memberships, including commercial fishers/harvesters, processors, wholesalers, retailers, and exporters (SIV/TSIC, 2018). Descriptions of the peak industry body within each State of relevance to the Otway Basin 2DMC MSS Operational Area are provided below.

5.5.2.4.1 Wildcatch Fisheries

Wildcatch Fisheries South Australia is based in Port Adelaide and is the peak industry body representing commercial fishers in South Australia. Industries represented by Wildcatch Fisheries South Australia are: Gulf St Vincent Prawn Boat Owners Association, the Western Zone (Abalone Industry Association of South Australia), Southern Zone, and Central Zone Abalone Fisheries, Lakes and Coorong Fishery Southern Fisherman's Association, South Australian Blue Crab Pot Fishers Association, Charter Boat Owners Association, Marine Scalefish Fishery (Marine Fishers Association), Northern Zone Rock Lobster Fishery, and the South Australian Women's Industry Network (WFSA, 2018).

5.5.2.4.2 Seafood Industry Victoria

SIV is the national peak body representing the Victorian seafood industry as a whole, including wild catch, aquaculture, and post-harvest sectors (SIV, 2018). SIV was formed in 2017, following identification of the need for, and value in, the formation of an influential national body to represent the fishing industry on national and international issues (SIV, 2018).

Melbourne-based SIV is a not-for-profit, non-government organisation that is the representative peak body for the Victorian seafood industry. The primary focus for SIV is safeguarding Victoria's seafood industry and to secure access to marine resources for the industry and seafood consumers (SIV, 2018). SIV responds on the industry's behalf, ensuring the communication of information between industry, fisheries stakeholder groups, and communities. SIV members include harvesters, processors, wholesalers, retailers and exporters of Victorian seafood, with every Victorian fishing access licence holder and quota owner represented by SIV.

There are 17 Professional Associations represented by SIV: Abalone Victoria (Central Zone), Apollo Bay Fishermen's Co-op, East Gippsland Estuarine Fishermen's Association, Eastern Victoria Sea Urchin Divers Association, Hearn Fishing Industries Pty Ltd, Lakes Entrance Fishermen's Co-op, Melbourne Seafood Centre, Port Franklin Fishermen's Association, Portland Professional Fishermen's Association, San Remo Fishermen's Co-op, Victorian Abalone Processors Association, Victoria Bays & Inlets Fisheries Association, Victorian Fish & Food Marketing Association, Victorian Rock Lobster Association, Victorian Trout Association, and the Western Abalone Divers Association (SIV, 2018).

SIV and the TSIC have developed a consultation policy for proponents to follow when engaging with commercial fishers. Further details on this policy are provided below.

As the representative peak body for the Victorian seafood industry, SLB engaged SIV to consult with all of the SIV members, including the Victorian fishers operating within and inshore of the Operational Area. This process included extensive and ongoing consultation with 612 licence holders, quota owners and operators, across eight different Victorian fisheries (including abalone, giant crab, rock lobster, scallop, in-shore trawl, and purse seine licence holders) who were asked a number of questions on how the proposed activity may specifically impact on their fishing activities. The outcome of SIV's industry engagement was provided to SLB in a consultation feedback report (**Appendix H**), in which a number of questions and concerns were raised by the SIV members about the proposed survey. The responses provided by the licence holders within the SIV engagement report are provided in **Table 32** below. The responses by SLB to the questions and concerns raised in the SIV consultation report are provided in **Appendix I.**

Table 32 Questions Presented to Stakeholders by SIV and Summary of the Received Responses

Questions presented to stakeholders	Summary of stakeholder's responses to questions
Have you ever fished within the area of the proposed activity? • If so, for what species? • Using the map with the Victorian fishing grids overlaid, could you please indicate the areas of interest for your fishing activities.	Fishers had fished for and caught squid, giant crab, blue eye trevalla, shark and other finfish in the area. There were concerns raised by rock lobster fishermen who have fished in and around the survey area pending time of year/availability.
Do you intend on fishing within the survey area during the time this survey is proposed to occur (between October 2019 and March 2020, initial questions asked for January – May 2019)?	All responders indicated that their catch history is stronger in the months January to May. There were fishers who intended to fish/have a right to fish within the survey area and outer Operational Area for squid, southern rock lobster, orange roughy, dory, miscellaneous deepwater species, and giant crab.
Do you consider yourself a potentially impacted person, through the operation of this survey? If so, would you like SIV to arrange a personal meeting with SLB?	A number of fishers were determined as potentially impacted by the MSS. Some respondents had already been contacted by SLB while others were not aware of the survey. Some positive commentary was received about SLB's engagement of SIV to undertake consultation with the fishing industry. All Western rock lobster fishers' rights are displaced by the survey and there was significant concern how the survey will impact the rock lobster fishery within the extent of the survey. It was raised that summer is right after the rock lobster spawning period, and that any activity which has the potential to reduce viability in one sector of the commercial fishing industry always has a knock-on effect in another, e.g. if one fisherman is no longer viable in an area and move to another area, pressure is added to the new area potentially increasing the number of impacted people in the fishing industry.
Is there any further information you would like SIV to report to SLB on the impact this survey will/might have on your fishery or you as a fisher?	What is the modelled outermost area of seismic sound exposure? Concerns were raised about the impact of seismic testing on squid migratory pathways. Concerns were raised on the impacts on the spawning success of squid, given that 10% of survey lines in less than 700 m cover the entire western Victorian squid fishery. Concerns were raised about the impacts of seismic on squid reproductive organs and squid eggs. How will SLB address the short-term/seasonal decline in catches and the possible "catastrophic" impact on larvae and squid eggs? Significant weight needs to be given to concerns about the proven impact of seismic on plankton. Rock lobster fishers raised concerns on the potential impact on rock lobsters and giant crab and stated that '*lack of scientific certainty should not be used to avoid adopting control measures*'. Questions were raised on the use of Day *et al*. (2016) as the definite limit of sound exposure on rock lobster. An independent review of the impact buffer was requested.

Questions presented to stakeholders	Summary of stakeholder's responses to questions
Are there any considerations that must be made for the species you fish for, migration patterns, reproductive phases, etc.?	**Spawning/Aggregation/Larvae concerns:** A number of critically important processes occur in the waters off South Australia during spring/summer – November-January is the most important period of the year for spawning and larval dispersal of most species. Disruption of the migration, spawning or larval cycle while in the water column has "every possibility of significantly impacting recruitment and settlement into a fishery" and needs to be considered prior to seismic operations. There is little information on the specific locations and spatial extent of spawning along the western Victoria coast. The findings of Richardson *et al*. (2017) should not be directly applied quantitatively to other regions with different oceanographic conditions and a detailed study of a particular region would be needed to quantify the spatial and temporal impacts in a particular region/season. There is "significant and alarming potential" that any denuding from the Otway Basin by the SLB MSS will be further impacted/compromised with 3D Oil's Dorigo MSS and Spectrum Geo's Otway Deep 3D surveys in similar waters. How has this and any other cumulative impact been considered in the EP? Fishers seek commitment to undertake a regional study to quantify the spatial and temporal impacts on fisheries resources, including water column testing for eggs and larvae.
Do you have any further questions you would like to ask SIV or for SIV to ask SLB on your behalf?	Can SLB guarantee there will be no effect on fish populations? Can SLB confirm that all seismic activity will only occur within the acquisition area? Will line turns be made within the primary acquisition area? If not, will the seismic air-guns be completely switched off prior to exiting the primary acquisition area on turning procedures or simply powered down? Responders seek that SLB present all research in equal light and do not use selective research to promote their views/opinions. Suggest a precautionary approach were an impact is recognised and the fishing industry collaborated with to arrive at mutually acceptable solution. Responders see the opportunity to review the full EP prior to submission. How is a recent Curtin University study applicable to the Otway Basin 2DMC MSS – are the sound sources similar just not multi-array, and what control measures will be adopted to address these findings?

5.5.2.4.3 Tasmanian Seafood Industry Council

TSIC is the peak body representing the interests of Tasmanian wild capture fishers, marine farmers, and seafood processors. TSIC works with industry sector groups to ensure ecological sustainability and ongoing economic contributions to the Tasmanian Economy. TSIC activities are overseen by a biannually elected Board (TSIC, 2018).

SIV (**Section 5.5.2.4.2**) and TSIC have developed the '*Policy in relation to mining, gas and petroleum sector consultation with the professional seafood industry*' to encourage an open and collaborative approach to consultation between oil and gas exploration companies and commercial fisheries. Development of the policy comes following the increasing number of proposals brought to peak bodies. Consultation of these proposals has been labelled by peak bodies as '*inconsistent and often inadequate*' (SIC/TSIC, 2018).

The policy provides details on the Australian professional seafood industry's position around future mining, gas and petroleum activities within the marine environment, and provides a process for the minimum standard of consultation with the professional seafood industry (SIC/TSIC, 2018). The key principles of the SIV and TSIC policy are as follows (SIC/TSIC, 2018):

- The professional seafood industry is a major impacted sector when oil and gas activities are conducted in the marine environment;
- The proponent has an obligation to properly engage with relevant seafood organisations, in particular the peak bodies (i.e. SIV and TSIC). Any potential issues and risks must be identified during the consultation process, and any risk must be mitigated to **ALARP**;
- Consultation should be undertaken in the most efficient way; i.e. with a co-ordinated consultation programme run through peak industry bodies with established connections and not individual fishers or small association bodies;
- The cost of running the co-ordinated consultation programme should be solely met by the proponent who gave rise to the need of the service;
- The following process should be followed:
    - First contact - The proponent should identify the jurisdiction (States and/or Commonwealth) within which they will be operating and make first contact with the seafood industry through the relevant peak body, including the provision of information through to the peak body. First contact and the provision of information should be done well in advance of the first briefing session with the peak body;
    - First briefing session – The first briefing session should discuss the approach and scope of a Consultation Plan which will be informed by where and when the proposed activity is going to take place, and therefore which industry sectors are likely to be impacted;
    - Costing provision by peak body – Following the briefing session, the peak body will act on behalf of the industry and provide a costed proposal to deliver the agreed Consultation Plan to meet the proponent's and industry needs, and to ensure seafood industry members are fairly treated; and
- Should a proponent fail to engage in meaningful consultation with the professional seafood industry, peak bodies will seek to have regulatory approvals deferred for proposed projects that may significantly impact upon the industry's interests.

SIV and TSIC believe that the duty to consult lies solely with proponents and that proponents must demonstrate that their consultation and negotiation strategies engage appropriately with the professional seafood industry, and must address, and where possible mitigate, environmental and access issues.

SLB engaged TSIC to conduct engagement and consultation with their members. Following this, TSIC prepared an Industry Communication and Engagement report outlining the outcomes of the engagement and consultation process, TSIC's position and concerns, and some recommendations for SLB to consider (TSIC, 2019).

TSIC's strategy was to engage with as many potentially impacted TSIC members as possible. A questionnaire and SLB factsheet were provided to TSIC members, with these documents also sent to the Tasmanian Rock Lobster Fishermen's Association for more targeted distribution. TSIC received a total of 60 responses, the majority of which were from the giant crab and rock lobster fishery (TSIC, 2019). Questions presented to TSIC members and a summary of the responses received are provided in **Table 33**, with the full report included as **Appendix J.** SLB's response to the questions/issues raised in the TSIC report is provided in **Appendix K**.

TSIC's position, concerns, and recommendations for consideration can be summarised as (TSIC, 2019):

- **Consultation fatigue and industry disengagement** – a poorer than expected response rate is thought to be a result of 'consultation fatigue' on account of the multiple MSS proposals overlapping the north-west Tasmania/King Island region causing disengagement within the seafood industry;
- **Sound exposure and cumulative sound exposure levels** – TSIC are unsure of the outer limits of any sound exposure from the Otway Basin 2DMC MSS, and noting many members fish within or in close proximity to the Operational Area, consider it important to fully understand any outer limits of exposure;
- **Impacts on southern rock lobster** – despite minimal direct overlap with the Operational Area, industry believes there are significant populations of rock lobster in relatively close proximity the Operational Area. Based on the results from IMAS research, TSIC requested the following:
  - An independent review of spatial limits to sound exposure;
  - Further information on the cumulative sound exposure impacts on rock lobsters; and
  - Consideration is given to deep water lobster stocks to the west of King Island and in the Victorian jurisdiction.
- **Impacts on giant crabs** – respondents expressed concerns that they will be directly impacted by the location and timing of the Otway Basin 2DMC MSS and noting the impacts on rock lobster, TSIC assume that MSS sound would have at least similar impacts. TSIC also note that giant crab stocks are currently at an all-time low;
- **Impacts on scale fish** – Tasmanian-based fishers hold access rights to the Commonwealth Southern and Eastern Scalefish and Shark Fishery, and will be displaced due to spatial and temporal overlap; however, TSIC note that this should be captured through consultation with Commonwealth fishers (see **Section 4** and **Appendix F**);
- **Impacts on zooplankton and larvae** – TSIC raised concerns on the impacts of zooplankton and larvae based on the results of Day *et al*. (2016) and McCauley *et al*. (2017), in particular impacts on rock lobster given their long larval stage and on stocks in north-west Tasmania;
- **Application of the Offset Principle** – TSIC support the application of the Offset Principle in recognition of their belief of the impacts that MSSs are having on the environment and future recruitment. TSIC recommends the establishment of an Offset Fund to allow projects to be established to support the marine environment and its resources.

Table 33 Questions Presented to Stakeholders by TSIC and Summary of the Received Response

Questions presented to stakeholders	Summary of stakeholder responses to questions
Are you willing to provide your name and contact details to SLB?	18 individuals representing 26 people agreed to provide their name and contact number (see **Appendix J** for details).
Do you fish in the proposed Operational Area?	Only three fishers indicated they fish in the Operational Area, and one indicated they have fished the area in the past; however, the majority noted they fish in relatively close proximity at certain times of the year and have concerns about deeper water rock lobster and giant crab stocks that live within or close to the Operational Area.
What fish species do you target between the months of October and April each year?	Southern rock lobster and giant crab were the two key species, although one respondent also mentioned scallops.
What method of fishing do you use?	Lobster or crab traps.
What depth range do you fish for your target species?	Rock lobsters' fish in depths up to 150 m. Giant crab fishers will fish out to 365 m (200 fathom). Responses indicate that some fisher's fish over the shelf break (for giant crab).
Do you have any further concerns around the impacts of the proposed seismic activity on your fishery or fishing operations?	The general opinion was that MSSs impact all aspects of marine life. Specific comments included: • All seismic activities impact juveniles of all species; • Trawl fisheries will be even more impacted; • Seismic adversely affects and kills giant crabs and other species; • Huge impact on rock lobster and crab larvae and juvenile and adult stocks of these species; • No scientific research on the impacts of seismic on giant crabs; and • Catch rates are always affected after a MSS.
Are there any broader concerns you have around seismic activity?	Commonalities in answers include: • Seismic kills larvae and adults, but what is the recovery time, assuming that it will recover? • Continued seismic activity will decimate the fishing industry; • Fishers cannot understand why the government continues to allow company after company to conduct these surveys – it should be done once, and the data shared by all. Legislation must be changed, and no new surveys allowed; and • Alternatives to MSSs are available. While these are slower and more expensive, streamers laid on the seabed instead of the sea surface stops damage in the water column.

Questions presented to stakeholders	Summary of stakeholder responses to questions
Do you have any specific questions for SLB?	Comments revolve around the oil and gas industry having their own agenda and that the interests of fishermen are ignored. The general perspective is that the oil and gas industry do not care about the environment, this sort of consultation is only ticking boxes, and meaningful changes are not produced. The seafood industry finds this hard to digest given that it is scientifically proven (IMAS research) that seismic causes significant damage.
Any other comments?	Responses were diverse but were condensed into the following: • Seismic has killed the giant crab fishery off the west coast of Tasmania before and will happen again after this survey; • Other fisheries (e.g. Alaskan crab fishery) took decades to recover; • A fisherman trawling after a large-scale MSS caught nothing but dead fish and shells; • SLB quote scientific evidence the MSSs do not cause damage by citing a Norwegian survey – no one can find evidence of this survey; • Fishermen get charged to access the fishery, and are implemented to all sorts of management to ensure the resources is sustainable – MSSs come through and everything is compromised; • Fishers stop fishing to protect breeding females with eggs staying in the water for 18+ months – seismic will compromise the eggs; • Respondents are not sure why they both with the process as the government has already decided to support the oil and gas industry and provide approvals before this process; • Recruitment will be impacted but the results won't be seen until some years down the track; • Need the offset principle applied to seismic to help rehabilitate the damage of seismic on eggs and larvae (i.e. future recruits); • Pay 5 boats to tie up for the year to leave adults in the water to breed and contribute to future recruitment – offset seismic impacts; • Tasmanian rock lobster fishery is working to improve stocks on the NW of Tasmania – MSSs compromise all the benefits made; • Other proposals for MSSs have been made in the same area; • Some fishers don't fish the area but participated to show support to those who will be impacted; and • One fisher made the comment "*I 100% support this*".

Source: TSIC, 2019

5.5.2.4.4 Southern Rock Lobster Limited and associated Rock Lobster Associations

Southern Rock Lobster Limited (**SRL**) serves as the national peak body working to further the interests of the Australian Southern Rock Lobster Industry (SRL, 2018) and represent the rock lobster industry in all three states. The primary function of SRL is to facilitate a process to guide expenditure of research and development levy funds collected from the rock lobster industry by State Government agencies and leverage via the Fisheries Research and Development Corporation, as well as to attract and secure funding from sources outside of the corporation. Members of SRL are: The South Australian Rock Lobster Advisory Council Inc., Tasmanian Rock Lobster Fisherman's Association (**TRLFA**), Victorian Rock Lobster Association, and the Australian Southern Rock Lobster Exporters Association (SRL, 2018).

5.5.2.5 Commercial Fisheries of Relevance to the Otway Basin 2DMC MSS Operational Area

Fishers operating in Commonwealth waters must obtain the correct permits and rights to commercially harvest targeted species, including Statutory Fishing Rights and Commonwealth Fishing Permits while fishers operating in state-managed fisheries must comply with relevant licence requirements obtained from the appropriate state departments.

Statutory Fishing Rights, granted under the Fisheries Management Act 1991, are required for Commonwealth managed fisheries where a Statutory Management Plan exists. Of relevance to the Operational Area are the Southern Bluefin Tuna, Bass Strait Central Zone Scallop, Southern and Eastern Scalefish and Shark, and Small Pelagic fisheries (**Figure 43**). Separate rights exist for each fishery, including: quota Statutory Fishing Rights allowing the take of a particular quantity of fish, boat Statutory Fishing Rights allowing the holder to use a boat in the fishery, and gear Statutory Fishing Rights that allow the use of a particular quantity of fishing equipment (AFMA, 2018c). For example, in order to fish for scallops in the Bass Strait Central Zone Scallop Fishery, concession holders must hold at least one quota Statutory Fishing Right for each species of scallops (*Pecten fumatus* and *Chlamys asperrimus*) and must fish off a nominated boat, with the number of Statutory Fishing Rights held determining what percentage of the Total Allowable Catch by weight that can be harvested by each concession holder (AFMA, 2018d). Statutory Fishing Rights can be leased, or permanently held by a person or company. Any boat authorised to fish under a Statutory Fishing Right must be an 'Australian boat' (as defined in the Fisheries Management Act 1991) (AFMA, 2018c).

Commonwealth Fishing Permits allow commercial fishing for Commonwealth managed species and are granted under the Fisheries Management Act 1991. The area of operation, boat being used and other conditions such as fishing methods and species taken are specified under these fishing permits. Commonwealth Fishing Permits can be granted for a maximum of five years, although the majority of permits get granted for one year and require holders to re-apply on an annual basis (AFMA, 2018c). Commonwealth Fishing Permits may be required in addition to Statutory Fishing Rights. Any boat authorised to fish under a Commonwealth Fishing Permit must be an 'Australian boat' (as defined in the Fisheries Management Act 1991) (AFMA, 2018c).

Commercial fisheries in South Australian state waters are regulated by PIRSA, and operators are required to obtain a licence or permit for the correct fishery, register the boat used for the fishing activity under the licence or permit, ensure the person in charge of the boat is a registered master, and register devices to be used for fishing activity under a licence or permit in respect of the fishery (PIRSA, 2018a).

Commercial harvesting of rock lobster in South Australia's Southern Zone is restricted to holders of a limited number of licences. Licences are endorsed with quota units and are issued for period of five years. In order to hold commercial pots and quota, fishers must be the holder of a current commercial licence. Pots used within the fishery must also be registered, with a maximum of 11,923 pots registered to the fishery. A minimum and maximum number of pots registered to an individual licence has also been set at 40 and 100 pots respectively (PIRSA, 2013).

Victoria's commercial fisheries are under the regulation of the VFA. Commercial fishers must hold a licence for their target fishery and register their boat in order to operate within Victorian state waters, resulting in a limited entry fishery. As with South Australian rock lobster fishery, the Victorian rock lobster fishery is also managed in separately managed zones, with a minimum and maximum number of pots allowed per licence holder and within the fishery as a whole (VFA, 2017).

Tasmanian commercial fisheries are regulated by the DPIPWE. Commercial fishers must hold the appropriate fishing licence according to the species being caught and must fish from a licensed fishing vessel. The use of a licensing system restricts entry to the Tasmanian commercial fishery; the maximum number of licences issued has been restricted for some species (e.g. rock lobster) and no new licences are presently being issued for most commercial species (DPIPWE, 2018a). For example, the harvesting of rock lobster from Tasmanian waters may only be carried out by rock lobster licence holders, with each licence requiring at least one rock lobster quota unit permanently held on it and have 15 quota units to participate in the fishery. A person may not benefit from, or hold more than, 200 quota units (TRLFA, 2018).

The waters of the Otway Basin support commercial fisheries targeting more than 15 species using a variety of fishing gear ranging from relatively selective gear such as rock lobster pots to less selective methods such as trawling (SETFIA, 2019). Information on the commercial fisheries identified by SETFIA (2019) as having recent catch or effort from within the Operational Area, and the permit and licence systems for each fishery is provided below. The SETFIA (2019) report assessed each fishery and reported the level of potential impact from the Otway Basin 2DMC MSS according to the following three classifications "significant", "some impact" or "no or negligible impact"; where the level of potential "impact" was calculated as 'the overlap of the Operational Area with the landed commercial catch (and revenue) within that same area'. However, the SETFIA (2019) report does not define the three levels of impact to a specific catch value, but it is noteworthy that only those fisheries that are expected to land more than $20,000 worth of catch annually from the Operational Area are considered to be at risk of a significant impact.

5.5.2.5.1 Commonwealth and State Rock Lobster Fisheries

Southern rock lobster (*Jasus edwardsii*) are distributed around southern mainland Australia, Tasmania and New Zealand in water depths of approximately 200 m (Linnane *et al*., 2018). Lobsters inhabit algal-dominated rocky reef habitats (Linnane *et al*., 2018), and are fished with baited pots that are generally set and hauled once each day. Most of the lobster catch comes from inshore waters less than 100 m deep. Southern rock lobsters' mate from April to July, with females then brooding up to 1 million eggs for 3 – 4 months over winter (MacDiarmid, 1989). Eggs are then released into the sea and hatch into naupliosoma, a larval phase which lasts for only a few hours. Once naupliosoma swim to the water surface, they become phyllosoma larvae. Phyllosoma are widely dispersed by currents and typically drift hundreds of kilometres offshore (Booth and Phillips, 1994). They have limited or no ability to swim horizontally and are thought to be distributed primarily by currents and eddies (Bruce *et al*., 2000; Bruce *et al*., 2007). There is however evidence that phyllosoma can migrate vertically in the water column, with studies showing that they tend to move away from the surface layer during the day (Booth, 1994; Bruce *et al*., 2000; Bradford *et al*., 2005).

The phyllosoma stage is estimated to last for 18 – 24 months and includes 11 phyllosoma developmental phases (Booth, 2006). After this time, phyllosoma metamorphose into puerulus larvae. Puerulus are transparent and resemble miniature lobsters; they are active swimmers and make their way to coastal reef habitats. Once there, they moult again and then settle as pigmented juvenile lobsters (Pecl *et al*., 2009).

As southern rock lobsters grow, they periodically moult by shedding their exoskeleton. Moulting is more frequent for juveniles and, after reaching sexual maturity, lobsters normally only moult once or twice a year. Adults tend to stay in the same region although have been recorded as moving distances of more than 80 km's. Breeding is able to begin once their carapace length reaches 60 – 70 mm and records show that southern rock lobsters can live for more than 20 years.
The recruitment and settlement of puerulus is highly variable among regions and years and is influenced by both local and large-scale environmental factors including water temperature, wave period, wind strength and oceanic currents. For example, in southern Australia, larval transport is dominated by an easterly displacement from western natal spawning sites by currents running parallel to the coast from south-west Western Australia to the east coast of Tasmania. Complex eddy fields and currents in offshore waters in southern Australia act to isolate some larvae from the predominant easterly flow with localized westerly displacement in some areas (particularly South Australian waters) (Bruce *et al.,* 2007).

There is also evidence of a seasonal trend where settlement is lower during autumn and peaks in winter and summer (Booth, 1994; Cohen and Gardner, 2007; Linnane *et al*., 2010).

The Southern Zone Fishery has the highest level of egg production in southern Australia and is an important source of puerulus for the overall south–eastern fishery (Linnane & Walsh, 2011). With the exception of southwest Western Australia, all regions receive more rock lobster stock from outside their own boundaries than from self-recruitment (Bruce *et al*., 2007). Southern rock lobster larvae have been found up to hundreds of kilometres from shore (Jeffs *et al*., 2001; Booth & Ovenden, 2000) although most have been caught over continental slope waters (Booth & Stewart 1992; Booth 1994).

As well as environmental factors, the movement of puerulus inshore is also influenced by their active swimming activity (Booth, 2001; Chiswell *et al.*, 2003; Jeffs *et al*., 2005). Southern rock lobster puerulus can swim at speeds of 10 – 40 cm/s for sustained periods which provides them with the capacity to move considerable distances towards the shore (Jeffs *et al*., 1999; Jeffs *et al*., 2001; Wilkin & Jeffs, 2011). They have also been observed swimming in straight lines at the sea surface at night (Jeffs & Holland, 2000). Some research report coherence or synchrony in settlement patterns across locations as evidence that large-scale oceanographic processes are primarily driving patterns in puerulus settlement (Booth 1994; Caputi, 2008; Linnane *et al*., 2014). However, this is not consistent among studies. For example, Hayakawa *et al.* (1990) was unable to determine a relationship between puerulus settlement and local environmental variables that would otherwise be associated with passive onshore transport of larvae. The findings of this study support the importance of active swimming in response to an orientation cue by puerulus.

When using an orientation cue, a pelagic organism will detect underwater sound and change their orientation to reach their preferred habitat (Montgomery *et al*., 2006; Au & Hastings, 2009). Few experiments have however investigated the use of orientation cues in southern rock lobsters (or other spiny lobster species). It is known that the ppuerulus of spiny lobsters have arrays of pinnate sensory setae along their antennae that may provide the capacity for sound detection (Jeffs *et al*., 1997; Jeffs *et al*., 2005; Montgomery *et al*., 2006).

Hinojosa (2015) conducted *in situ* experiments in New Zealand and demonstrated that puerulus actively moved toward sound of a natural reef at wind intensities < 20 ms^{-1}. This suggests that puerulus use reef sound as a cue to find reef habitats in which to settle in certain weather conditions.

This author found that puerulus made directional choices within the confines of a choice chamber within which there would have been a negligible sound pressure gradient (given that there is very little attenuation of sound propagated in seawater, especially at the lower frequencies that dominated the replayed reef noise). Therefore, it was concluded that it is most likely that the puerulus were sensing and responding to the directionality of the particle velocity component of sound rather than any pressure differential.

Underwater sound was also implicated as a possible cause for more than 4,000 puerulus caught in the seawater intake of a power station on the west coast of New Zealand (Booth, 1989; Jeffs *et al*., 2005). More recently, underwater sound from reefs was found to advance the physiological development of puerulus to juveniles (Stanley *et al*., 2015). This literature also suggests that puerulus are able to detect sound.

The 2014/15 combined stock assessment for South Australia, Victoria, and Tasmania estimated that the combined egg production for Southern rock lobster was above the limit reference point, suggesting that TACCs may be able to be increased (SETFIA, 2019).

South Australia Rock Lobster Fishery

In South Australia, the Rock Lobster Fishery is managed by PIRSAs Fisheries and Aquaculture Division and is separated into two zones; a Southern and Northern Zone. The 2015/16 fishing year annual catch was 1,592 t at an estimated value of $138 million (Mobsby & Koduah, 2017). Most of the rock lobster catch in South Australia is landed in the Southern Zone, which comprises all marine waters between the mouth of the Murray River and the Victorian border. The lobsters are harvested with steel-framed pots that are set overnight and retrieved at first light (Linnane *et al*., 2018). The main fishing season for the Southern Zone is from 1 October to the end of May, with the majority of fishing concentrated from 1 October to January (*Expert 1 – Sensitive Information*).

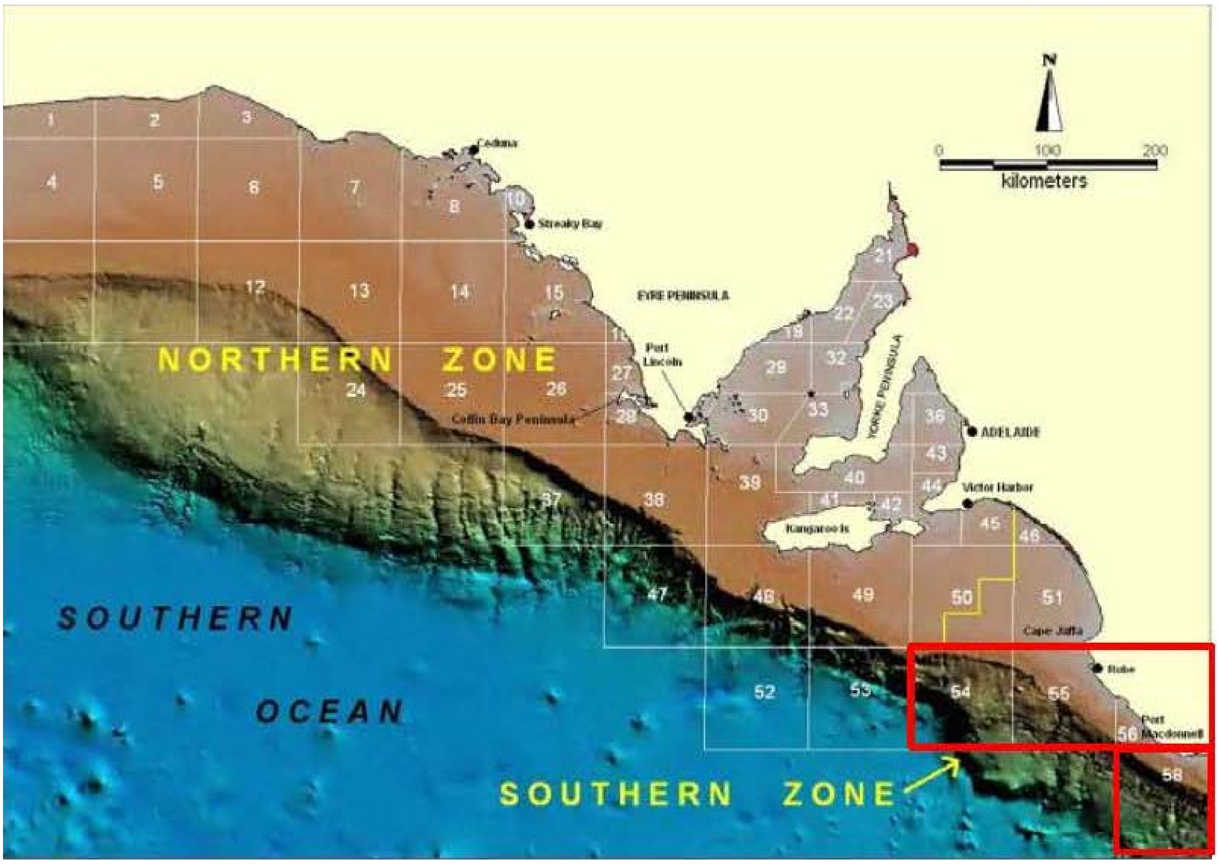
Effort within the South Australian Rock Lobster Fishery has remained relatively stable since 2010 but is currently low in a historical context (Linnane *et al*., 2018). The South Australian Government has management jurisdiction for rock lobster from the low water mark out to 3 NM in all waters and has also negotiated an Offshore Constitutional Settlement (**OCS**) with AFMA for jurisdictional control of rock lobster in all waters adjacent to South Australia from 3 NM to the edge of the Australian Fishing Zone (200 NM from shore). Puerulus (larval-stage lobsters) settlement in the Southern Zone has been below the long-term average throughout the period 2010 – 2016, and it is likely that recruitment from 2015 – 2021 will also be below the historical average (Linnane *et al*., 2018). Despite low levels of recruitment, management of the fishery has allowed the South Australian Southern Zone Rock Lobster Fishery to be classified as 'sustainable' (Linnane *et al*., 2018).

The South Australian Southern Zone Rock Lobster Fishery is a limited entry fishery, with a maximum of 181 licences available. Each licence must hold a minimum of 40 quota units (equal to 40 pots), with a maximum quota holding per licence of 100 quota units (i.e. 100 pots). A maximum of 11,923 pots may be registered in the South Australian Southern Zone Rock Lobster Fishery (Linnane *et al.,* 2018). For the South Australian Northern Zone Rock Lobster Fishery there is a maximum of 63 licences available, and a maximum of 3,694 registered pots, with a minimum of 20 pots and maximum of 100 pots per licence (Linnane *et al*., 2018a).

The Operational Area overlaps with Southern Zone Marine Fishing Areas (**MFA**) 54, 55, 56 and 58 (**Figure 44**). The majority of the Southern Zone catch is taken from MFA 54, 55 and 58. Annual catch in these MFAs decreased 1,850 t in 2007/08 to approximately 1,240 t since 2009/10 in line with a decline in TACC. Despite the drop-in catch, value increased from approximately $70 million per annum to $113 million in 2015/16. Catch and effort within the Southern Zone are consistently high from October – January, through to March in some years, dropping during April and May. Baited pots are used to target rock lobster over reef structures, with approximately 40% of the total catch taken in depths shallower than 30 m, and 40% taken shallower than 80 m (**Figure 45**).

Based on the water depths within the Operational Area and depths fished by lobster fishers, SETFIA undertook a depth analysis of the landings and estimated that 7.2% (90.1 t) of the total catch came from within the Operational Area, with a total value of $8.2 million (SETFIA, 2019).

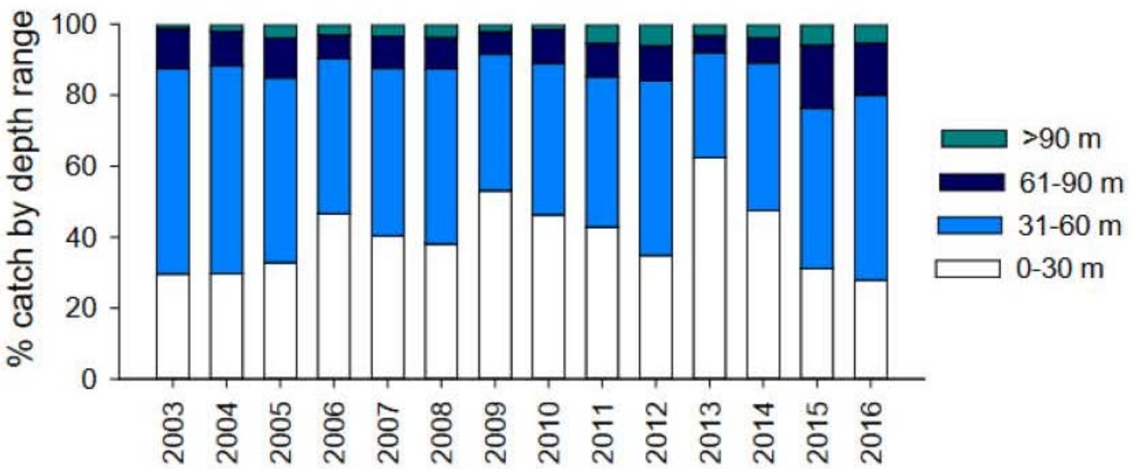
Figure 44 South Australian Rock Lobster Fishery Northern and Southern Zones with Marine Fishing Areas



Source: Taken from SETFIA, 2019

Note: Marine Fishing Areas that overlap with the Operational Area are outlined in red

Figure 45 Percentage of Catch by Depth from 2003 – 2016 in the Southern Zone for the South Australian Rock Lobster Fishery



Source: Linnane *et al*., 2017 as shown in SETFIA, 2019

Victorian Rock Lobster Fishery

The Victorian rock lobster fishery extends along the Victoria coast, out to Commonwealth waters. The Victorian rock lobster fishery is managed in two separate zones: the Western Zone and Eastern Zone, with separate Total Allowable Commercial Catch (**TACC**) set for each zone. The majority of catch in the Victorian rock lobster fishery originates from the Western Zone, within which the majority of the Operational Area overlaps. In 206/17, 209 t of rock lobster was landed within the Western Zone with a value of $16.5 million, while 53 t was landed in the Eastern Zone. The Victorian rock lobster fishery is considered to have recovered after over-exploitation (SETFIA, 2019).

TACC in the Western Zone for the 2015/16 fishing year was set at 230 t; this represents the second year at this catch level, and the seventh consecutive year that the full TACC has been taken (VFA, 2018b). The highest catch within the Western Zone in the 2015/16 fishing year came from Portland (99.9 t), followed by Warrnambool (75.5 t) and Apollo Bay (52 t) (VFA, 2018b). TACC in the Eastern Zone for the 2015/16 fishing year was set at 59 t for the second consecutive year. Effort required to catch the full TACC in the Eastern Zone appears to be increasing, suggesting a reduced biomass in the fishery (VFA, 2018b). Spawning of rock lobster in Victoria waters occurs from June – November. The rock lobster fishery is closed from September – November during the spawning season (*Expert 2 – Sensitive Information*). Catch has historically increased from a minimum in September to a peak in December and January, followed by a gradual decrease.

In order to harvest rock lobster from Victoria waters, fishers must hold a Rock Lobster Fishery Access Licence. For the Western Zone rock lobster fishery, a maximum of 71 licences are available, and a maximum of 5,162 pots are allowed. In order to be activated, a licence must hold a minimum of 20 pots. Quota units are attached to a Rock Lobster Fishery Access Licence and each licence must have a minimum quota holding of 10 units in order to be activated. Within the Eastern Zone rock lobster fishery, there is a maximum of 36 licences available, and a maximum of 2,021 pots allowed. In order to be activated, a licence must hold a minimum of 15 pots and each licence must have a minimum quota holding of five units (VFA, 2017).

From 2008 to 2017, approximately 853 t of rock lobster was taken from within the Operational Area. Annual catch within the Operational Area dropped from approximately 100 t to 72 t in 2015, increasing to 80 t in 2017. Despite falling catches, the value of rock lobster catch has increased from 2014 onwards; annual value of the catch taken from within the Operational Area ranged from $0.4 – $1.5 million (SETFIA, 2019).

Recent fishing effort by the Victorian rock lobster fishery has occurred within the Operational Area. SETFIA (2019) has estimated 41% of the catch has been caught from the Otway Basin 2DMC MSS Operational Area, with an annual average value of $5.3 million.

Tasmania Rock Lobster Fishery

The rock lobster fishery is a major Tasmanian industry providing significant benefits from exports from the commercial fishery and a highly popular and iconic recreational fishery. In the 2015/16 fishing year the annual Tasmanian rock lobster catch was 1,138 t, with an estimated value of $93 million (Mobsby & Koduah, 2017).

The Tasmanian rock lobster fishery is a limited entry fishery with a maximum of 312 licences issued. There is a maximum of 10,507 individual transferable rock lobster quota units, with a rock lobster fishing licence requiring at least one rock lobster quota unit permanently held on it, and 15 quota units to participate in the fishery. A person may not benefit from or hold more than 200 quota units (TRLFA, 2018).

Annual rock lobster catch within the fishing grids that overlap within the Operational Area from 2008-17 has ranged from 0.7 t to 4.2 t, with 1.5 t caught in the 2016/17 fishing season. Effort has also fluctuated, with a maximum of approximately 5,678 pot lifts recorded in 2010/11, and a minimum of 754 pot lifts in 2015/16. As expected, highest revenue from catch coincided with the 2010/11 maximum, with a revenue of approximately $0.5 million, although the lowest revenue did not match the lowest effort recorded in 2015/16, with the lowest revenue of $0.04 million recorded in 2013/14 (SETFIA, 2019).

Although no data on seasonality within the Operational Area was provided by SETFIA (2019), catches inshore of the Operational Area (towards Tasmania) suggest November – April have historically been months of high catch levels (SETFIA, 2019).

Recent fishing effort by the Tasmanian rock lobster fishery has occurred within the Operational Area. It is estimated that 0.3% of the Tasmanian rock lobster fishery is caught from the Otway Basin 2DMS Operational Area with an annual average value of $169,000.

5.5.2.5.2 Small Pelagic Fishery

The Small Pelagic Fishery operates off southern Western Australia, South Australia, Victoria, Tasmania, New South Wales, and some parts of Queensland (**Figure 46**), typically outside 3 NM, around southern Australia to 31°S (near Lancelin, north of Perth). Almost all small pelagic stocks are multijurisdictional (managed by both the Australian and state governments) under OCS arrangements. The exception is the western stock of Australian sardine, which is managed by South Australia and Victoria.

The Small Pelagic Fishery targets four species; Australian sardine (*Sardinops sagax*), blue mackerel (*Scomber australasicus*), jack mackerel (*Trachurus declivis*), and redbait (*Emmelichythys nitidus*). Purse seine nets were historically used within this fishery; however, this has been largely replaced by midwater trawling (SETFIA, 2019).

Australian sardine is found primarily in temperate waters throughout the eastern Pacific Ocean. They are a coastal species usually found from inshore waters to the edge of the continental shelf, down to depths of about 200 m. Australian sardine are often found in large schools. Feeding is thought to mainly occur during the day. Spawning occurs during spring – summer in the southern part of its range, and in summer – autumn in the northern range (AFMA, 2018e). Spawning of sardines in Victoria waters occurs from September – December, with the Victorian commercial sardine fishery peaking in March – June (VFA, 2018c). In the 2015/16 fishing year, Victorian fishers landed 1,524 t of sardines ($1.7 million) and South Australian fishers landed 41,103 t ($25.9 million) (Mobsby & Koduah, 2017). Commercially caught sardines are primarily used as feed for the Port Lincoln southern bluefin tuna aquaculture farms, with small amounts also sold for human consumption and as fishing bait for recreational fishermen (PIRSA, 2014).

Blue mackerel is a schooling pelagic species that occurs in tropical and temperate waters of the Pacific Ocean. They can be found to depths of 200 m over the continental shelf, although juveniles inhabit inshore waters and shallower waters. Blue mackerel tend to school by size, as well as with other fish such as jack mackerel. Feeding is thought to occur during the day. Spawning occurs in spring and summer in outer continental shelf waters off northern New South Wales and southern Queensland (AFMA, 2018e). Catch and value statistics were unavailable at the time of reporting.

Jack mackerel is a pelagic schooling species found around the south-east and southern coasts of Australia over the continental shelf and outer shelf margin. *T. murphyi* is more common in oceanic waters off the edge of the continental shelf. They are commonly found at depths of 20 – 300 m. Jack mackerel school by size, with juveniles found in shallower waters than adults. Feeding is thought to occur both during the day (*T. declivis*) and at night (*T. murphyi*). Spawning occurs during late spring – early summer. Spawning begins off the south-east coast of Australia and moves progressively south over the summer (AFMA, 2018e). Catch and value statistics were unavailable at the time of reporting.

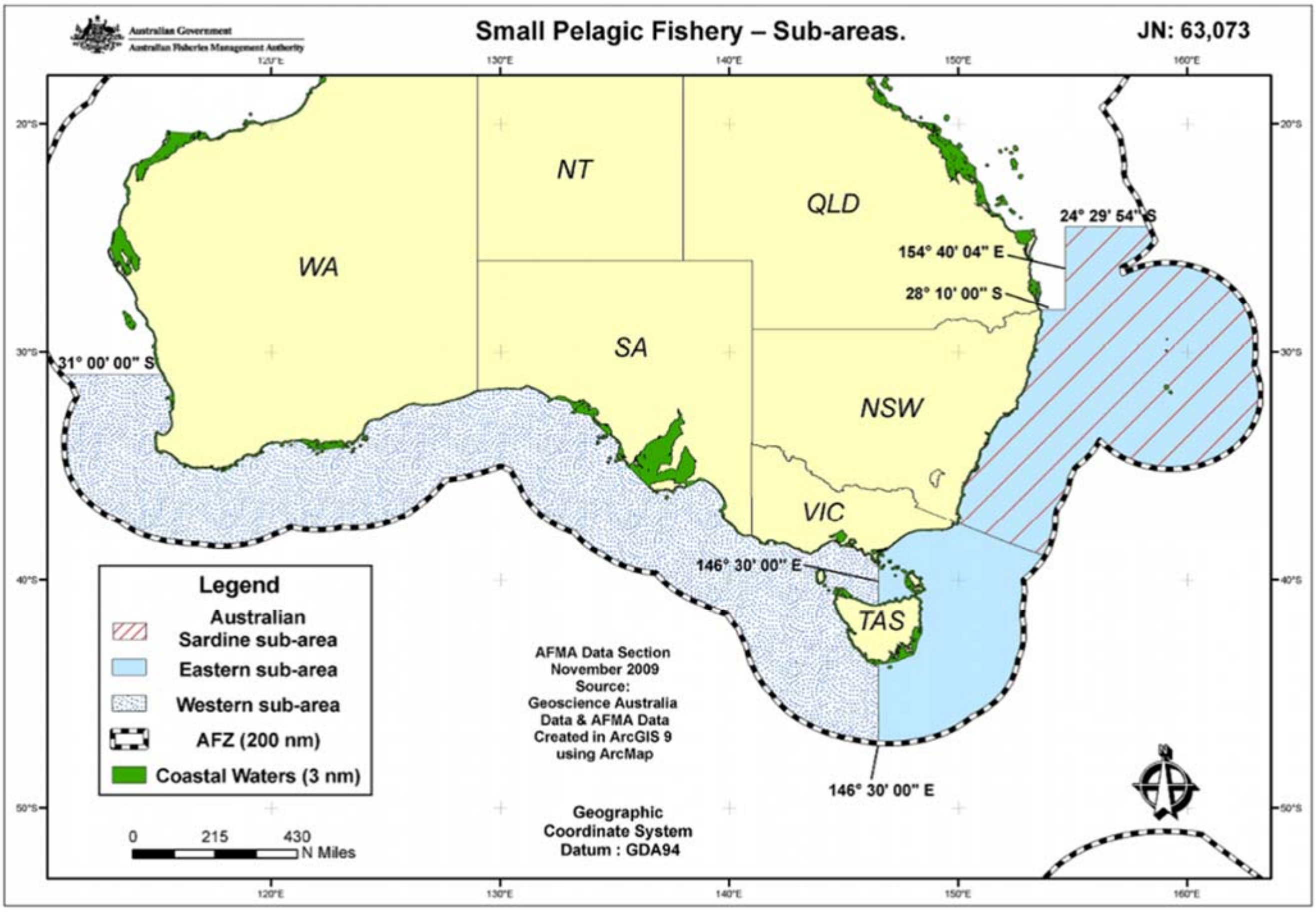
Redbait is a widespread pelagic species that occurs in association with seamounts, mid-oceanic ridges and the continental shelf in the south-west Atlantic, Indian and south Pacific Oceans. They are found at depths of 20 – 500 m. Redbait form schools by size and by depth. Juveniles tend to occur near the surface while adults are found in deeper water close to the sea floor. Adults move up into the water column at night. Spawning occurs over 2 – 3 months during spring (AFMA, 2018e). Catch and value statistics were unavailable at the time of reporting.

Australia's Small Pelagic Fishery is a Commonwealth Fishery, with fishers required to hold AFMA allocated Statutory Fishing Rights that allow them to catch the fish species that are under quota; each species caught within the Small Pelagic Fishery is managed under a separate quota. There are currently 61,047,305 Quota Statutory Fishing Rights within the Small Pelagic Fishery (AFMA, 2018e). In the 2017/18 fishing season, 30 entities held Quota Statutory Fishing Rights, with three vessels active in the fishery; two purse seine vessels and one mid-water trawl vessel (ABARES, 2018). Access to the South Australian sardine fishery is provided through a licence for the Marine Scalefish Fishery with a sardine net endorsement. The number of licences with sardine net endorsements has been capped at 14 (PIRSA, 2014). Commercial harvest within the Victorian sardine fishery is managed by limited entry licensing and gear restrictions.

SETFIA (2019) reports that there is a very small amount of recent effort in the Small Pelagic Fishery that overlaps with the Operational Area; however, given less than five vessels were associated with the Small Pelagic Fishery that fished within the Operational Area from 2008-17, catch, effort and value of the fishery could not be reported (SETFIA, 2019).

However, SETFIA (2019) has estimated that catch from the Operational Area from this fishery would be negligible.

Figure 46 Small Pelagic Fishery Sub-areas



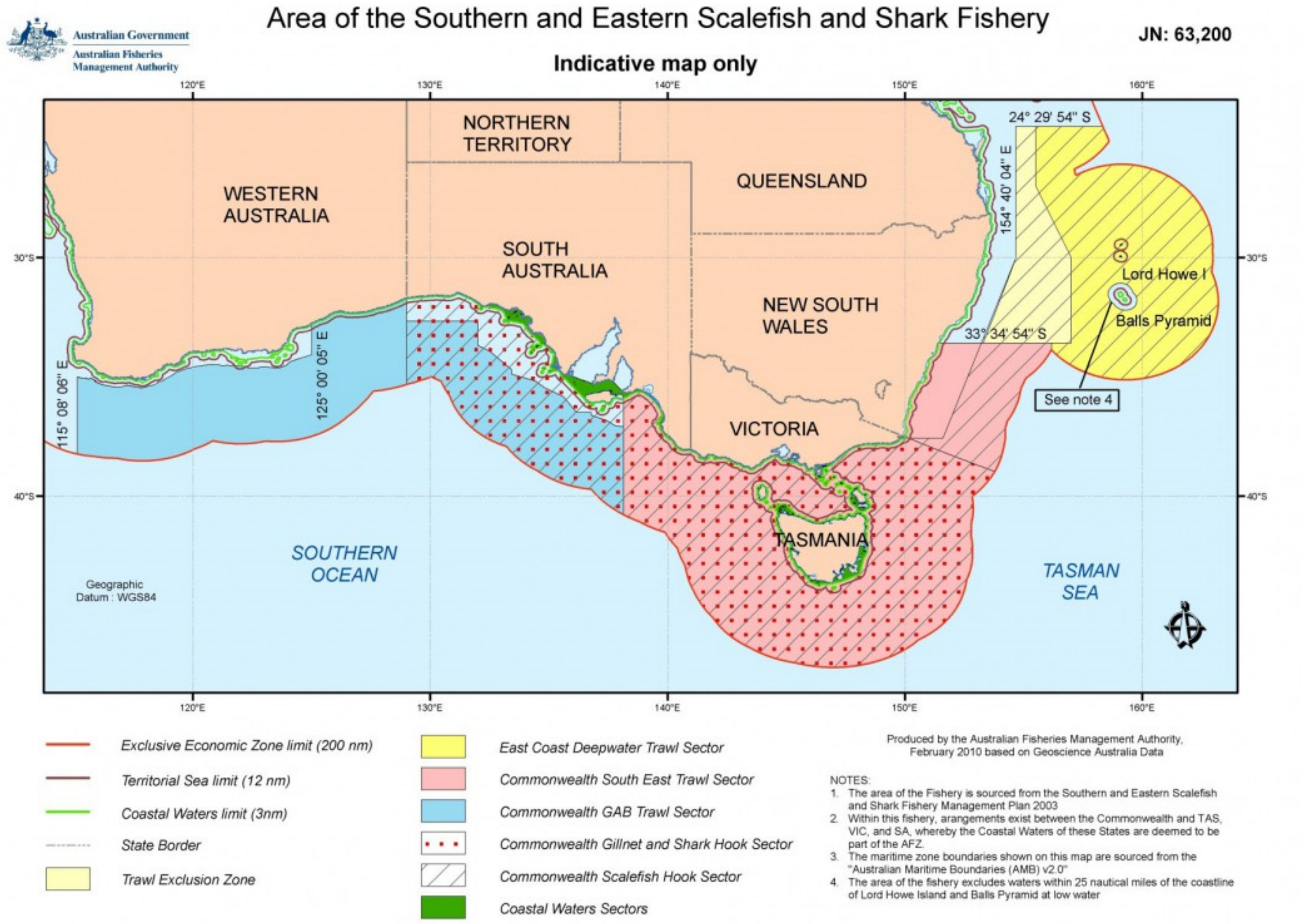
Source: AFMA, 2018e.

5.5.2.5.3 Southern and Eastern Scalefish and Shark Fishery

The Southern and Eastern Scalefish and Shark Fishery (**SESSF**) is a multi-sector, multi-gear and multi-species fishery, targeting a variety of fish, squid and shark stocks. This fishery is the main provider of fresh fish to the Melbourne and Sydney markets (SETFIA, 2019). The management area covers almost half the area of the Australian Fishing Zone and spans both Commonwealth waters and the waters of several Australian states under OCS arrangements. The SESSF is comprised of five sectors; the Commonwealth Trawl Sector (**CTS**), Great Australian Bight Trawl Sector, East Coast Deepwater Trawl Sector, Gillnet and Shark Hook Sector, and the Scalefish Hook Sector (**SHS**) (**Figure 47**). The SGSHS and the SHS are collectively referred to as the Gillnet, Hook and Trap Fishery (**GHAT**). Only the CTS and GHAT fisheries operate within the Operational Area (SETFIA, 2019).

SESSF quota species that are likely to be caught within the Operational Area include blue eye trevalla, blue grenadier, blue warehou, flathead, gemfish, gummy shark, jackass morwong, john dory, mirror dory, ocean perch, pink ling, ribaldo, sawshark, school shark, silver trevally, and silver warehou (SETFIA, 2019).

Figure 47 Southern and Eastern Scalefish and Shark Fishery



Source: AFMA, 2018f.

The Commonwealth SESSF is mainly managed through a closed fishery, fisheries-wide TACC limits for each quota species, gear restrictions, and closed areas. In order to participate in the fishery; fishers must hold a relevant fishing concession providing access to the area in which to fish, stipulating the method by which they are allowed to fish, and relevant quota holdings for quota managed species. In the Southern and Eastern Scalefish Fishery, Statutory Fishing Rights allow the holder to take a particular quantity of fish or use a boat in the fishery.

Fishing Permits within the SESSF are specific to a fishing sector and may be granted to allow fishing activities which are not covered under the Scalefish Management Plan. Permits may be granted to allow Commonwealth operators to take Commonwealth managed quota species in coastal waters. These permits are:

- **South Australian coastal waters – shark hook and/or gillnet**: Permits allow operators to take school and gummy shark under quota from South Australian waters. Operators must also hold a fishing concession issues by the State of South Australia that allows the use of the same fishing gear. The holder may also be required to hold a Commonwealth boat Statutory Fishing Right that authorises the use of the same gear type;
- **Tasmanian coastal waters**: Permits allow the take of school and gummy shark under quota from Tasmanian coastal waters. Operators must also hold a fishing concession issues by the State of Tasmania that allows the use of the same fishing gear. The holder may also be required to hold a Commonwealth boat Statutory Fishing Right that authorises the use of the same gear type;

- **Tasmanian Rock Lobster Zone**: Permits allow the take of school and gummy shark inside the area of waters defined in a Tasmanian Rock Lobster Permit; and
- **Victoria coastal waters – inshore trawl**: Permits allow the use of gear authorised under a Commonwealth trawl boat Statutory Fishing Right in Victorian coastal waters.

In the 2017/18 fishing season for the Commonwealth Trawl and Gillnet, Hook and Trap Sectors of the SESSF, there were 57 trawl and 37 scalefish hook boat Statutory Fishing Rights, with the number of active vessels recorded as 32 trawl, 18 Danish-seine, and 29 scalefish hook vessels. The Great Australian Bight Trawl Sector has 10 boat Statutory Fishing Rights that allow a boat to fish in the fishery, and separate quota Statutory Fishing Rights allowing quota species to be landed. Four trawl vessels and one Danish-seine vessel operated in the fishery during the 2017/18 fishing season. For the 2017/18 fishing season of the Shark Gillnet and Shark Hook Sector there were 61 gillnet and 13 hook Fishing Permits actively fished by 38 gillnet and 38 hook vessels (AFMA, 2018f).

Commonwealth Trawl Sector

With over 100 years of catch history, the CTS is one of Australia's oldest commercial fisheries. The sector's area of operation extends from Cape Jervis in South Australia around the Victoria, Tasmania and New South Wales coastlines northward to Barrenjoey Point. There were 18 Danish seine and 32 otter-board trawl vessels actively operating in the CTA fishery during the 2017/18 season (Patterson *et al*., 2018a).

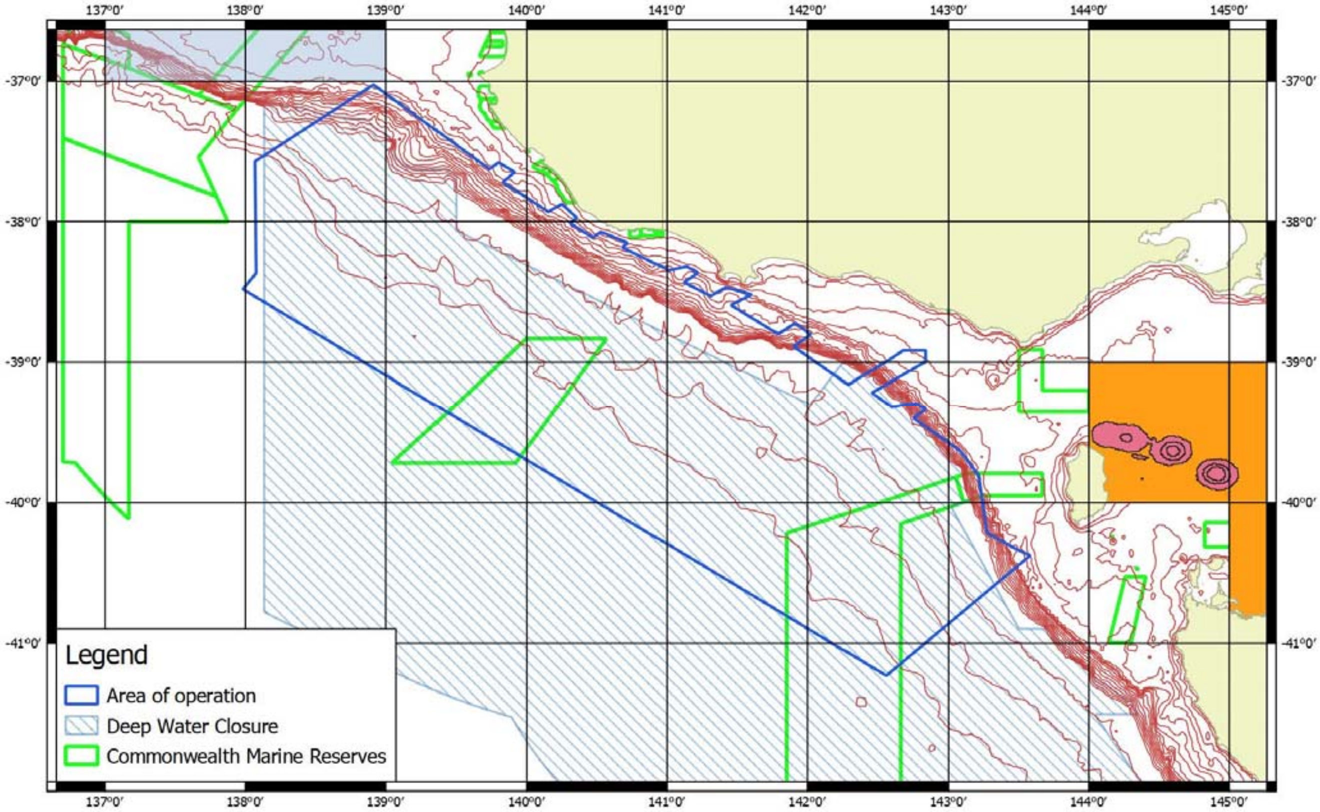
The Operational Area covers the Zeehan and Nelson Commonwealth Marine Reserves. The Nelson and most of the Zeehan Commonwealth Marine Reserves are classified as 'Special Purpose Zones' within which commercial fishing is prohibited. The inshore section of the Zeehan Commonwealth Marine Reserve is classified as a 'Multiple Use Zone' within which some commercial fishing is allowed; however, Danish seine, demersal trawl, and scallop dredge operations are prohibited. Furthermore, trawl vessels are prohibited from fishing deeper than the "Deepwater Trawl Closure" (**Figure 48**). The closure aims to be at the 700 m isobaths, but in reality, somewhat varies in depths (SETFIA, 2019).

Although some effort by the Danish seine sector was reported within the Operational Area, this was likely a reporting/data entry error as Danish seines are usually restricted to flat sandy bottom in waters less than 200 m (SETFIA, 2019). The waters west around King Island are fished by the otterboard trawl sector. Historical effort data shows some otterboard trawl effort along the shelf break; where since 2008 between ten and 18 CTS vessels (out of 32 active otterboard trawl vessels) have reported high annual fishing effort within the Operational Area. Annual catch within the Operational Area ranged from 1,890 t (caught in 2010) to about 870 t (caught in 2014). Between 2008 and 2018, a total of 12,405 t was caught within the Operational Area with a value of $44.6 million (SETFIA, 2019).

Catch within the Operational Area is typically dominated by slope dwelling species such as blue grenadier, silver warehou, and Gould's squid, while pink ling and mirror dory are also major species. Effort by the CTS fishery within the Operational Area is highest in January, April and May, and lowest from July to September. Total catch is typically highest in March to May (SETFIA, 2019).

Recent fishing effort by the CTS Otterboard sector has occurred within 15% of the fishery being caught from within the Operational Area, which has an annual catch value estimate of $4.5 million.

Figure 48 Deepwater Closure and Commonwealth Marine Parks with Operational Area Overlaid



Source: SETFIA, 2019

Gillnet and Shark Hook Sector (SGSHS)

The SGSHS sector extends from the South Australia/Western Australia border to the Victoria/New South Wales border and targets gummy shark using demersal gillnets and longlines. The SGSHS is restricted to waters shallower than 183 m. Catch in the SGSHS sector peaked in 1986 at 4,000 t; however, catch has significantly decreased since on account of declining school shark stocks, conservative school shark management arrangements to promote recovery, and removal of effort through Government-led structural adjustments and closures.

The SGSHS sector has fished within the waters of the Operational Area using both demersal gillnets and demersal longlines, with a total of 43 different SGSHS vessels fishing within the Operational Area between 2008 and 2018. The number of vessels operating within the Operational Area in any one-year ranges from 9 to 15. Annual effort within the Operational Area doubled between 2011 and 2013 and has since remained relatively high. Annual catch has also increased to more than 35 t in 2017/18, with catch value also increasing from approximately $100,000 to more than $200,000 in 2017/18. Monthly effort within the Operational Area peaks from April to June, and is lowest in July to September, with catch weight showing a similar pattern of a maximum in June and minimum in July. Main species caught within the Operational Area are gummy shark, school shark, and common sawshark (SETFIA, 2019).

Some recent fishing effort by the SGSHS sector has occurred within the Operational Area, where it is estimated that 0.8% of the overall catch from this fishery comes from the Operational Area with an average annual value of $132,000.

Scalefish Hook Sector

The SHS sector operates from the South Australia/Western Australia border, around south-east Australia and up the east coast, where it targets pink ling, hapuku and blue-eye trevalla using demersal longlines and droplines (SETFIA, 2019).

The SHS overlaps with the Operational Area, with annual catch rates within the Operational Area ranging from 80 t in 2009/10 to 10 t in 2011/12 with a value of $700,000 and $90,000 respectively. Typical annual catch rates from within the Operational Area are 40 - 60 t. Most effort within the Operational Area occurs during March – April and October – November, with highest catches occurring in February and November (SETFIA, 2019).

Recent fishing effort by the SHS sector has occurred within the Operational Area, with an annual average catch value of $132,000.

5.5.2.5.4 South Australian and Tasmanian Scalefish Fisheries

South Australia Scalefish Fishery

The South Australian Marine Scalefish Fishery is a multi-species and multi-gear fishery operating in all coastal waters of South Australia between the Western Australia and Victoria border. Main species caught within the fishery are gummy shark, yellow-eye mullet, and Australian salmon.

The Operational Area overlaps with four MFAs, with recent effort recorded in the area. A total of 300 t with a value of $1.7 million was taken from within the Operational Area between September 2007 and May 2017. Although seasonality of catch is inconsistent over time, effort has been lowest from June – August, and relatively stable throughout the remainder of the season.

Recent fishing effort by the South Australian Marine Scalefish Fishery has occurred within the Operational Area. It is estimated that 1.5% of catch for this fishery comes from within the Operational Area with an annual average value of $167,000.

Tasmanian Scalefish Fishery

The Tasmanian scalefish fishery is a multi-gear and multi-species fishery operating within coastal Tasmanian waters predominantly made up to small owner-operated commercial businesses (DPIPWE, 2018b). A range of scalefish, sharks, and cephalopods are harvested, mainly using gillnets, hooks, and seine nets. While the majority of the fishery operates along the northern (i.e. east of King Island towards Flinders and Cape Barren Islands), southern and eastern coasts of Tasmania, a number of species are also targeted along the north-west and western coastline. A small proportion of the Tasmanian scalefish fleet specialise in a single activity or target a single species, with scalefish representing a supplementary fishery for many operators, such as those fishing for rock lobster (Moore *et al*., 2018).

To catch and sell scalefish from Tasmanian waters, specific scalefish licences must be held. The platform for a commercial scalefish licence package is a fishing licence (vessel), with a fishing licence (vessel) having four different vessel length categories: 0-<6 m, 0-<10 m, 0-<20 m, and >20 m. There are a limited number of vessel licences in each length category (DPIPWE, 2018b). **Table 34** lists all licence of relevance to the Tasmanian Scalefish Fishery. Since 2001, the number of general scalefish licences has declined, mainly on account of a two-thirds reduction in the number of 'Scalefish C' licences issued. In 2015, there was an increase in the number of active licences, particularly 'Scalefish B' and 'Scalefish C' licences, mainly due to a rise in the number of new entrants activating existing licences, and the diversification of some rock lobster fishers (Moore *et al*., 2018).

The Operational Area overlaps 'very slightly' with reporting grid 4C2. From 2007-17, at many as five different vessels fished within the Operational Area in any one year, with a total of approximately 4 t caught during this period with a catch value of $25,720. Due to the small number of vessels operating within the Operational Area, SETFIA were unable to report catch data in a finer time-scale (i.e. annually). Most catch is taken during summer months; 2.2 t of fish was caught between 2007/08 and 2017/18, with a value of $13,266 (SETFIA, 2019). SETFIA (2019) were unable to report on data from other seasons.

More than 90 different species have been reported in catch logbooks. Gummy shark and striped trumpeter are the main species caught within the Operational Area, with sand flathead, jackasss morwong, yellowtail kingfish, ling, school shark, snapper, sweep, bastard trumpeter, striped trumpeter, blue warehou, blue throated wrasse and purple wrasse also caught (SETFIA, 2019).

Six gear types were deployed within the Operational Area; bottom longline, drop line, dip net, gillnet, handline, and shark longline. Of these six, only handlines were used by more than five operators, catching a total of 1.9 t of fish in the period between 2007 and 2017 (SETFIA, 2019).

Recent fishing effort by the Tasmanian Scalefish Fishery has occurred within the Operational Area. Although the percentage of catch caught from the Otway Basin 2DMC MSS Operational Area cannot be reported, is has been estimated that the annual average catch value from the Operational Area is $2,572 (SETFIA, 2019).

Table 34 Licences of relevance to the Tasmanian Commercial Scalefish Fishery

Fishing Licence Type	Number of Licences in 2017/18
Gear Based Licences	
Scalefish A	64
Scalefish B	148
Scalefish C	59
Beach seine A	25
Beach seine B	24
Purse seine net	9
Small mesh gillnet	10
Automatic squid jig	18
Danish seine (general)	6
Danish seine (limited)	1
Species Based	
Australian salmon	7
Banded morwong	26
Octopus	2
Southern calamari	17
Wrasse	61
'Other' licences	
Mackerel A	4
Mackerel B	1
Rock lobster	311
Vessel (all fisheries)	689
Personal (all fisheries)	483

Source: DPIPWE, 2018b

5.5.2.5.5 Eastern Tuna and Billfish Fishery

The Eastern Tuna and Billfish Fishery operates in the EEZ along east Australia, from Cape York to the South Australia/Victoria border, and on the high seas of the Pacific Ocean (Patterson *et al.*, 2018). The majority of catch within this fishery is taken using pelagic longlines, although minor-line methods are also used. Albacore (*Thunnus alalunga*), yellowfin tuna (*Thunnus albacares*), swordfish (*Xiphias gladius*), bigeye tuna (*Thunnus obesus*) and striped marlin (*Kajikia audax*) are the main target species. Most of the recent fishing effort was focused off New South Wales and southern Queensland (SETFIA, 2019).

SETFIA report that there is a very small amount of recent fishing effort within the Operational Area. While some effort was reported in 2017 from within the Operational Area, less than five Eastern Tuna and Billfish Fishery vessels operated within the Operational Area from 2008-17, therefore catch, effort, and value of the fishery cannot be reported (SETFIA, 2019).

The Eastern Tuna and Billfish Fishery currently comprises 86 long-line and 93 minor line boat Statutory Fishing Rights, and 1,076,026 quota Statutory Fishing Rights for each quota species (AFMA, 2018g).

Although a very small amount of effort from the Eastern Tuna and Billfish Fishery has occurred within the Operational Area, the percentage of catch and annual average catch value from the Operational Area is negligible (SETFIA, 2019).

5.5.2.5.6 Western Tuna and Billfish Fishery

The Western Tuna and Billfish Fishery operates in EEZ waters across southern, western, and northern Australia. The fishery mainly uses pelagic long-lines, although minor-line methods are also used. Yellowfin tuna, swordfish, bigeye tuna, and striped marlin are the main target species (SETFIA, 2019).

There are 95 Statutory Fishing Rights in the Western Tuna and Billfish Fishery, although in 2017, only three long-line vessels and one minor-line vessel were active (Patterson *et al*., 2018). The majority of the recent effort is focussed off Western Australia, with swordfish, yellowfin tuna and bigeye tuna dominating the catch (SETFIA, 2019)

In 2017, a very small amount of activity associated with the Western Tuna and Billfish Fishery occurred within the Operational Area; however, as less than five vessels fished the Western Tuna and Billfish Fishery within the Operational Area, catch, effort, and value of the fishery cannot be reported (SETFIA, 2019).

The Western Tuna and Billfish Fishery comprised 95 boat Statutory Fishing Rights in 2014 (recent data not available) (AFMA, 2018h).

Although a very small amount of effort from the Western Tuna and Billfish Fishery has occurred within the Operational Area, the percentage of catch and annual average catch value from the Operational Area is negligible (SETFIA, 2019).

5.5.2.5.7 Southern Bluefin Tuna Fishery

Southern bluefin tuna (*Thunnus maccoyii*) occur throughout the Atlantic, Pacific and Indian Oceans. The fish are highly migratory and travel long distances; they are pelagic and found to depths of 500 m. Southern bluefin tuna tend to school by size and form large surface schools at certain times of the year. Juveniles are generally associated with coastal and continental shelf waters.

The Southern Bluefin Tuna Fishery covers the entire sea area around Australia, out to 200 NM from the coast (**Figure 49**) and is managed under the Southern Bluefin Tuna Fishery Management Plan 1995 under national law, and additionally under the Fisheries Management Act 1991. Since 1992, most of the Australian catch of southern bluefin tuna has been taken by purse seining within the Great Australian Bight (ABARES, 2018) between December and March each year (AFMA, 2018i), with approximately 95% of the catch taken from the Great Australian Bight (CSIRO, 2018). A long-line fishery also operates along Australia’s east coast (ABARES, 2018).

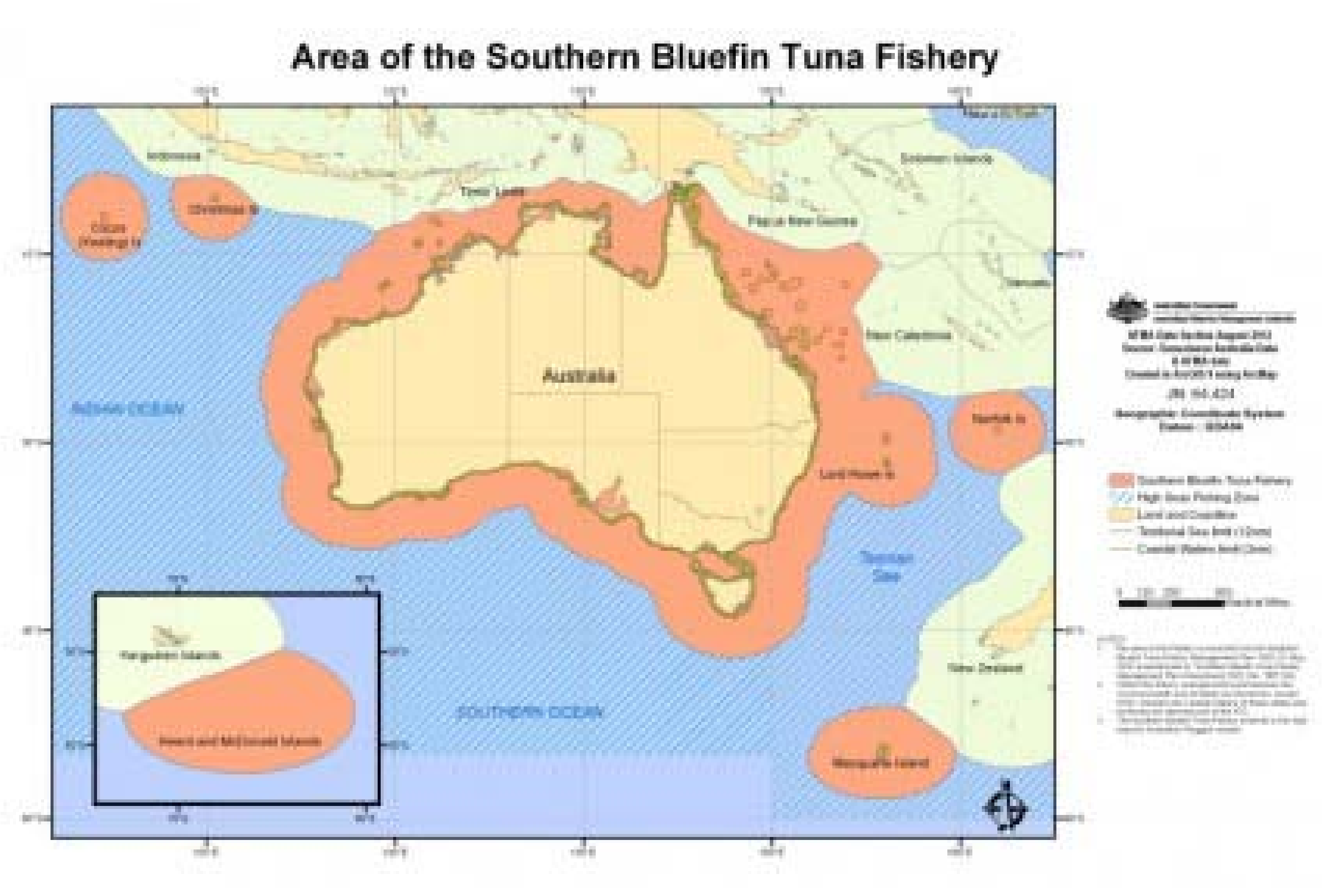
Following the catch of juvenile southern bluefin tuna in the Great Australian Bight, the fish are transferred to large floating cages (pontoons), which are then slowly towed back to more sheltered waters near the coast, particularly Port Lincoln in the Spencer Gulf. Within the pontoons the juvenile tuna are fed frequently for 3 – 6 months to ensure fast growth and weight-gain ready for sale to predominantly international markets, particularly in frozen form to Japan (AFMA, 2018i). Within the Spencer Gulf there are several ‘Tuna Farming Zones’ in waters out to 40 m where wild caught tuna are on-grown. Ranching licences within these zones must meeting conditions relating to stocking rates, site fallowing and environmental monitoring (Seafood Frontier, 2018), in order to continue to operate.

To fish for southern bluefin tuna, fishers must hold Statutory Fishing Rights allocated by the AFMA, which allow fishers to catch southern bluefin tuna under a quota system. In 2017 there were 84 Statutory Fishing Right owners for the Southern Bluefin Fishery (AFMA, 2018i). Total Allowable Catch in 2016/17 was 5,697 t, with six active purse seine and 16 active long-line vessels operating during that year, landing 5,334 t of fish with a value of $38.57 million (Patterson *et al.*, 2018). Total Allowable Catch limits are set by the Commission for the Conservation of Southern Bluefin Tuna (**CCSBT**). During the 2017 – 2018 season the Total Allowable Catch was increased to 6,165 t, with the South Australian industry having one of the best years since the early nineties resulting in quota limits being reached almost a month earlier than normal (ASBTIA, 2018a). In 2010, the CCSBT introduced a Catch Documentation Scheme to the fishery to track southern bluefin tuna products from capture to sale.

There is a very small amount of fishing effort for southern bluefin tuna within the Operational Area. As less than five Southern Bluefin Tuna Fishery vessel operated within the Operational Area from 2008-17, catch, effort, and value data cannot be reported. SETFIA can report, however, that some effort was reported from within the Operational Area during 2017 (SETFIA, 2019). The closest fishing area to the Operational Area that is routinely targeted for southern bluefin tuna is to the east of Kangaroo Island (**Figure 50**), over 100 km from the boundary of the Operational Area.

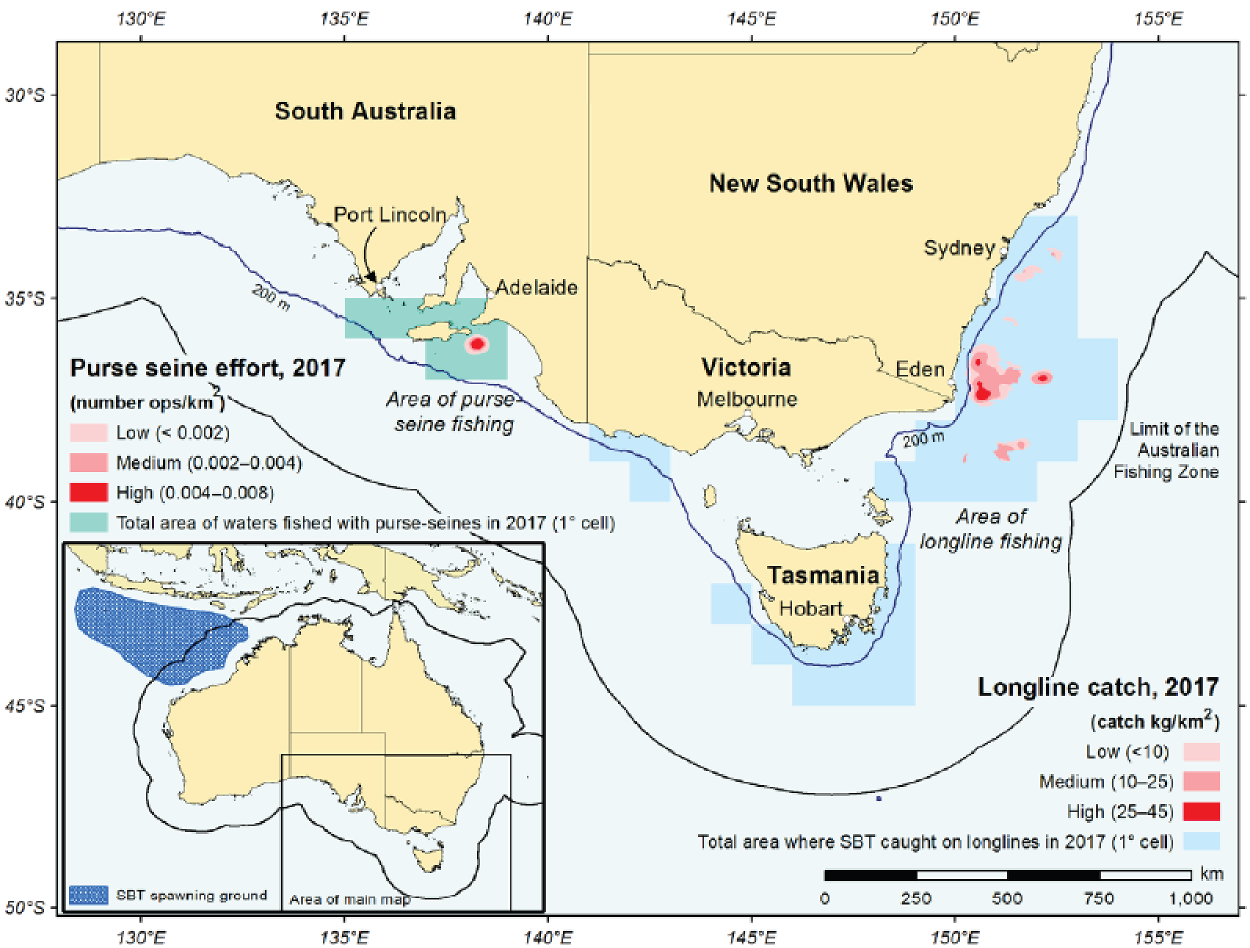
Although a very small amount of effort from the southern bluefin tuna fishery has occurred within the Operational Area, the percentage of catch and annual average catch value is negligible.

Figure 49 Extent of Southern Bluefin Tuna Fishery



Source: AFMA, 2018i

Figure 50 Purse-seine Effort and Long-line Catch in the Southern Bluefin Tuna Fishery, 2017



Source: ABARES, 2018

5.5.2.5.8 Commonwealth and State Squid Fisheries

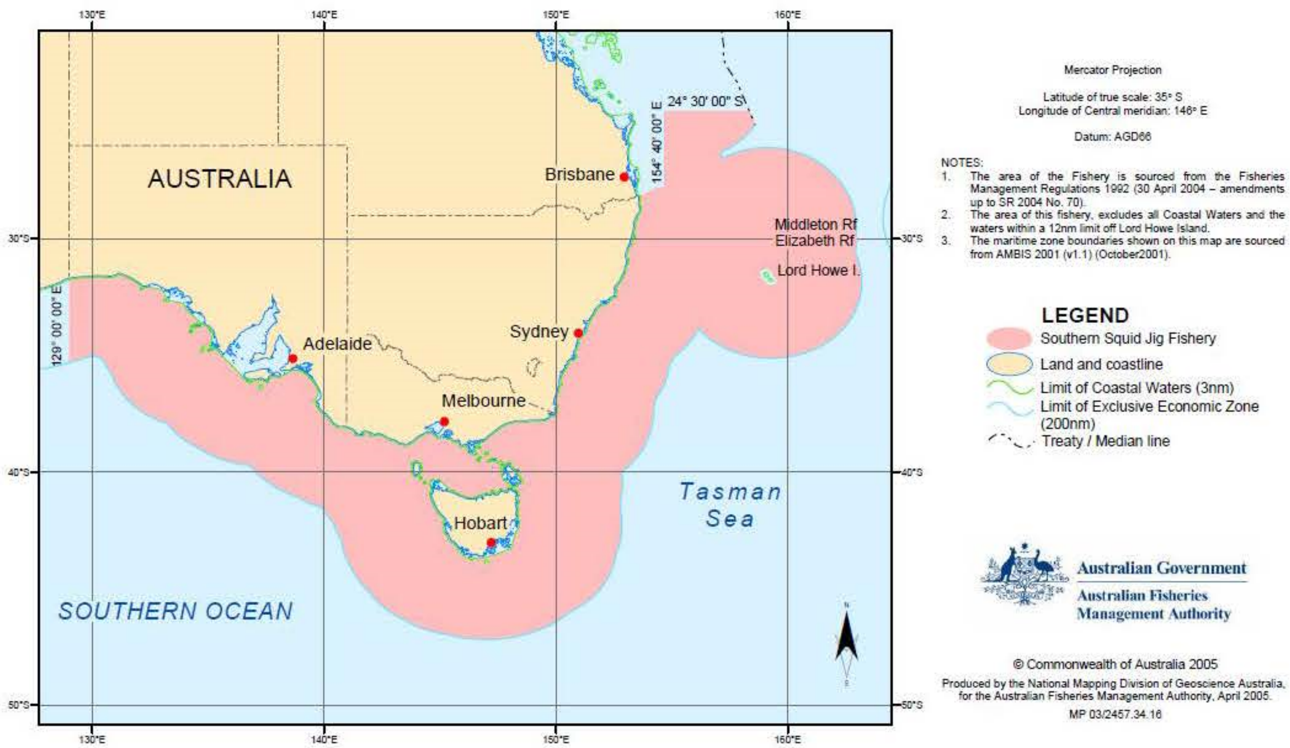
The Southern Squid Jig Fishery operates off New South Wales, Victoria, Tasmania, South Australia, and parts of Queensland, with most of the fishing effort occurring off the south-east of Australia (**Figure 51**). The fishery targets a single species, Gould's squid (*Nototodarus gouldi*), also known as arrow squid. Gould's squid inhabit temperate and subtropical waters of Australia and New Zealand. They can be found in estuaries and pelagic environments to depths of 800 m and are most abundant over the continental shelf at depths of 50 – 200 m. Larvae and juveniles are most often found in shallow coastal waters. Gould's squid aggregate near the seabed during the day and move into the water column at night to feed. Gould's squid are targeted by a jigging fleet (AFMA, 2018j). During engagement with commonwealth fishers a small number of submissions were received by squid jig fishers and it was stated that they fish for squid off Victoria in water depths of 60 – 120 m (S. Richey, **Appendix C**). The commercial catch for the Southern Squid Jig Fishery in 2016-17 was 213 t, with a value of $0.57 million.

AFMA manages the Commonwealth Southern Squid Jig Fishery by limiting effort, restricting how many boats can fish in the area, and regulating what gear can be used. In order to participate in the fishery, a fisher must be issued with a Statutory Fishing Right, which authorises the holder to use a certain number of squid jigging machines during the year. The number of machines is set annually and is determined by a Total Allowable Effort throughout the fishery. In 2017, there were 4,900 Gear Statutory Fishing Rights, eight active vessels, and a total fishing effort of 1,332 jig hours (ABARES, 2018). Due to poor domestic prices and high fuel costs, fishing effort and the number of vessels participating in the fishery has been in decline since 1996, with the eight vessels operating in 2017 representing 80% latency (Patterson *et al*., 2018).

From 2008 – 2017/18, eleven vessels fished within the Operational Area, with a total catch within the Operational Area over this period of 73 t; valued at approximately $148,000. Squid catch is highly variable both spatially and temporally. Within the wider Southern Squid Jig Fishery, the majority of catch and effort occurs from January – June (SETFIA, 2019). Due to the small number of fishing events within the Operational Area, SETFIA were unable to report on seasonality within the Operational Area (SETFIA, 2019), therefore it must be assumed to reflect that of the wider fishery. The main 'local' port used by the jigging fleet fishing the Operational Area is Portland (Victoria).

Some recent fishing effort by the Southern Squid Jig Fishery has occurred close to, but outside of, the Operational Area. However, it is estimated that 3.4% of the annual catch is caught within the Operational Area with a value of approximately $14,000.

Figure 51 Southern Jig Squid Fishery Area

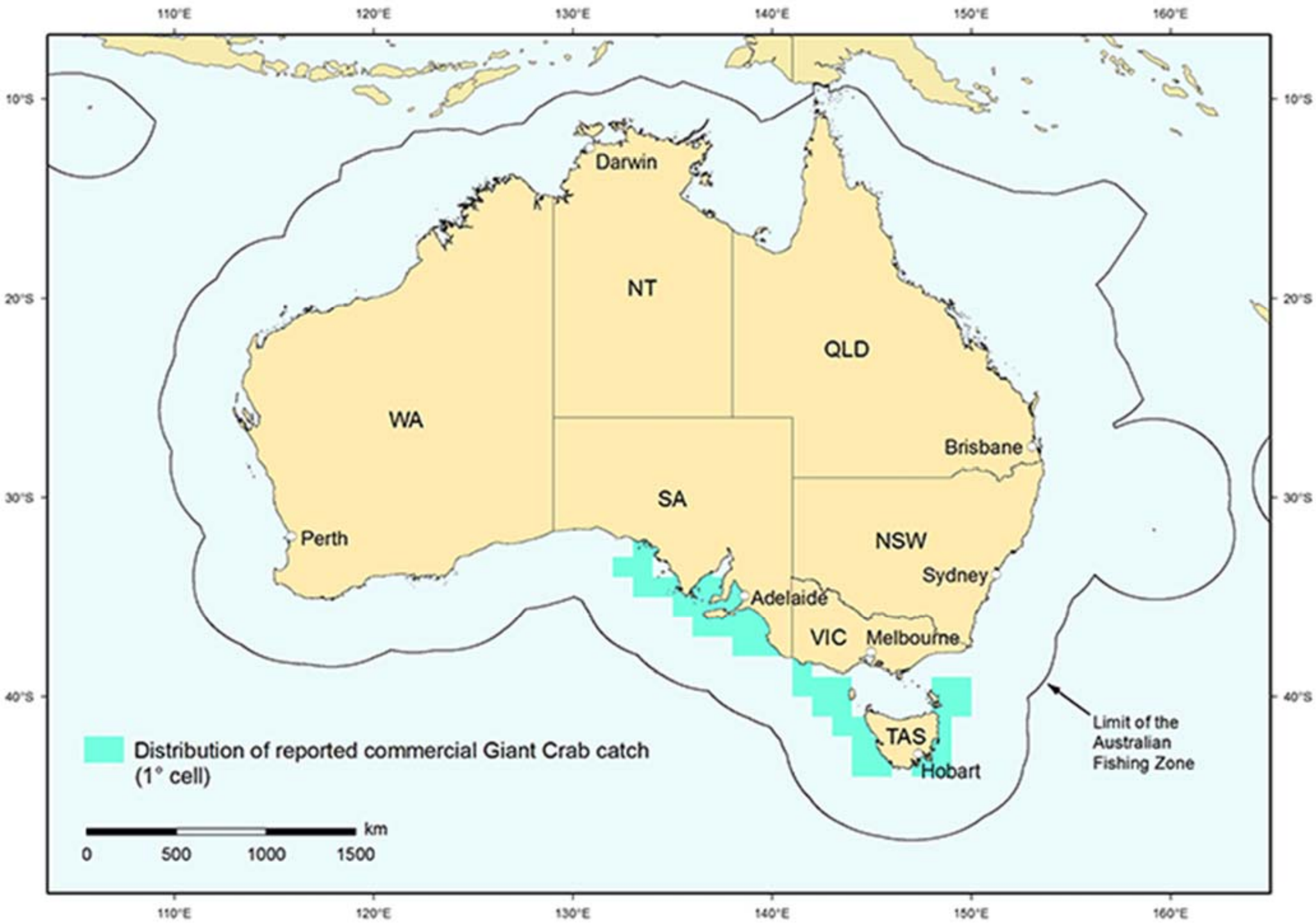


Source: AFMA, 2018j.

5.5.2.5.9 Giant Crab Fishery

Giant crab (*Pseudocarcinus gigas*) are only found in southern Australian waters between central New South Wales to southern Western Australia, including Tasmania. Giant crabs inhabit the continental slope at depths of around 200 m and are most abundant along the narrow band of the shelf edge. Crabs are caught using baited commercial pots (modified rock lobster pots or purpose-built steel traps) and the fishery is a small, limited entry fishery closely linked to the Rock Lobster Fishery. Most catch is taken in water deeper than the main lobster fishery, along the shelf break, between 150 – 300 m deep off the east coast of Tasmania and from west coast Tasmania to South Australia (**Figure 52**). Mating of giant crab occurs in June – July, with females carrying eggs for approximately four months before the eggs hatch in October and November (Kailola *et al*., 1993).

Figure 52 Distribution of Commercial Giant Grab Catch



Source: FRDC, 2018

South Australia Giant Crab Fishery

South Australia's giant crab fishery is linked to the rock lobster fishery. One licence holder in the miscellaneous fishery and all licence holders in the rock lobster fishery can commercially harvest giant crab through quota entitlements. Non-quota holders have an allowance of up to five individual giant crabs per fishing trip as by-product. In 2015, 14 licence holders held giant crab quota; one in the miscellaneous fishery and 13 in the rock lobster fishery, with another 230 rock lobster licence holders that could harvest giant crab as by-product (i.e. did not hold quota) (PIRSA, 2017). The giant crab catch in South Australia during the 2015/16 fishing season was estimated to have a value of approximately $1.4 million (PIRSA, 2018b). The South Australian Southern Zone giant crab fishing season runs between 1 October and 30 April. Females with external eggs cannot be kept and must be returned to the water as soon as possible (PIRSA, 2018b).

Due to the small number of operators in the fishery, SETFIA were unable to provide detailed data, and no information on seasonality or spatial distribution of catch and effort was available (SETFIA, 2019).

Victorian Giant Crab Fishery

Victoria's giant crab fishery is a small, limited entry fishery closely linked to the rock lobster fishery. The fishery is managed in two zones (i.e. the Western and Eastern Zones), which reflect the zonal boundaries of the rock lobster fishery. The fishery targets giant crab using baited rock lobster pots in depths of 150 – 300 m (Fisheries Victoria, 2010). The giant crab fishery is based in the Western Zone, with no harvest of giant crab in the Eastern Zone. The closed season for females is from 1 June to 15 November, and for males from 15 September to 15 November, with the retention of berried females prohibited (SETFIA, 2019).

In order to harvest giant crab in the Western Zone, fishers must hold a giant crab fishery (Western Zone) access licence which can only be operated when it is joined to a rock lobster fishery (Western Zone) access licence. There is a maximum of 30 giant crab fishery (Western Zone) access licences available. Pot entitlements for giant crab are linked to rock lobster entitlements. Quota units can only be owned by giant crab fishery access licence holders, and although there is a maximum of 500 quota units in the fishery, there is no maximum or minimum number of quota units that can be attached to a licence (VFA, 2010). Following the beginning of a targeted giant crab fishery in the early 1990s, there has been a general decline in catch and effort in the fishery. As of September 2017, there were 14 Fisheries Access Licences state-wide, with a TACC of 10.5 t (SETFIA, 2019).

A total of 116.9 t of giant crab has been caught within the Operational Area from 2008 – 2017. Annual catch within the Operational Area has decreased from more than 20 t in 2009 to approximately 7 t in 2014. Catch has now plateaued at around 10 t. Effort has also decreased considerably since 2009; where in 2017 there was only one active fisher (SETFIA, 2019).

Recent fishing effort by the Victorian giant crab fishery has occurred within the Operational Area with 100% of catch potentially originating from within the Operational Area, with an annual average value of $223,000 (SETFIA, 2019).

Tasmanian Giant Crab Fishery

Most catch of the Tasmanian giant crab fishery comes from the west coast, and the fishery is currently classified as ‘overfished stock’, with accompanying reduction of TACC to 20 t or less. Part of the fishery area is in Commonwealth waters; however, the entire fishery is managed by Tasmania under an OCS. Recorded catches for 2015 – 2016 were 25 t, with an estimated value of $2 million (Mobsby & Koduah, 2017). The Tasmanian giant crab fishery is a limited entry fishery that is managed by individual transferrable quotas. Fishers may not commercially harvest giant crab unless in the possession of a fishing licence for giant crab or rock lobster. A portion of the Total Allowable Catch is allocated to commercial fishers based on the number of giant crab quota units held and owned by the licence holder. According to the Fisheries (Giant Crab) Rules 2013, the maximum number of giant crab quota units within the Tasmanian fishery has been set at 1,035, with each licence requiring a minimum of one quota unit to allow access to the fishery. The number of quota units on a licence cannot exceed 300.

There was no reported catch of giant crab in the Operational Area during 2008/09 – 2016/17 within either the giant crab fishery or the Tasmanian rock lobster fishery, (SETFIA, 2019).

5.5.2.5.10 Abalone Fisheries

The abalone fishery is one of the most valuable commercial fisheries in southern Australia; 3,394 t was collected during the 2015/16 fishing season, with an estimated value of $131.5 million (Mobsby & Koduah, 2017). Each State regulates fishing zones with licencing, strict TACCs and fishing seasons. The fishery is diving-based in inshore areas less than 30 m water depth, whereas the Otway Basin 2DMC MSS will operate in waters deeper than 50 m. The fishery primarily targets blacklip abalone (*Haliotis rubra*), although the less-common greenlip abalone (*H. laevegata*) is also harvested in comparatively small numbers.

Abalone are harvested by hand by divers operating from boats and using hookah gear (a long hose delivering air to the diver from a compressor onboard the boat) (PIRSA, 2012). Abalone have a 4 to 7-day planktonic period, with the larvae of blacklip and greenlip abalone tending to settle near parental reefs (Morgan & Shepherd, 2006).

South Australia Southern Zone Abalone Fishery

The Southern Zone of the South Australian Abalone Fishery includes all coastal waters east of 139°E longitude, with the exception of the Coorong and waters inside the Murray River mouth. The fishing season runs from 1 September – 31 August. Over the past ten years, the total annual value of the Southern Zone Abalone Fishery ranged from $3.5 million to over $5 million (SETFIA, 2019). In South Australia, blacklip abalone have a spring (October – December) and an autumn (February – April) spawning period (Shepherd, 2008), while greenlip abalone have a single, short synchronous spawning period from late spring to early summer (PIRSA, 2012).

Access to the South Australian abalone fishery is provided through a licence, with each licence endorsed with quota units for either the Southern, Central, or Western Zone. There is a limit of 35 commercial licences for the South Australian abalone fishery, 23 in the Western Zone, and six each in the Central and Southern Zones. Quota units are issued annually as separate entitlements after the TACC has been set (PIRSA, 2012).

Although the Operational Area overlaps with several reef codes, abalone diving is generally restricted to water depths less than 30 m, and it is therefore highly unlikely that any abalone catch originates from inside the Operational Area. The highest catch rates from the overlapping areas are generally taken from November to December, coinciding with the most effort. March and June also see relatively high catch and effort.

Although recent fishing effort has been reported for the Operational Area (665 t of abalone was caught in the overlapping reef codes from 2007-17), further depth analysis conducted by SETFIA (2019) indicates that 0% of catch actually comes from within the Operational Area (as the reef codes extend beyond the Operational Area into shallower waters).

Victorian Abalone Fishery

Abalone are collected along the majority of the Victoria coastline with a TACC set annually based on the outcomes of a stock assessment process. State wide in the 2015/16 fishing season, 728 t of abalone were collected, with an estimated value of $19.7 million (Mobsby & Koduah, 2017). The Operational Area is adjacent to the Western Zone and the western end of the Central Zone.

Victoria's commercial abalone fishery is subdivided into three management zones, with Abalone Access Licences required in order to participate within the fishery. There is a total of 71 Abalone Access Licences within the Victorian fishery; 14 in the Western Zone, 34 in the Central Zone and 23 in the Eastern Zone. This equates to a maximum of 71 divers operating on any particular day across the fishery. A maximum number of quota units have been set for each management zone, with maximum black-lip abalone quota units set at 280, 680, and 460 within the Western, Central, and Eastern Zones respectively. A maximum of 14 and 34 quota units have been set for green-lip abalone within the Western and Central Zones. There are no quota units for green-lip abalone in the Eastern Zone (VFA, 2015). To operate a licence, each licence holder is required to attach a minimum of five black-lip abalone quota units to the licence at all times (VFA, 2015).

As there has been no fishing effort by the Victorian Abalone Fishery within the Operational Area, SETFIA (2019) has not included this fishery in their assessment.

Tasmanian Abalone Fishery

The Tasmanian wild abalone industry is the largest wild abalone fishery in the world; 1,744 t of abalone was collected state wide during the 2015/16 fishing season, with an estimated value of $79.7 million (Mobsby & Koduah, 2017), providing around 25% of the total annual global harvest (Tasmanian Abalone Council, 2018). In 2015 – 2016 there were 120 licence holders State wide (ABARES, 2018). Two of Tasmania's commercial abalone collection zones are located adjacent to the Operational Area, namely the Western Zone and the Northern Zone, with each zone divided into multiple sections. The majority of coast is actively fished.

There has been no recent catch of effort associated with the Tasmanian Abalone Fishery within the Operational Area (SETFIA, 2019).

5.5.2.5.11 Commonwealth and State Scallop Fisheries

The scallop fishery primarily targets commercial scallops (*Pecten fumatus*) although doughboy scallops (*Chlamys asperrimus*) are also collected in smaller numbers. Over 5,000 t of scallops were collected during the 2015/16 fishing season, at an estimated value of $14.0 million (Mobsby & Koduah, 2017). Scallops are collected using towed dredges that dig or lift scallops out of the seabed. The default scallop fishing season is 1 April – 31 December.

Management of the Bass Strait Scallop Fishery was split between the Commonwealth, Tasmania and Victoria under an OCS arrangement. Three zones exist: the Commonwealth Central Zone, a Victorian Zone and a Tasmanian Zone (**Figure 53**).

The Bass Strait Central Zone Scallop Fishery operates in Bass Strait east from the Victoria/South Australia border. The fishery covers areas of Bass Strait between the Victorian and Tasmanian scallop fisheries that lie within 20 NM of their respective coasts. The commercial catch for the 2015/16 fishing season was 2,260 t, valued at $4.6 million (Mobsby & Koduah, 2017).

The Bass Strait Central Zone Scallop Fishery is a Commonwealth Fishery managed by AFMA. Fishers are required to hold Statutory Fishing Rights in order to harvest scallops. There are currently 444,500 commercial scallop Quota Statutory Fishing Rights and 455,000 doughboy scallop Statutory Fishing Rights (AFMA, 2018k). In the 2017 fishing season there were 63 fishing permits, and 12 active vessels (ABARES, 2018).

In South Australia, commercial scallop fishing is managed by PIRSA as a Miscellaneous Fishery (PIRSA, 2017a). The scallop fishery is small-scale, targeting two species, commercial scallop (*P. fumatus* also known as king scallop) and *C. bifrons* (queen scallop). Scallop dredges are prohibited in South Australia and scallops can only be collected by divers, and therefore fishers operate in water depths <30 m. There are currently three miscellaneous fishery licence holders within the South Australian scallop fishery that are permitted to hand-collect scallops while diving (PIRSA, 2017a).

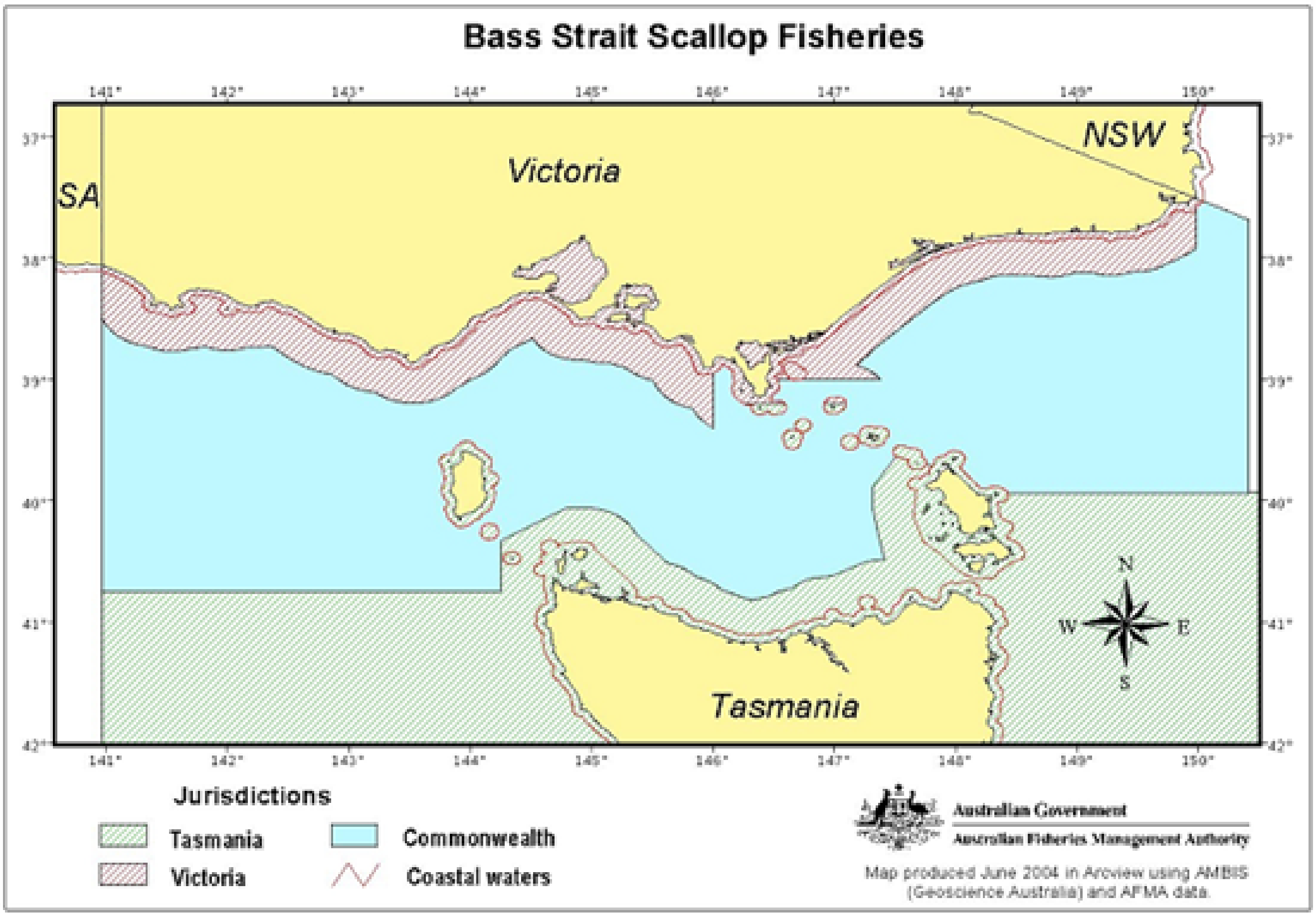
The waters of the Victorian Zone extend out to 20 NM from the high tide water mark but exclude the bays and inlets along the coast where commercial fishing for scallops is prohibited. Most Victorian commercial scallop fishing occurs off eastern Victoria. Apollo Bay is the main scallop port nearest to the Otway Basin 2DMC MSS Operational Area. Due to low stocks, the TACC was set at zero between 2010 – 2013 and then increased to 136.5 t for subsequent years. Low stocks continue, and fishers are 'exploring' the fishery to find new areas; no catch data are available for these activities (VFA, 2018d).

In order to fish within Victoria's Scallop Fishery, fishers must possess a Victorian Scallop (Ocean) Fishery Access Licence. The number of licences within the fishery has been capped at 91, with approximately 10 – 15 boats active within the fishery (VFA, 2018d).

Commercial scallop fishing in Tasmania mainly occurs on the east coast and in Bass Strait. Commercial catch was 744 t during the 2015/16 fishing season, with a value of $1.7 million (Mobsby & Koduah, 2017). Both Tasmanian fishing grounds are outside the Otway Basin 2DMC MSS Operational Area. At present, the commercial scallop fishery in Tasmanian waters is closed following a two-year ban to help improve stock levels (DPIPWE, 2018c). This does not affect the Bass Strait Central Zone Scallop Fishery.

There has been no recent effort by the Bass Strait Central Zone Scallop Fishery, and no effort by the Victorian Scallop (Ocean) Fishery within the Operational Area, therefore SETFIA (2019) did not include these fisheries in their assessment.

Figure 53 Bass Strait Central Zone Scallop Fishery



Source: AFMA, 2018k.

5.5.2.5.12 Other fisheries

Victorian Ocean General Fishery

A Victorian Ocean General Access Licence allows licence holders to carry out fishing activities using a variety of gear types in marine waters other than Port Phillip Bay, Western Port, Gippsland Lakes, and any inlet of the sea (SETFIA, 2019). Licence holders in this fishery can land fish other than abalone, jellyfish, southern rock lobster, giant crab, commercial scallop, and sea urchins; more than 45 different species of fish were recorded from the Operational Area from 2008 – 2017, with gummy shark, snapper, and King George whiting the main species caught. Fishers usually conduct day trips and operate out of small vessels (<10 m), and may fish at anchor or while underway (SETFIA, 2019).

Effort of the Victorian Ocean General Fishery has historically been low within the Operational Area; however, recent effort has occurred. A total catch of 44.1 t was taken from within the Operational Area between 2008 – 2017, with annual catches ranging from less than 1 t (in 2017) to approximately 19 t (in 2012). Effort within the Operational area has decreased since 2008. It is worth noting that there is considerable latent effort in the Victorian Ocean General Fishery (SETFIA, 2019).

Although recent fishing effort by the Victorian Ocean (General) Fishery has occurred within the Operational Area, the annual average catch value is “Confidential”.

Victorian Wrasse (Ocean) Fishery

Victorian Wrasse (Ocean) Fishery licence holders use hand lines to target bluethroat and purple wrasse from reef habitats. Fishers conduct day trips out of small vessels (<10 m) and may fish at anchor or while underway (SETFIA, 2019).

Wrasse are generally caught in relatively shallow water, hence although a small amount of effort overlapped with the Operational Area, it is unlikely that fishing effort will expand further into the Operational Area (SETFIA, 2019).

Some effort by the Victorian Wrasse (Ocean) Fishery has occurred within the Operational Area; however, the percentage of catch and the annual average catch value is “Confidential”, SETFIA (2019) but is considered to be negligible.

South Australian Charter Boat Fisheries

The South Australian Charter Boat Fishery operates in South Australian marine waters and is a commercial platform for recreational fishing (Tsolos & Boyle, 2015). The catch is taken by recreational fishers, with charter operators required to report catch and effort in logbooks.

While detailed catch and effort data was not provided by SETFIA due to confidentiality issues, some details applicable to the Otway Basin 2DMC MSS Operational Area are available. The Charter Boat Fishery is seasonal, with effort peaking in January and February and lowest in July and August. The main target species near the Operational Area are southern bluefin tuna, snapper, and King George whiting (Rogers *et al*., 2017). The number of licences, active licences, and effort have all decreased since 2012 (Tsolos & Boyle, 2015).

Recent effort by the Charter Boat Fishery has been reported for within the Operational Area. It has been estimated that 0.6% of catch for the South Australian Charter Boat fishery originates from within the Operational Area, although the annual average value is “Confidential” (SETFIA, 2019).

5.5.2.6 Marine Aquaculture

Several hundred marine aquaculture licenses are issued in South Australia. The major species grown are southern bluefin tuna (*Thunnus maccoyi*), yellowtail kingfish (*Seriola lalandi*), Pacific oysters (*Crassostrea gigas*), blue mussels (*Mytilus galloprovincialis*) and abalone (*Haliotis* spp.). Marine aquaculture is predominantly conducted in areas west of Kangaroo Island, in locations that are outside of the Otway Basin 2DMC MSS Operational Area.

No records of marine aquaculture exist for Victorian waters within or adjacent to the Otway Basin 2DMC MSS Operational Area.

In Tasmania, salmonid farming occurs within the waters of Port Macquarie (Strahan) in enclosed waters adjacent to the southeast corner of the Otway Basin 2DMC MSS Operational Area. In Tasmania, salmonid aquaculture produced 54,772 t of fish, with an estimated value of $704 million (Mobsby & Koduah, 2017) from 45 licence holders (ABARES, 2018). Otherwise, no records of marine aquaculture exist for Tasmanian waters within or adjacent to the Operational Area.

5.5.3 Shipping

5.5.3.1 Ports and Harbours

The majority of coastal settlements adjacent to the Otway Basin 2DMC MSS Operational Area have small protected boat harbours and/or anchorages that are used as a base for commercial fleets (of varying sizes) and recreational vessels. Between Adelaide and Melbourne, there is only one commercial import/export port: Portland (Victoria).

The Port of Portland is a deep-water bulk port strategically located between the ports of Melbourne and Adelaide. The Port specialises in bulk commodities, particularly agricultural, forestry and mining products as well as aluminium and fertiliser. It has approximately six million tonnes in annual throughput. The export trade includes grain, woodchips, logs, aluminium ingots and livestock, while import commodities are alumina, liquid pitch and fertiliser products.

In South Australia, a new purpose-built rock lobster fishing fleet base and residential marina has been constructed at Cape Jaffa. Elsewhere, Robe has a long-established commercial rock lobster fishing base and Port MacDonnell has a large breakwater constructed to provide safe anchorage for Australia’s largest fleet of rock lobster fishing vessels, which operate along the length of South Australia’s coast.

In western Victoria, most coastal settlements with harbour facilities are used to provide safe havens and services to the commercial fishing industry, and recreational fishing and boating interests (Water Technology, 2012). In addition to imports and exports, the commercial fishing fleet in Portland includes visiting squid boats, abalone diving, two shark boats catching gummy shark, five local trawlers (plus visiting trawlers), six lobster boats fish western Victoria, some which target giant crab at times and four boats fishing in Tasmanian waters for lobster and giant crab. Squid and abalone are processed at local factories in Portland.

Elsewhere in Victoria, Port Fairy has a small fleet of fishing vessels based in the Moyne River, and Warrnambool, one of Victoria’s largest coastal cities, has a new breakwater that provides protected anchorage for a small number of commercial vessels. Apollo Bay (east of Cape Otway) has a port enclosed by two large breakwaters which is home to a local fishing industry and commercial fleet of 16 boats, including trawlers, rock lobster boats and charter boats.

Midway across Bass Strait, Currie (King Island, Tasmania) provides a safe, west-coast anchorage for most of the island’s rock lobster fishing fleet of 18 vessels. Two abalone divers are also based on King Island. Grassy Port, on the east coast, is the island’s main port, which has a roll-on-roll-off facility equipped with cranes and a stern-loading ship ramp, which can also handle containerised shipping. Grassy Port is an all-weather port, forming part of a triangular service between Melbourne (Victoria) and Devonport (Tasmania), with imports of groceries, fuel and agricultural needs (fertilisers and stock feed), and exports of livestock, beef, dairy (cheese and cream) and wool.

The west coast of Tasmania is very rugged and exposed to wild weather. There are no safe, all-weather anchorages between Woolnorth and Arthur River, and the only large safe harbour with port facilities is Macquarie Harbour (Strahan) which is 190 km south along the coast from Bass Strait. Strahan Port is classified as ‘very small’ with limited facilities and berth depths less than 5 m. Strahan Port services vessels working along the west coast, as well as the local aquaculture (salmonid).

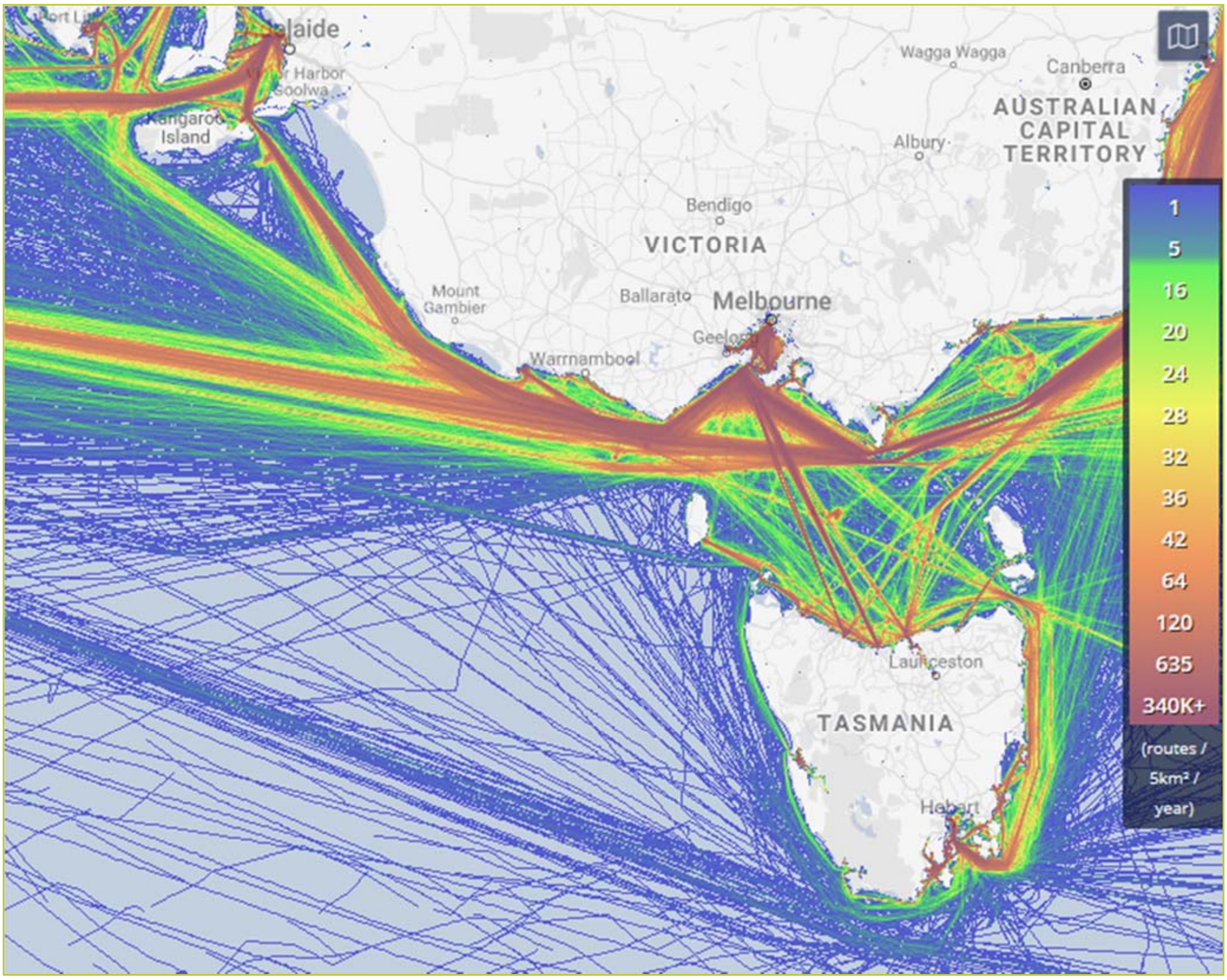
5.5.3.2 Commercial Shipping

The Otway Basin 2DMC MSS Operational Area overlaps with major shipping routes around southern Australia (**Figure 54**). The highest density of shipping occurs along routes between Perth, Adelaide and Melbourne. Vessels along the main routes are primarily tankers and cargo vessels, whereas fishing vessels and pleasure craft are most likely to occur outside the shipping lanes. There is also regular support vessel activity associated with existing offshore developments in the Otway Basin.

Lower density commercial activity is apparent along the west coast of Tasmania, mainly in inshore areas. Much of this activity will be associated with commercial fishing such as rock lobster and abalone.

The high commercial shipping traffic in parts of the Operational Area will require careful management to ensure safe navigation for all marine users, especially due to the comparatively slow speed and limited manoeuvrability of the seismic vessel. The AMSA is identified as a stakeholder for consultation regarding maritime safety.

Figure 54 Density of Marine Traffic in 2017



Source: https://www.marinetraffic.com/en/ais/home/

5.5.4 Oil and Gas Activities

Offshore areas of the Otway Basin have been the target of exploration and production activities since the early 1990s. Currently there are six exploration permits in offshore areas of the Otway Basin (NOPTA, 2018):

- T/30P - Lattice Energy Limited;
- T/49P - 3D Oil T49P Pty Limited;
- VIC/P43 - Lattice Energy Limited;
- VIC/P44 - Cooper Energy (CH) P/L (with Peedamullah Petroleum Pty Limited and Mitsui E&P Australia Pty Limited);
- VIC/P62 - Loyz Oil Australia P/L; and
- VIC/P69 - Lattice Energy Limited.

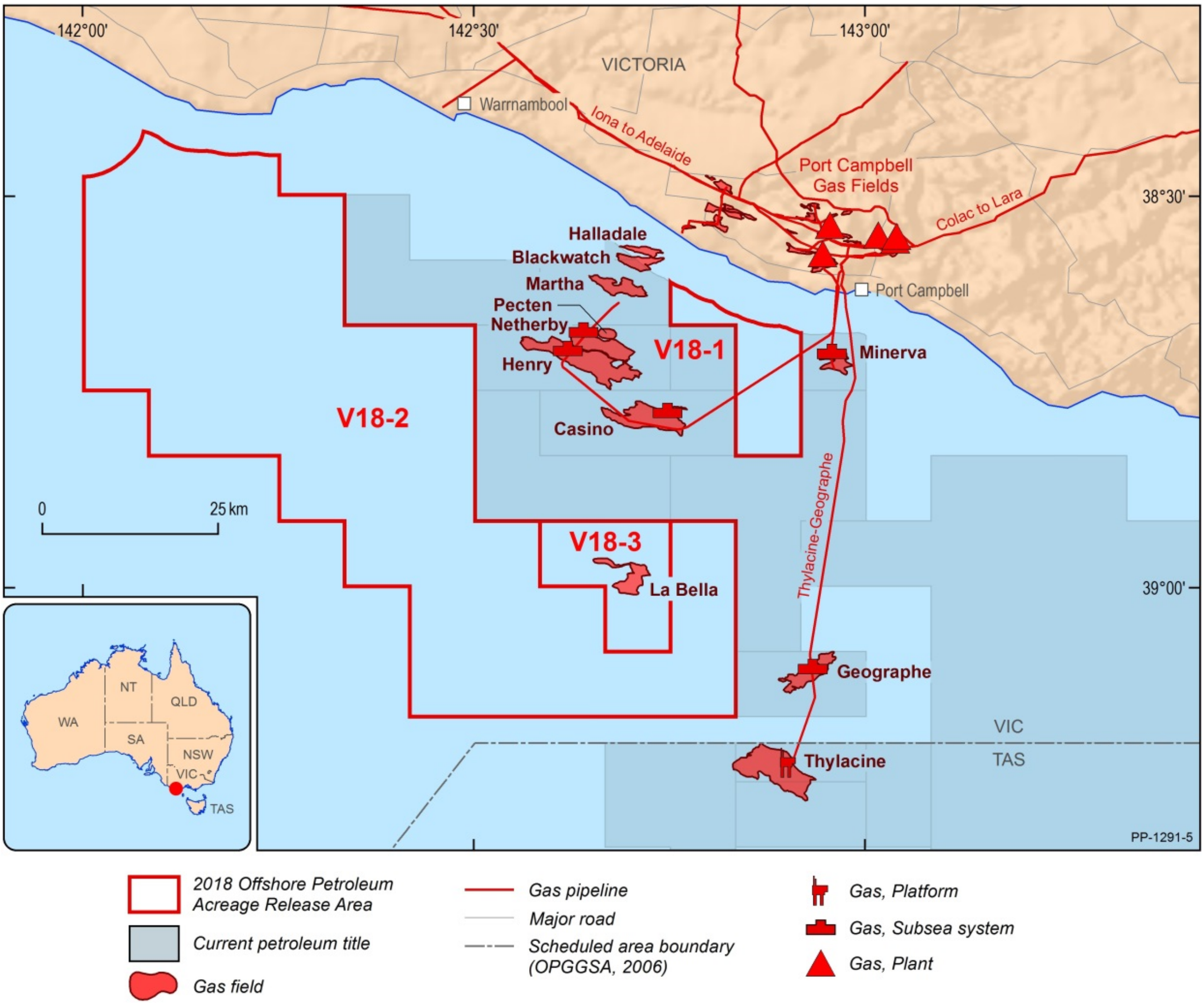
Currently there are six active gas production licenses and two retention leases in offshore areas of the Otway Basin (NOPTA, 2018):

- T/L2 - Lattice Energy Limited (with Toyota Tsusho Gas E&P Otway Limited) – THYLACINE;
- T/L3 - Lattice Energy Limited (with Toyota Tsusho Gas E&P Otway Limited) – THYLACINE SOUTH;
- VIC/L22 - BHP Billiton Petroleum (Victoria) P/L (with Cooper Energy (CH) P/L) – MINERVA;
- VIC/L23 - Lattice Energy Limited (with Toyota Tsusho Gas E&P Otway Limited) – GEOGRAPHE;
- VIC/L24 - Cooper Energy (CH) P/L (with Peedamullah Petroleum P/L and Mitsui E&P Australia P/L) – CASINO;
- VIC/L30 - Cooper Energy (CH) P/L (with Peedamullah Petroleum P/L and Mitsui E&P Australia P/L) – HENRY;
- VIC/RL11 - Cooper Energy (CH) P/L (with Peedamullah Petroleum P/L and Mitsui E&P Australia P/L) – MARTHA; and
- VIC/RL12 - Cooper Energy (CH) P/L (with Peedamullah Petroleum P/L and Mitsui E&P Australia P/L) – HALLADALE.

The offshore production areas in the Otway Basin (**Figure 55**) primarily comprise subsea gas systems, and one gas platform (Thylacine), connected to gas processing plants in Victoria via two subsea pipelines. These structures are within the north-east corner of the Operational Area and recognition of mandatory Petroleum Safety Zones (**PSZ**) around the surface and subsea facilities will be required. The operators were identified as stakeholders for inclusion in the consultation process.

Lattice Energy Limited, formerly Origin Energy Resources Limited, is planning further offshore drilling for their Otway Gas Development (Geographe and Thylacine), with drilling of up to seven appraisal wells currently scheduled early 2019 (subject to NOPSEMA approved EPs). The proposed wells comprise one production well (Geographe 3), three appraisal wells (Geographe 4, Thylacine West and Thylacine North) and three exploration wells (one west of Thylacine and two north of Geographe).

Figure 55 Offshore Production Areas in the Otway Basin



Source: Department of Industry, Innovation and Science, 2018.

5.5.5 Tourism and Recreation

South Australia's coast from Kingston SE to the Victorian border is known as the Limestone Coast. The coast provides good surfing, diving and fishing opportunities.

Tourism along Victoria's west coast is focused on the iconic Great Ocean Road. Like their counterparts in South Australia, the coastal settlements attract tourists interested in coastal scenery, surfing, diving, fishing and whale-watching.

Tasmania's west coast is largely inaccessible and unpopulated, attracting low numbers of mainly shore-based bushwalkers and fishers. King Island tourism is predominantly centred on walking, surfing and dining on local fresh produce.

The following provide further details on marine-based recreational activities (e.g. fishing, diving, surfing, whale watching, and boating) of relevance to the Otway Basin 2DMC MSS.

5.5.5.1 Fishing

Recreational fishing is an important past-time in Australia with over 3.4 million Australians engaging in recreational fishing activities each year (RFAC, 2008). Participants range from once-a-year fishermen to heavily invested game fishermen (DoAWR, 2018a). Recreational fishing in state waters is subject to state-specific rules and regulations including seasonal closures, licence requirements, and catch bag and size limits. A Recreational Fishing Licence is required to take, or attempt to take, any species of fish (including shellfish) by any method in Victorian waters (VFA, 2018e). In Tasmanian waters, a Recreational Sea Fishing Licence is not required when fishing with a rod and line, but is required for the taking of scallops, rock lobsters and abalone and for the use of set lines and certain type of net (DPIPWE, 2018d). There are no requirements for any type of recreational fishing licence in South Australian waters (PIRSA, 2018a).

Where open seasons or seasonal closures are in place, these have been outlined in **Table 35**. Seasonal closures are often established to protect fished species during breeding seasons and may be permanent, seasonal, or temporary (PIRSA, 2018a). Note that not all recreationally fished species are subject to seasonal closures.

Table 35 Recreationally Fished Species with Open Seasons or Seasonal Closures

Species	State	Open Season or Seasonal Closures
Rock lobster	Tasmania (Western region)[1]	Females: Open 3 November 2018 – 30 April 2019 Males: Open 3 November – 31 August 2019
	Victoria[2]	Females: Closed 1 June – 15 November Males: Closed 15 September – 15 November
	South Australia (Southern Zone)[3]	Closed 31 May – 1 October
Abalone	Victoria (intertidal zone – waters less than 2 m)[2]	Permanent closure
	Victoria (Central Victorian Waters)[2]	Open on set nominated days: Every Saturday and Sunday between 16 November and 30 April the following year Every declared public holiday in the state of Victoria during the above period; and 25 December – 2nd Saturday in January the following year.
	Victoria (all other areas excluding the above)[2]	Open all year
	South Australia (all aquatic reserves and intertidal reef areas)[3]	Permanent closure – this closure extends to all intertidal bottom-dwelling organisms
Giant crab	Tasmania[1]	Females: Open 3 November 2018 – 30 April 2019 Males: Open 3 November – 31 August 2019
Squid spawning closure	Tasmania (north coast)[1]	Closed 1 – 31 October 2018
Scallop	Tasmania[1]	Usually open from the Saturday before Easter to the end of July 2019 open season: 13 April – 31 July 2019
Striped trumpeter	Tasmania[1]	Closed 1 September – 31 October
Banded morwong	Tasmania[1]	Closed 1 March – 30 April
Pipi	South Australia (between 28 Mile Crossing and the Victoria/South Australia border)	Closed 1 June – 31 October
Prawn	South Australia (waters less than 10 m deep)	Permanent closure
	South Australia (waters greater than 10 m deep)	Closed January and February

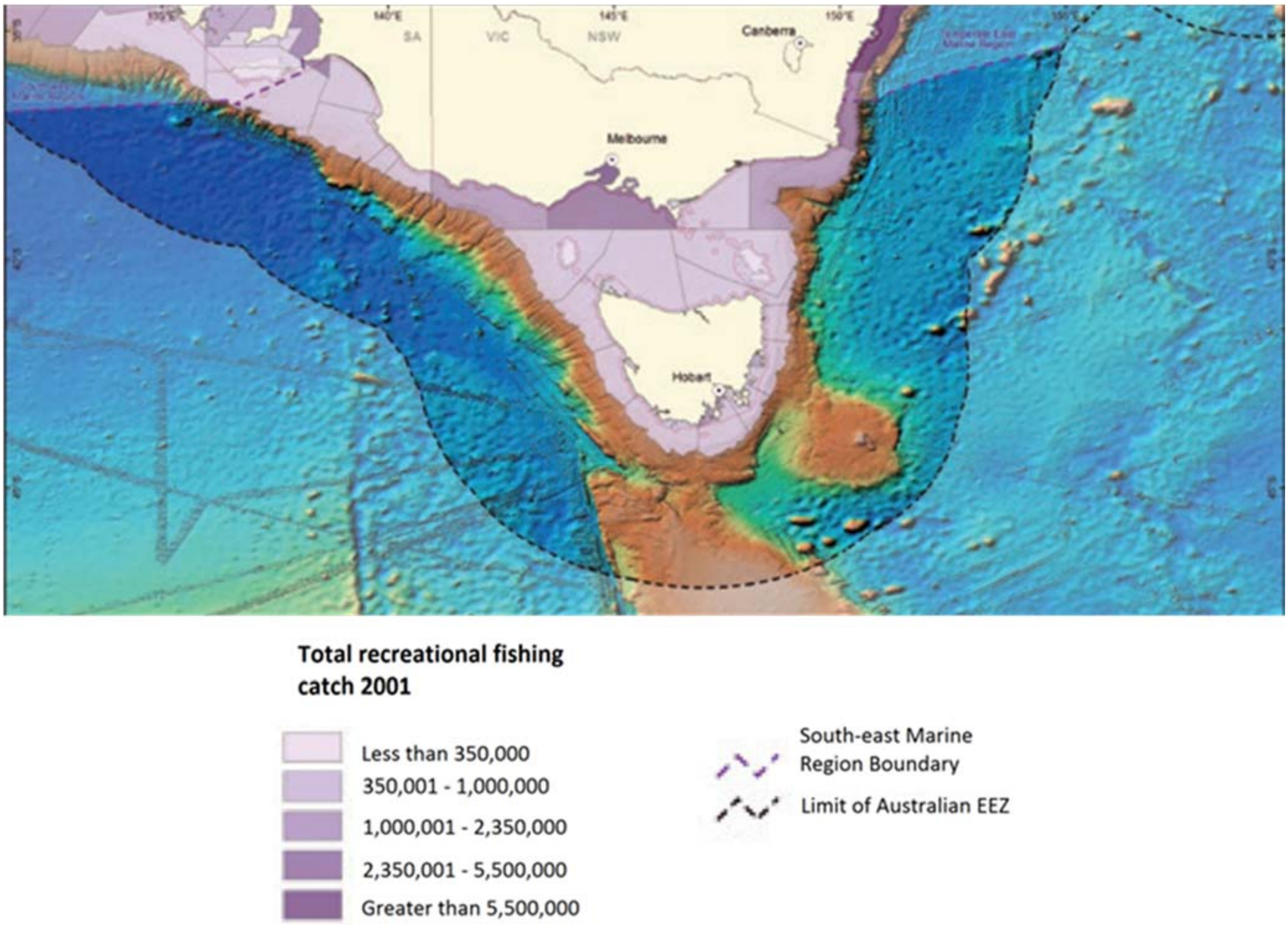
1 TASGov, 2018
2 VFA, 2018f
3 PIRSA, 2018

Several recreational fishing clubs are present in each state many of which run fishing competitions throughout the year.

Charter boats allow a commercial platform for recreational fishing activities and provide valuable input into coastal regions. For example, the economic value of charter fishing in South Australia has been estimated to be $3.0 – 4.7 million per annum; however, this figure does not illustrate the true value of the industry (e.g. it does not capture indirect benefits such as maintenance and operational costs) (PIRSA, 2011). This value is for South Australia and does not include Victorian and Tasmanian charter operations. Fishing charters generally operate from most coastal towns (ENRC, 2002). The majority of charter boats target reefs, seagrass meadows, un-vegetated soft bottom, sheltered beaches and tidal flat habitats (PIRSA, 2011). Primary target species for charter vessels generally mirror those that are targeted by recreational fishers. Charter operators must comply with recreational fishing restrictions and prohibitions, such as seasonal closures, minimum and maximum sizes, and catch limits.

The distribution of recreational fishing in the South-east Marine Region is shown in **Figure 56**, with further details for each state provided below.

Figure 56 Total Recreational Fishing Catch across the South-east Marine Region



Source: Adapted from Commonwealth of Australia, 2015

Although recreational fishing occurs in all coastal waters in South Australia the majority of activity occurs in the Spencer Gulf, Gulf of St Vincent, and surrounding Kangaroo Island to the west of the Operational Area, with a lower intensity along the Limestone Coast (PIRSA, 2016). The majority of fishing is off privately-owned boats followed by land-based fishing off the shore and rocks (compared to off public wharves/jetties) (Giri & Hall, 2015). In a survey of South Australian recreational fishermen, Triantafillos *et al*. (2014) found that approximately 67% fished inshore (within 5 km of the coastline), while approximately 45% utilised offshore waters (greater than 5 km from shore). In the south-east of South Australia, fishing effort is relatively evenly spread throughout the coast, although highest effort occurs around Kingston/Robe, with lowest effort off the Coorong beaches (Giri & Hall, 2015). Commonly targeted species in South Australia include blue swimmer crab, King George whiting, Australian herring, pipi, garfish, squid, striped trumpeter, snapper, Australian salmon, mulloway, and scallops (Triantafillos *et al*., 2014), with Australian herring and King George whiting the most commonly caught finfish (Giri & Hall, 2015).

Rock lobsters are also recreationally targeted in South Australian waters, with fishermen allowed to use drop nets, pots (with ~9000 recreational rock lobster pots registered in South Australia, *Expert 1 – Sensitive Information*), or SCUBA to take lobsters during the open season (Linnane *et al*., 2018), while abalone are caught by snorkelling or SCUBA diving (PIRSA, 2012).

Victoria has the third highest number of recreational fishermen across all of Australia, although this is likely a reflection on its relatively large population size (Henry & Lyle, 2003). Port Phillip Bay (to the east of the Operational Area) is the most important embayment in Victoria for recreational fishing (Ford & Gilmour, 2013) and provides an indication of the species targeted by recreational fishermen throughout Victorian waters. More than 62 species are recreationally caught in Port Phillip Bay including finfish, sharks, and shellfish; however, the most targeted species are King George whiting, flathead, snapper, garfish, Australian salmon, and gummy shark (Ford & Gilmour, 2013). Game fishing for pelagic sharks (primarily mako shark) occurs off the northwest coast of Tasmania over summer months (Tracey *et al.,* 2013). Although recreational fishing occurs year-round, Ford and Gilmour (2013) suggest the peak fishing period (based on Port Phillip Bay catch) is November – April.

Recreational fishing is a popular past time in Tasmania, with at least 120,000 Tasmanians fishing at least once a year (Lyle *et al.,* 2009). The waters of the west and northwest coast of Tasmania support comparatively lower levels of recreational fishing than the Tasmanian east coast. Most fishing events are carried out by resident fishermen (Lyle *et al*., 2009). Shore-based fishing along this coast is more important than boat-based fishing, and while some fishermen target offshore waters (greater than 5 km from the shore), the majority of effort occurs 5 km or less from shore. The main target species along the west coast are rock lobster, abalone, and trumpeter. Rock lobster catch is predominantly from inshore waters between November and March, with fishing activity peaking immediately following the season opening in November. Abalone catch generally occurs during summer and autumn months, peaking from December to January (Lyle *et al*., 2009). Lyle *et al*. (2009) reported a seasonal trend in catch throughout all Tasmanian water, with catches low in winter and early spring, reflecting the overall lower levels of fishing activity during these seasons.

Tuna are targeted in the offshore waters along the Victoria coastline, with southern bluefin a main focus of recreational fishermen and charter operators. Boat skippers head to the waters of the shelf edge chasing these big game fish. While the timing of the tuna season varies on an annual basis, tuna are typically present along the coast from later summer through to early winter (Smith, 2018). It is possible that the presence of these game fish is associated with upwelling systems (Smith, 2018). Tourism activities associated with the tuna industry are particularly important for the town of Portland, with a number of charter vessels, as well as privately owned boats operating out of Portland, Victoria. Tuna fishing in Tasmanian waters is restricted to off the east coast (Lyle *et al.,* 2009).

5.5.5.2 Diving

Recreational diving inshore of the Operational Area generally occurs in water depths less than 30 m, concentrating around structures such as piers and shipwrecks, or natural reefs and rocky outcrops. While divers use these areas for sightseeing, many also dive to harvest target species such as abalone and rock lobster (when in season – see **Table 35**). A number of dive charters offer guided tours, operating out of the various ports inshore of the Operational Area.

Despite the often-rough coastal conditions along the Great Ocean Road, a number of popular shore dive sites can be found here including the breakwater and surrounding shipwrecks at Warrnambool, Stingray Bay (part of the Merri Marine Sanctuary), and Middle Island. Pickering and Thunder Point are also popular dive spots and are accessible from shore or boat. Water depths for the dives at these sites range from 3 to 24 m (Visit Victoria, 2018). Surrounding Port Campbell are a number of popular dive sites based around shipwrecks, including some sites that are accessible only by boat (Visit Victoria, 2018).

Visibility in Tasmanian waters ranges from 12 m in summer to in excess of 40 m in winter. Popular dive sites on the northwest of the island include Rocky Cape and Boat Harbour, and the many shipwrecks around King Island (Discover Tasmania, 2018). These dive sites are typically only accessible by boat.

5.5.5.3 Whale Watching

Migrating southern right and blue whales attract visitors to the Victoria coastline from approximately May to early October. The coastline encompassing Portland and Warrnambool offer some of the best shore-based whale watching locations atop cliff tops, rocky outcrops, and purpose-built viewing platforms (Visit Victoria, 2018a). At the southern right whale nursery grounds offshore from Logan's Beach in Warrnambool, whales can be observed from within 100 m of the coastline from viewing platforms (Visit Victoria, 2018a). In Portland, popular viewing locations include off the coast from Cape Bridgewater to Narrawong, Port of Portland and the cliffs above Nuns Beach and Portland Bay (Visit Victoria, 2018a). Blue whales rarely approach land; however, the headlands of Cape Nelson and Cape Bridgewater provide opportunities for viewing blue whales at a distance (Visit Victoria, 2018a). Offshore whale spotting is undertaken from helicopters and light planes, and occasionally vessels.

The majority of whale watching around Tasmania occurs on the more sheltered eastern coastline and will not be affected by the Otway Basin 2DMC MSS.

5.5.5.4 Surfing

The rugged Limestone Coast creates heavy surf breaks that are typically only surfed by experienced surfers. Popular surfing areas include Robe, Beachport, Port MacDonnell, Cape Northumberland, Guichen and Rivoli Bays, Southend, Cullens, and Posties (Surfing Atlas, 2018).

Along the Great Ocean Road west of Cape Otway is Johanna Beach; considered to be one of the top surfing beaches in Victoria. Other valued surf areas include Princetown, Gibson Steps, Port Campbell, and Peterborough, Lighthouse and Green Island, The Passage, and the reefs as Gabbos and Gooloos (Visit Victoria, 2018b). Further west around Warrnambool popular breaks include Logan's Beach, The Flume, Levy's Beach, East Beach, while hot spots for long surf breaks include Shelley beach, the water tower near Portland, Yellow Rock, Crumpets, and Whites Beach (Visit Victoria, 2018b). While the most popular time for surfing along the Great Ocean Road is the school holiday period of mid-December to mid-January, the best time of the year for surfing is autumn and winter (March – August) (Wildlife Tours, 2018).

Surfing along the northwest Tasmania coast includes challenging waves at Marrawah settlement (Ann Bay, Mawson Bay, and Green Point) due to Southern Ocean groundswells. Further north on King Island is Martha Lavinia Beach, which contains a unique wave that breaks both left and right, depending on wind and swell direction, and is referred to as 'the jewel in the crown'. Across Tasmania, summer periods provide the mildest waves, with bigger waves arriving with the wilder winter weather (Discover Tasmania, 2018a).

5.5.5.5 Sailing/Boating

Recreational boating is popular throughout Australia. Approximately 1 million recreational boaters utilise Australian waters each year for fishing, cruising/sight-seeing, and water-sports (e.g. jet-skiing, water skiing, and wake-boarding) (NMSC, 2009). Most recreational boating occurs in bays and sheltered waters, although open waters are also utilised including those greater than 5 NM from shore. In general, the larger the boat, the further from shore it will travel. The majority of boats in South Australia (59%), Victoria (64%), and Tasmania (55%) are 5 – 9.9 m in length, and this may be a reflection of the more exposed coast and variable sea and weather conditions within state waters (NMSC, 2009). In general, most boating occurs over summer months, with the least amount of boating activity in cooler winter months (NMSC, 2009). All operators of registered recreational motorboats in South Australia, Victoria, and Tasmania waters are required to hold a marine licence.

Approximately 52,128 recreational motorboats are registered in South Australia (**Table 36**), the fourth lowest total across all Australian states (Prideaux, 2012). Recreational boat users in South Australian waters have a preference for open waters (NMSC, 2009), although it is likely that the majority of recreational boat use in South Australia will occur to the west of the Operational Area in the Spencer Gulf, Gulf of St Vincent, and around Kangaroo Island.

The state of Victoria has the third highest number of registered recreational motorboats in Australia, with a total of approximately 173,554 registered boats (**Table 36**) (Prideaux, 2012). Recreational boating in Victoria is concentrated around bays and inlets such as Port Phillip Bay to the east of the Operational Area, although some coastal waters are also used. Of those boaters using coastal waters, the most common launch site is Portland. Boating trips are mainly associated with fishing, with a small number of boaters launching for the purpose of touring/cruising. Recreational boating activity peaks from October through to April, although boating activities also continue throughout the 'off season' (Social Research Institute, 2015).

Although the total number of motorboat users in Tasmania (29,657) represents the third lowest number in Australia (**Table 36**) (Prideaux, 2012), on a per capita basis registered motorboat ownership in Australia is highest in Tasmania (MAST, 2015). Due to the exposed conditions along the west coast of Tasmania, recreational boating activity is low, with use of the marine environment increasing around King Island due to the shelter provided by the island.

The annual Melbourne to King Island Ocean Yacht Race between Queenscliff (Victoria) and King Island (Tasmania) is held on the second weekend in March. The race starts off Queenscliff and covers 114 NM to finish off Grassy Harbour, King Island. The race is run by the Ocean Racing Club of Victoria in conjunction with the King Island Boat Club (ORCV, 2018). The Ocean Racing Club of Victoria also runs two races at Christmas; the Melbourne to Hobart ('Westcoaster') yacht race which tracks across Bass Strait from Melbourne and along the west and south coasts of Tasmania before finishing in Hobart, and the Melbourne to Devonport yacht race which tracks south across Bass Strait.

Table 36 Number of Registered Recreational Boats in States of Relevance to Operational Area

State	Approx. no boats <24 m	Approx. no boats >24 m	Approx. total
South Australia	51,844	284	52,128
Victoria	172,847	707	173,554
Tasmania	29,370	287	29,657

Source: Prideaux, 2012, as described in Commonwealth of Australia, 2017

5.5.6 Defence Activities

The Otway Basin 2DMC MSS Operational Area does not overlap with any permanent Australian Defence Force (**ADF**) training areas, and no ADF exercises have been identified for the Otway Basin 2DMC MSS survey period in 2019 – 2020. Nevertheless, the ADF is identified as a stakeholder for consultation, to confirm the absence of overlap between the Otway Basin 2DMC MSS Operational Area and defence activities during the operational schedule.

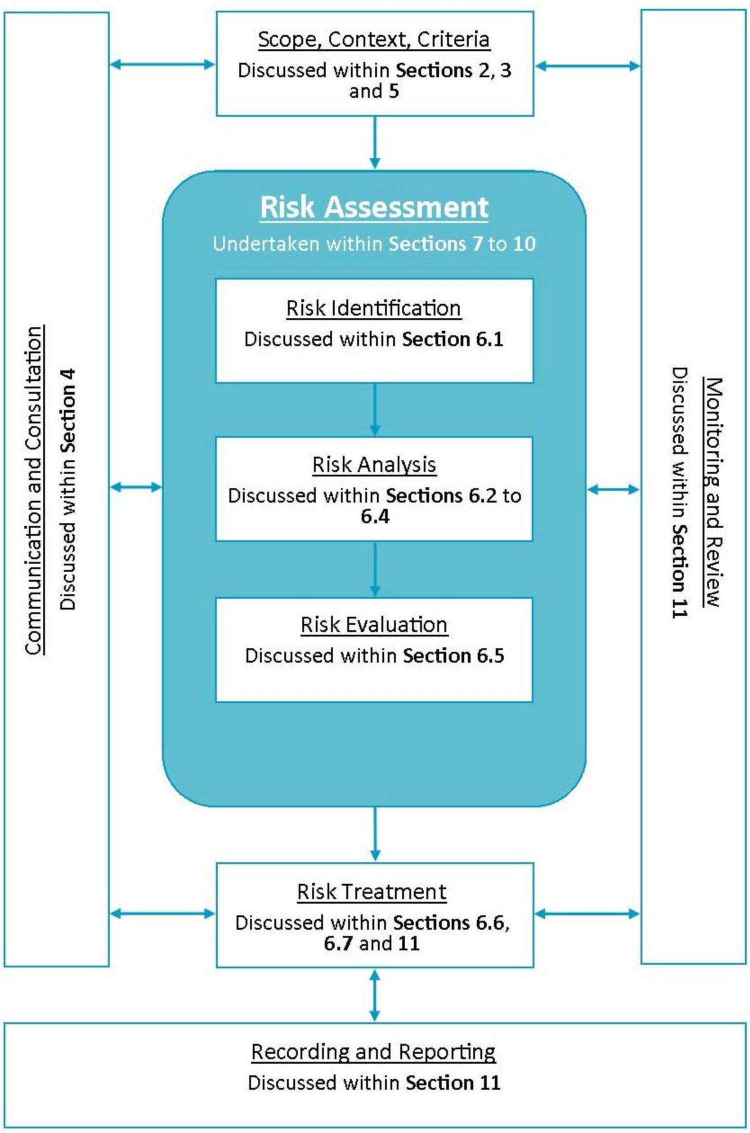
Prior to commencing any seismic survey, the ADF will be notified of survey details and area coordinates to ensure no military activities will coincide with seismic operations in the area.

6 Environmental Impact and Risk Assessment

Regulation 13(5) and 13(6) of the Environment Regulations requires SLB to include details of all environmental impacts and risks from the proposed activity, along with an evaluation of these impacts and risks appropriate to the nature and scale of each impact or risk, for all planned and unplanned operations. This assessment must detail the control measures which will be utilised to reduce the impacts and risks of the activity to **ALARP** and an **Acceptable Level**.

The following impact and risk assessment methodology has utilised the joint Australian & New Zealand International Standard Risk Management – Guidelines, (**AS/NZS ISO 31000:2018**) (ISO, 2018). **Figure 57** shows a modified version of the AS/NZS ISO 31000:2018 risk management process diagram and provides a guide on the processes used during the development of this EP, along with the sections which addresses each aspect of the risk management process.

Figure 57 Risk Management Process Adopted from AS/NZS ISO 31000:2018



Source: modified from ISO, 2018

6.1 Details of Environmental Impacts or Risks

Regulation 13(5)(a) of the Environment Regulations requires an EP to include details of the environmental impacts and risks for the activity to establish a link between the proposed activity and the environment that may be affected.

A robust assessment has been undertaken for the Otway Basin 2DMC MSS to identify all activities associated with the proposal which may have an impact or risk on the environment. The robust assessment was centred on best professional judgement of SLB based on their extensive experience undertaking seismic surveys both globally and more specifically in the Asia-Pacific Regions. This was combined with the professional judgement of SLR and their extensive experience in preparing Marine Mammal Impact Assessments for over 95% of the seismic surveys in New Zealand. This practical and technical experience of SLR resulted in key project members being incorporated into the Seismic Code Review Group and Technical Review Groups for the New Zealand Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations.

The identified activities for the Otway Basin 2DMC MSS have been split into two sub-categories, dependant on whether they are an integral part of the project (i.e. planned activities) or those which have a risk of occurring but are not intended to happen as part of normal operations (i.e. unplanned activities). The following activities have been considered within this assessment:

- Planned activities (**Section 7**):
  - Physical presence of the seismic vessel and towed equipment (**Section 7.1**);
  - Acoustic disturbance to the marine environment (**Section 7.2**);
  - Routine permissible waste discharges (**Section 7.3**);
  - Atmospheric emissions (**Section 7.4**); and
  - Artificial light emissions (**Section 7.5**).
- Unplanned activities (**Section 8**):
  - Establishment of invasive marine species (**Section 8.1**);
  - Streamer loss (**Section 8.2**);
  - Vessel collision or sinking, and its associated potential hydrocarbon spill (**Section 8.3**); and
  - Hydrocarbon spill response (**Section 8.4**);
  - Accidental release of hazardous and non-hazardous materials (**Section 8.5**).

In addition to the above sub-categories, the potential cumulative impacts and risks from the Otway Basin 2DMC MSS have been considered within **Section 9**.

6.2 Evaluation of Known and Potential Environmental Impacts or Risks

Regulation 13(5)(b) of the Environment Regulations requires an EP to include an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk. This evaluation involves the consideration of the cause and source of the impact or risk, whether they have a positive or negative consequence and the likelihood of those consequences occurring.

The evaluation of the known and potential environmental impacts or risks has considered previous assessments for the same type of activity, a review of scientific studies, stakeholder consultation feedback and the context of the existing environment. This information forms the basis for which the impacts or risks can be assessed, in addition to focusing the development of the control measures on those activities for which the impact or risk is the greatest. The evaluation of the significance of impacts and risks for each of the activities (both planned and unplanned) as part of this EP were undertaken using a variety of methods, including:

- Adherence to environmental standards;
- Proactive and professional judgement, including utilising industry experience;
- Quantitative analysis; and
- Quantitative analysis, including through numerical analysis or predictive modelling.

As part of the risk assessment process, the significance of known and potential impacts or risks from each activity is assessed with the assumption that control measures have been implemented. This then assists in determining whether any activities require additional controls to reduce the potential impacts/risks from the activities to **ALARP** and **Acceptable Levels**.

6.3 Development of Control Measures

Regulation 13(5)(c) of the Environment Regulations requires an EP to include the control measures that will be used to reduce the impacts and risks of the activity to **ALARP** and an **Acceptable Level**.

The development of the control measures for the Otway Basin 2DMC MSS is primarily based on industry best practice, and also includes an assessment of the legislative requirements, stakeholder concerns and expectations, and ensuring that the principles of ESD are met. The experience gained by SLB from previous MSS also played an important role in the development of control measures, in terms of those control measures which can feasibly be implemented for reducing the environmental impacts and risks to **ALARP**.

During the development of the control measures for this EP, the practicability and effectiveness of each measure has been considered and assessed. This assessment included consideration of a number of factors for each control measure, including availability, reliability, independence, compatibility, benefit and cost among other aspects. Clear justification is required for each control measure that is assessed in order to determine whether they will be implemented during the Otway Basin 2DMC MSS.

6.4 Environmental Performance of Control Measures

Regulation 13(7)(a–c) of the Environment Regulations requires every EP to:

- Set out the environmental performance outcomes against which the performance of the titleholder (in this case SLB) in protecting the environment is to be measured;
- Set environmental performance standards for the control measures; and
- Include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

As part of the development of control measures (**Section 6.3**), environmental performance outcomes, standards and measurement criteria are developed to ensure those control measures are implemented and maintained in a manner that reduces the impact and risk of the activity to **ALARP** and an **Acceptable Level**.

Environmental performance outcomes are a specified measurable level of performance required for the management of environmental aspects of an activity to ensure that the environmental impacts and/or risks are of an **Acceptable Level**. Each activity associated with the Otway Basin 2DMC MSS will include an environmental performance outcome which relates to all the environmental features that may be impacted or are at risk from the occurrence of the activity.

Environmental performance standards relate specifically to each control measure and are parameters which control measures are assessed against to ensure they consistently perform to reduce the impact or risk to **ALARP** and to an **Acceptable Level**. These environmental performance standards set levels at which an incident becomes a ‘recordable incident’ (**Section 10**) and will be utilised as part of performance monitoring of the activity.

Environmental performance outcomes and standards are required to have appropriate measurement criteria which define how the performance will be measured and determine whether the outcomes have been met during the activity.

6.5 Residual Risk Assessment

An Environmental Risk Assessment (**ERA**) has been undertaken to identify the relative significance of the potential effects from the Otway Basin 2DMC MSS based on a likelihood and consequence approach. AS/NZS ISO 31000:2018 (ISO, 2018) has been used to develop the ERA. In particular, the ERA methodology used in this EP has been adapted from MacDiarmid *et al.* (2012) which sets out a risk assessment framework for activities in New Zealand's EEZ and extended continental shelf. In addition to MacDiarmid *et al.* (2012), Southall *et al.*, (2007) has been utilised to develop consequence levels from underwater noise based on thresholds that predict the physiological effects on marine mammals in New Zealand waters during seismic surveys. Although this framework was initially developed for activities within New Zealand's jurisdiction, it is considered that it is relevant and appropriate for use to contribute towards the development of the ERA for the proposed activities in Australia. Guidance from Clark *et al.* (2017) has also been used to refine the ERA methodology so that it is specific and relevant to this EP.

To summarise, the main steps undertaken for the ERA process are to:

- Identify the potential sources of impact/risk (including magnitude, scale, frequency and intensity);
- Assess the potential consequences for each impact/risk across all potential environmental receptors (with operational procedures and proposed mitigation measures in place) – based on the criteria in **Table 37**;
- Assess the likelihood of a consequence occurring for each receptor – based on the criteria in **Table 38**; and
- Assign an overall classification of impact/risk for any residual impacts – based on the criteria in **Table 39**.

Table 37 Criteria for Assessing Potential Consequence Levels

Consequence level	Scale of Effect	Duration of Effect	Effect on Populations & Protected Species and Recovery Period	Effect on Socio-Economic Receptors	Effect on Habitat & Ecosystem Function
0 – Negligible	Highly localised effect (<1 km^2)	Short-term and intermittent/temporary	No predicted adverse effects to populations. Immediate recovery. No protected species impacted.	No disruptions to normal activities. No predicted effects on natural resources or local communities.	Undetectable, affecting <1% of original habitat area. Ecosystem function unaffected.
1 - Minor	Localised effect (1 – 5 km^2)	Short-term, occurring frequently but ceases when activity ceases	Possible adverse effect to populations, but not sufficient enough to be detectable. Rapid recovery would occur (weeks to months). Some individuals of protected species may be impacted.	Short term disruptions to normal activities (weeks to months). Possible minor adverse effects to natural resources and/or local communities.	Measurable but localised, affecting 1 – 5% of original habitat area. Minor changes to ecosystem function.
2 - Moderate	Medium scale effect (5 – 20 km^2)	Medium-term but ceases when activity ceases	Detectable impacts to populations. Could affect seasonal recruitment but does not threaten long-term viability. Recovery probably measured in months to years. Some population level effects may become apparent for protected species.	Medium-term disruptions to normal activities (months). Moderate adverse effect to natural resource and/or local communities.	Potential impacts more widespread, affecting 5 – 20% of original habitat area. Moderate changes to ecosystem function.
3 - Severe	Large scale effect (20 – 50 km^2)	Long-term but ceases when activity ceases	Impacts to populations are severe and may limit capacity for population increase. Recovery measured in multiple years. Population level impacts are detectable for protected species.	Long-term disruptions to normal activities (years). Severe adverse effect to natural resources and local communities.	Widespread impacts, affecting 20 – 60% of original habitat area. Severe changes to ecosystem function.
4 - Major	Very large scale effect (50 – 100 km^2)	Long-term and continues after activity ceases	Long-term viability of populations is clearly affected. Local extinctions are a real possibility if activity continues. Recovery period of decades. Serious conservation concerns for protected species.	Extensive disruptions to normal activities (years to decades). Highly significant and major adverse effects to natural resources and potentially affecting national communities.	Activity may result in major changes to ecosystem or region, affecting 60 – 90% of original habitat area. Major changes to ecosystem function.
5 - Catastrophic	Regional effect (>100 km^2)	Permanent	Local extinctions are expected in the short-term. Long-term recovery greater than decades and possibly never recovers. Very serious conservation concerns for protected species.	Very extensive disruptions to normal activities (decades). Catastrophic, widespread and potentially irreparable damage to natural resources. Massive negative and potentially irreversible effects on local and national communities, which may not be able to maintain pre-effect livelihood.	Activity will result in critical changes to ecosystem or region, affecting virtually all original habitat. Total collapse of ecosystem.

Table 38 Criteria for Assessing Consequence Likelihood

Level/Score	Description	Likelihood of exposure
1	Remote	Highly unlikely but theoretically possible
2	Rare	May occur in exceptional circumstances
3	Unlikely	Uncommon, but has been known to occur elsewhere
4	Possible	Occurred in a minority of similar studies or projects
5	Likely	Likely to occur and has generally occurred in similar projects
6	Certain	Could be expected to occur more than once during project delivery

* Whereby 'likelihood' = the likelihood of a consequence occurring from the various activities

Table 39 Overall Risk of Residual Impacts

		Consequence Level					
		0 – Negligible	1 – Minor	2 – Moderate	3 – Severe	4 – Major	5 – Catastrophic
Likelihood of Consequence	1 – Remote	Negligible (0)	Low (1)	Low (2)	Low (3)	Low (4)	Low (5)
	2 – Rare	Negligible (0)	Low (2)	Low (4)	Moderate (6)	Moderate (8)	Moderate (10)
	3 – Unlikely	Negligible (0)	Low (3)	Moderate (6)	Moderate (9)	High (12)	High (15)
	4 – Possible	Negligible (0)	Low (4)	Moderate (8)	High (12)	High (16)	Extreme (20)
	5 – Likely	Negligible (0)	Low (5)	Moderate (10)	High (15)	Extreme (20)	Extreme (25)
	6 – Certain	Negligible (0)	Moderate (6)	High (12)	Extreme (18)	Extreme (24)	Extreme (30)

A description of the overall risk rankings contained within **Table 39** from 'Negligible' to 'Extreme' can be found within **Table 40**.

Table 40 Risk Ranking Descriptions

Risk Ranking		Potential Impact	Potential Impact Significance
	Extreme (18 – 30)	Extreme Risk – unacceptable for project to continue under existing circumstances. Requires immediate action. Equipment could be destroyed with large environmental impact as a result of a spill or discharge to the environment.	Considered significant
	High (12 – 16)	High Risk (intolerable risk) – where the level of risk is not acceptable and control measures are required to move the risk to lower the risk categories. Medium environmental impact from a spill or discharge to the environment.	Considered significant
	Moderate (6 – 10)	Moderate Risk – requires additional control measures where possible or management/communication to maintain risk at less than significant levels. Small environmental impact from a spill or discharge to the environment. Where risk cannot be reduced to 'Low' control measures must be applied to reduce the risk to **ALARP**. Requires continued tracking and recorded action plans.	Considered significant
	Low (1 – 5)	Low Risk – where the level of risk is at a broadly **Acceptable Level** and generic control measures are already assumed in the design process but require continuous monitoring and improvement. No further development of control measures is practicable and/or the costs of implementing further controls are disproportionate to the environmental benefit.	Not significant
	Negligible (0)	Negligible Risk – no intervention or further monitoring is required. No environmental impact.	Not significant

6.6 Demonstration of ALARP

Regulation 10A(b) and 13(5)(c) of the Environment Regulations requires that the EP demonstrates that the environmental impacts and risks of the activity will be reduced to **ALARP**.

To ensure the impacts and risks from the proposed activities are **ALARP**, a hierarchy of controls has been utilised which follows a tiered system of 'eliminate-substitute-reduce-mitigate' (**Table 41**). The consideration of elimination and substitution is generally used for those activities which require further controls due to their higher impacts/risk. Whereas, the controls for those activities which are known to have **Negligible** or **Low** impacts/risks are primarily focused on the reduction and/or mitigation aspect of the hierarchy to ensure they are **ALARP**.

Table 41 General Hierarchy of Controls

Control	Example	Effectiveness
Eliminate	Elimination of the risk or impact, such as eliminating the light source to remove impacts from artificial light emissions	↓
Substitute	Substitute the method of an activity in favour of a lower impact one, such as substituting Heavy Fuel Oil for Marine Gas Oil to reduce the amount of atmospheric emissions	
Reduce	Reduction of the risk or impact, such as reducing the oil content in discharged water to reduce the potential contamination of the sea	
Mitigate	Mitigate the potential risk or impact of conducting an activity, such as maintaining separation distances from land when discharging wastes to mitigate the potential impacts on coastal environments	

The aim of the controls is to reduce the residual risk to a **Low** ranking (**Table 40**) however if the risk remains at a higher ranking, it must be assessed as to whether it has been reduced to **ALARP**. For example, it must be considered as to whether there are any additional reasonable and practicable control measures that can be applied to reduce the risk or impact, without the sacrifice being disproportionate to the benefit of risk reduction.

6.7 Risk Acceptability

Regulation 10A(c) and 13(5)(c) of the Environment Regulations requires an EP to demonstrate that the environmental impacts and risks of the activity, and the associated control measures to be implemented, will be of an **Acceptable Level**. The criteria used to determine whether the residual risks of an activity following the implementation of the control measures, following the demonstration of **ALARP**, is at an **Acceptable Level**, are based on the seven criteria contained within **Table 42**. For each criterion, 'acceptability questions' have been developed to demonstrate compliance. Each criterion has been assessed for each activity, both planned and unplanned, within **Sections 7** and **8**. For each risk acceptability criterion to be accepted, compliance with the requirements in **Table 42** must be demonstrated.

Table 42 Risk Acceptability Criteria

Criteria	Acceptability Questions	Acceptability is Confirmed
Ecologically sustainable development	ESD is defined 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'. Section 3A of the EPBC Act sets out three main matters; the first of which is that the activity needs to be carried out in a manner consistent with the principles of ESD. Therefore, ESD is an integral aspect in determining risk/impact acceptability. Based on this, is the management of the risks/impacts associated with the proposed activities carried out in a manner that is consistent with the five principles of ESD as defined within the EPBC Act (**Section 2.2**)?	The Otway Basin 2DMC MSS is consistent with the five principles of ESD.
Legislative requirement	Is the management of the risks/impacts (including the control measures) being implemented in accordance with the relevant Australian and International legislation, conventions and standards such as those outlined within **Section 2** (i.e. EPBC Act Policy Statement 2.1, MARPOL, Marine Notices, Marine Orders)?	Compliance with all of the legislative requirements, standards and policies and can be demonstrated when audited.
Internal context	Does the management of the risks/impacts associated with the activity align with the internal policy of the titleholder (in this case SLB's QHSE Policy, **Section 1.2**)?	Internal or external audits of procedural systems confirm all policies in place that align with the EP.
Industry best practice	Has the management of the risks/impacts been conducted in accordance with industry best practice, such as the APPEA Code of Environmental Practice and the International Associated of Geophysical Contractors (**IAGC**) Environmental Manual for Worldwide Geophysical Operation (**Section 2.3**)?	The impact of potential risk, through control measures is managed so that it is compliant with all relevant industry best practice guidelines.
Stakeholder expectations	Have any concerns of the risks/impacts from the activity been raised through consultation (described throughout **Section 4** and **Appendix F**), and have any relevant control measures been developed to address these concerns (included in relevant control measure tables for each activity)?	All stakeholder concerns and submissions have been responded to, adequately addressed and closed out.
Existing environment context	Has the development of the control measures taken into account the environmental values and sensitivities at a local, regional or global level, where relevant? Is the management of the risks/impacts in accordance with the relevant species specific or protected area management plans, such as Conservation Advice, Management Plans, or Recovery Plans? If there is no management plan in place for a World Heritage property, National Heritage Place, Commonwealth marine reserve, Commonwealth heritage place or Ramsar wetland, then is the activity (and its environmental management) consistent with Australian World Heritage, Australian IUCN reserve, National Heritage, Commonwealth heritage or Australian Ramsar management principles, as defined in the EPBC Regulations 2000. Are the risks/impacts managed in alignment with the relevant conservation values defined within the South-east Marine Region Profile (Commonwealth of Australia, 2015)?	With the implementation of the control measures, the potential impacts from each of the activities must be consistent with all of the relevant management plans, conservation advice, recovery plans and the general nature of the receiving environment of the Otway Basin 2DMC MSS Operational Area and wider receiving environment.

Criteria	Acceptability Questions	Acceptability is Confirmed
ALARP	Are all reasonable and practicable control measures in place to reduce the impact or risk of the activity? Have the costs (financial or otherwise) of implementing further control measures been considered, and are either included as a control measure or not included where it is considered they are disproportionate to the benefit gained?	General agreement that the residual risk from the activity has been demonstrated to be ALARP.

7 Environmental Impacts from Planned Activities

The planned activities associated with the Otway Basin 2DMC MSS include:

- Physical presence of seismic vessel and towed equipment (**Section 7.1**);
- Acoustic disturbance to the marine environment (**Section 7.2**);
- Routine permissible waste discharges (**Section 7.3**);
- Atmospheric emissions (**Section 7.4**); and
- Artificial light emissions (**Section 7.5**).

This section of the EP goes through the impact and risk evaluation for each of the planned activities listed above that will be included within the Otway Basin 2DMC MSS, for each of the receptors of relevance within the Operational Area and wider environment using the methodology described within **Section 6**. This evaluation, with the inclusion of control measures, will demonstrate that the impacts and risks associated with the Otway Basin 2DMC MSS will be reduced to **ALARP** and will be of an **Acceptable Level**.

7.1 Physical Presence of Seismic Vessel and Towed Equipment

7.1.1 Description of Source of the Impact

During the Otway Basin 2DMC MSS, the seismic vessel will tow a single streamer at a speed of approximately 4 – 5 knots and a maximum depth of 7.5 m. The towed equipment includes 24 acoustic sources arranged as three sub-arrays and one streamer up to 11 km in length. The towed streamer contains a number of receiving hydrophones and is equipped with a tail buoy that has a radar reflector and light at the terminal end.

A purpose-built seismic vessel will be contracted for the Otway Basin 2DMC MSS that is capable of safely undertaking the survey within the environmental conditions the vessel will be exposed to within the Otway Basin during the survey period.

The survey vessel will be accompanied by a support vessel, which will be in close proximity at all times. The support vessel will be utilised to manage possible interactions between the seismic vessel and towed equipment with other marine users.

The seismic and support vessels will henceforth be collectively referred to as the ‘survey vessels’.

7.1.2 Known and Potential Impacts to Environmental Receptors

The physical presence of the survey vessels and towed acoustic equipment, which are essential for data acquisition during the Otway Basin 2DMC MSS, has the potential to result in the following effects on environmental receptors:

- Disruption to normal animal behaviours;
- Displacement of animals from preferred areas of habitat;
- Displacement of other marine users from routes or activity areas;
- Collision with a vessel; and
- Entanglement with the towed equipment.

It is considered that the biggest risks that may result from the physical presence of the seismic vessel and the towed equipment is the potential for a physical impact on marine mammals and turtles (i.e. collision and entanglement), the displacement of marine mammals from the immediate vicinity of the survey vessel, the displacement of commercial fishers from fishing grounds and the physical interaction with deployed fishing gear. There is also the potential for interruptions to other marine activities to occur such as commercial shipping, tourism, and recreational activities.

7.1.2.1 Marine Reptiles

Yellow-bellied sea snakes have been observed in Tasmanian and Victorian waters. Although they are the most pelagic species of all the known sea snakes, their distribution is usually within a few kilometres of the coastline and therefore are unlikely to interact with the survey vessels and towed equipment. Given the significant offshore distance of the Otway Basin 2DMC MSS, it would be very unlikely that one of these sea snakes was observed within the Operational Area and they have not been further assessed in this EP.

Leatherback and loggerhead turtles are known to migrate through the waters of the Operational Area so there is potential that they could be confronted by the physical presence of the survey vessels and towed equipment during the Otway Basin 2DMC MSS. While behavioural disruptions and displacement from certain areas are possible as a result of such disturbances, the biggest threat to turtles comes from collision or entanglement with the towed equipment that make up the acoustic array, in particular the tail buoy.

Turtles are vulnerable to vessel strike due to their relatively small size and the significant amount of time spent just below the sea surface (Commonwealth of Australia, 2017a). A successful avoidance is determined by the animal's response time, which is affected by both vessel speed and visibility. Hazel *et al*. (2007) found that 60% of green turtles were able to successfully flee from approaching vessels travelling at 2 knots. A turtle's ability to flee was severely reduced as the vessel's speed increased, with 22% successfully fleeing at 6 knots and only 4% at 10 knots. It was concluded that most turtles cannot avoid vessels travelling at speeds greater than approximately 2 knots (Hazel *et al.,* 2007). Turtles are likely responding to visual cues of the vessel instead of sound cues; if turtles were relying primarily on sound, the reverse result would be found with greater response rates to faster (and therefore louder) vessel approaches (Hazel *et al*., 2007).

Tail buoys are the most likely part of the towed equipment to trap marine turtles. There are two main areas on the tail buoy which may trap turtles; between the buoy and the connecting chains (the most common area of entrapment), or underneath the buoy in the 'undercarriage' structure (Ketos Ecology, 2009). In order to become trapped in the tail buoy, the animal would have to come in close proximity to the buoy. There are two theories as to why turtles become trapped against seismic tail buoys; startle diving in front of the towed equipment, or as a result of foraging along the seismic cables (Ketos Ecology, 2009). Entanglement in tail buoys would be fatal due to water movement holding the turtle against the buoy, keeping the turtle from being able to reach the surface to breathe (Ketos Ecology, 2009).

Surface behaviour of the turtle increases its chance of entrapment. For example, those basking at or just below the water surface during hot and calm conditions are slow to react to threats, with dive reactions occurring at close range based on visual detections of the threat (Ketos Ecology, 2009). Startle dive reactions in turtles at the sea surface responding to approaching towed equipment and vessels have been observed at as little at 1 m from the threat (Weir, 2007). All species of marine turtle potentially present within the Operational Area are expected to exhibit resting/basking surface behaviours.

Turtles have been observed swimming immediately over seismic cables, leading to the suggestion that the animals are feeding on barnacles and other organisms off the seismic cables. While not all species of turtle forage on barnacles and other invertebrates, such prey species are known to make up part of the diet of loggerhead turtles, a species with an unlikely but possible presence within the Otway Basin 2DMC MSS Operational Area (Ketos Ecology, 2009).

Although there are no peer-reviewed literature documenting incidences of turtle entanglement in towed seismic equipment (Nelms *et al.,* 2016), 'turtle guards' were developed to prevent turtle interactions with tail buoys following anecdotal reports of turtle entrapments off the west coast of Africa (Nelms *et al.,* 2016) and the suggestion of entrapment as a growing concern (Ketos Ecology, 2009). Guards are fitted to the buoy and act as a physical barrier to exclude turtles from the space between the buoy and undercarriage (Ketos Ecology, 2009). Certain designs may also allow the turtle to be deflected away from the buoy. The tail buoy utilised in the Otway Basin 2DMC MSS will be fitted with a turtle guard.

The '*National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna'* provides a guiding framework for mitigating the risk of vessel collisions with marine megafauna, including marine turtles (Commonwealth of Australia, 2017). An intended outcome of the National Strategy is the development of a mitigation measures 'toolkit'. To date this toolkit has not yet been developed; however, installation of turtle guards on tail buoys and the slow speed of the seismic vessel are considered to be effective mitigation measures against ship strike and entanglement for marine turtles. There are no mitigation measures that will be implemented on board the support vessel to minimise the risk of collision with marine turtles, although any incidents with turtles will be reported, as recommended under the National Strategy.

Vessel disturbance is particularly an issue for turtles in shallow coastal foraging habitats and nesting areas where vessel traffic is typically more concentrated (Commonwealth of Australia, 2017a). The Otway Basin 2DMC MSS Operational Area does not represent a particularly important area for marine turtles; i.e. it does not support breeding/nesting populations and being in deep waters, is outside of the typical coastal range of most marine turtles.

The risk to populations of marine turtles arising from the physical presence of the survey vessels and towed equipment during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Unlikely*).

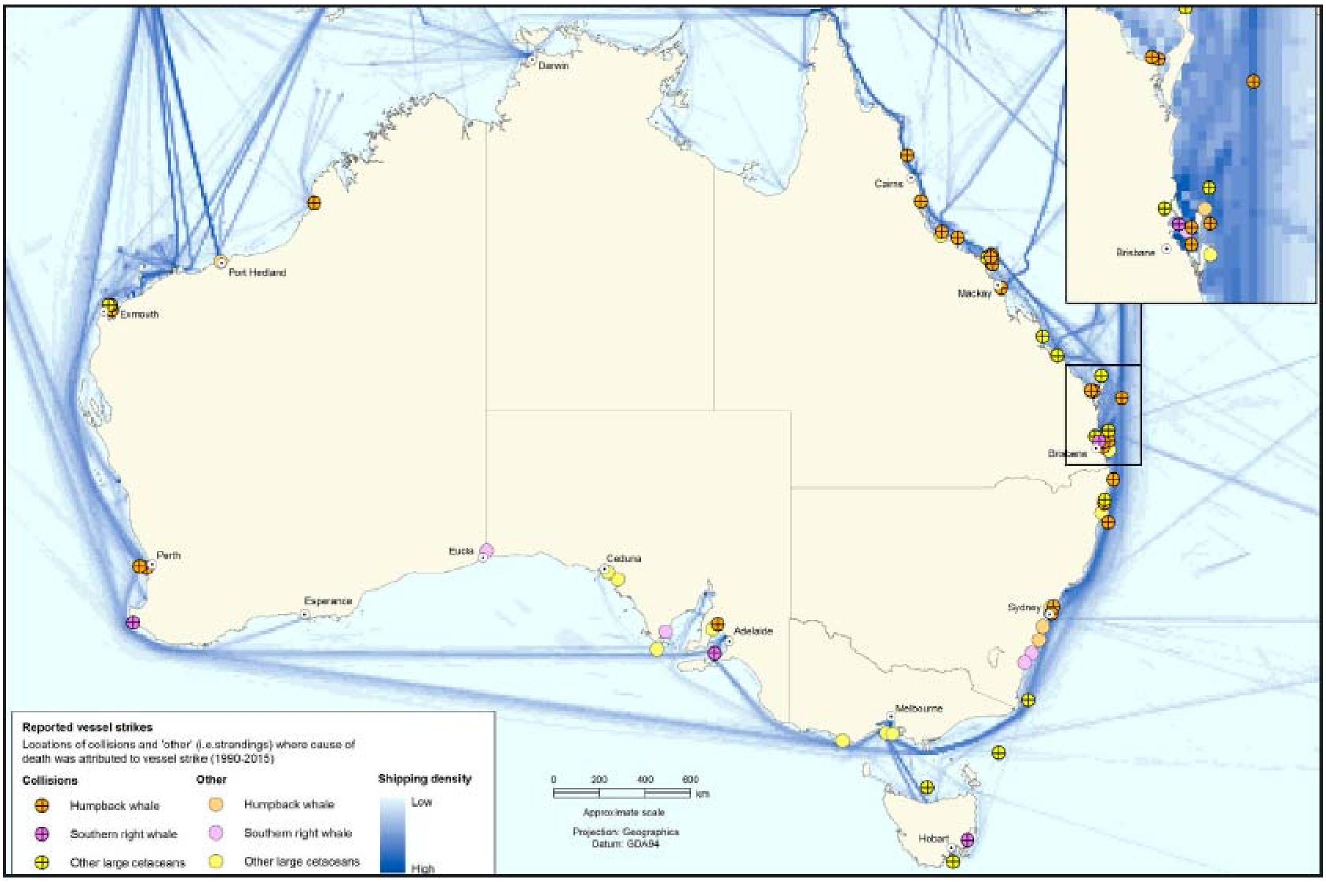
7.1.2.2 Cetaceans

Disruption of normal animal behaviour and displacement is of particular concern when it occurs frequently or over a prolonged period and affects critical behaviours such as feeding, breeding and resting. The physical presence of the survey vessel and associated towed equipment may cause some temporary and localised changes in marine mammal behaviours and/or displacement from habitat. **Table 20** provides a summary timeline depicting the expected presence of cetaceans in the Otway Basin 2DMC MSS Operational Area.

Marine mammals show two main stereotypical behaviours in the presence of vessels: avoidance or attraction (Wűrsig *et al*., 1998); both behaviours can affect energy expenditure and disrupt natural activities. Avoidance most commonly leads to an animal becoming displaced from an area; however, such disturbance is predicted to be temporary due to the transitory and temporary duration of seismic activities in any single location. Furthermore, marine mammals must be in relatively close proximity to the vessels and equipment in order to be affected by their physical presence.

There are 109 records of ship strike on cetaceans in Australian waters from 1997 to 2015. Species documented in the ship strike record include humpback (47%), southern right (13%), sperm (3%), pygmy blue (2%), blue (2%), pygmy sperm (2%), dwarf minke (2%), pygmy right (1%), fin (1%), Antarctic minke (1%), and 'unidentified' (26%) whales (Commonwealth of Australia, 2017). Known ship strikes or stranding events attributed to ship strike have been recorded in the vicinity of the Otway Basin 2DMC MSS Operational Area for humpback, southern right, and 'other large' whales (**Figure 58**). There are limited records of ship strike with dolphins in Australian waters (Commonwealth of Australia, 2017). Of the six Australian states, Victoria and Tasmania represent the states with the lowest number of documented whale strikes (Commonwealth of Australia, 2017).

Figure 58 Location of Reported Vessel Collisions with Whales or 'Other' Incidents where Cause of Death is attributed to Vessel Collision



Source: Commonwealth of Australia, 2017

Jensen and Silber (2004) demonstrated that vessel type plays a role in the likelihood of a ship strike resulting in animal mortality. In a review of the global ship strike database, the majority of fatal strikes were caused by navy vessels and container/cargo ships/freighters, which typically travel at relatively high speeds above 15 knots. Seismic vessels (categorised in the study as 'research' vessels) accounted for only one ship strike incident out of a total of 292 reported incidents (Jensen & Silber, 2004).

The faster a vessel travels, the greater the likelihood of whale mortality. Jensen and Silber (2004) reported a mean speed of 18.6 knots for vessels involved in lethal ship strikes. During data acquisition, seismic vessels typically travel at approximately 4 – 5 knots; three to four times slower than the mean fatal speed documented by Jensen and Silber (2004). Records of sub-lethal effects are less reliable on account of the difficulty in assessing injury in free swimming cetaceans following a collision.

Large marine mammals (baleen whales and the larger toothed whales) are most at risk of ship strike when exhibiting surface behaviours such as feeding and resting. Based on the findings of Jensen and Silber (2004) and Peel *et al.* (2016), and the assessed likelihood of encountering each cetacean species during the Otway Basin 2DMC MSS, ship strike during the MSS is of most concern with regard to fin, humpback, sperm, blue, sei, and southern right whales. Although Bryde's whales have been reported as particularly vulnerable to ship strike due to their slow swimming speed and extensive use of surface waters (Constantine *et al*., 2012), this species is not considered to be at a high risk during the Otway Basin 2DMC MSS as the Operational Area does not overlap with the typical distributional range of this species.

Humpbacks whales represent the single species of marine mammal with the highest number of vessel strikes in Australian waters, although this may be a reflection on the reasonably high abundance of humpback whales in Australia (Peel *et al.,* 2016). Humpbacks utilise waters of the Otway Basin 2DMC MSS Operational Area during migrations, at which time they are unlikely to spend extended periods of time resting or feeding at the sea surface. Instead they will be actively moving along their relatively coastal migration pathways. Based on tracked migration routes, humpback whales will be present in the east to southeast of the Operational Area in the period from April – May (TSSC, 2015) and then again in October – November (Andrews-Goff *et al*., 2018). The Otway Basin 2DMC MSS is proposed to commence acquisition in October 2019; however, where possible the survey design will be aimed to acquire the eastern portion of the Operational Area after November 2019 to avoid any potential conflict with humpback migrations and reduce the potential for collision or displacement.

Southern right whales are the second most represented species on the Australian vessel strike records (Peel *et al*., 2016), and they utilise the Victoria coastline as a calving and nursery ground which increases their vulnerability to ship strike. These coastal areas tend to be in shallow water depths (<10 m) and are well inside the minimum depth of operation for the Otway Basin 2DMC MSS. The seismic vessel has a maximum draught of 7.4 m and 96% of the Otway Basin 2DMC MSS Operational Area is in water depths greater than 200 m, therefore the seismic vessel will not come into contact with southern right whales while they are on their calving or nursery grounds. Breeding and calving for southern right whales occurs between May and October. SLB will acquire the tie lines at the start of the survey (i.e. 15 October 2019 – 31 December 2019) or the tie lines will be acquired at the end of the survey (i.e. 1 March 2020 – 30 April 2020). These temporal mitigations are to avoid any overlap with breeding and calving southern right whales, feeding aggregations of blue whales and humpback whale migrations.

Fin, blue, sperm and sei whales all undertake feeding activities (and potentially resting behaviours) within the general area surrounding the Otway Basin 2DMC MSS Operational Area. Foraging habits of these species is closely linked to the presence of the Bonney Upwelling in November – March along the northern/coastal boundary of the Otway Basin 2DMC MSS Operational Area (**Figure 41**). The behaviour of blue whales in response to commercial ship movement was documented in McKenna *et al*. (2015) who observed a dive reaction (a shallow dive during surface period) in response to an approaching vessel but no evidence of any lateral avoidance. This suggests that the ability of this species to avoid ships is limited (McKenna *et al*., 2015). Whales actively involved in feeding behaviours may be 'distracted' from perceiving threats (Laist *et al*., 2001), further limiting their ability to avoid vessels. In 2009 and 2010, a single stranding event of a blue whales with visible ship strike injuries along the Victoria coastline inshore of the Bonney Upwelling was recorded (as referenced in Commonwealth of Australia, 2015a). These stranding events may support the idea that these large whales become 'distracted' while foraging. There are no records of ship strike involving fin whales in Australian waters (Peel *et al.,* 2016).

Sperm whales are also known to spend extended periods of time at the sea surface, where they sleep at or just below the surface. Resting whales are typically non-responsive to passing vessels, and it is important to note that sperm whales do not vocalise during resting periods. The resting behaviours of sperm whales are weakly diurnal, occurring mainly during periods of darkness (i.e. between 1800 and 2400hrs) (Miller *et al*., 2008). As a result, resting animals would not be detected by either visual observations or the use of PAM; hence would be particularly prone to ship strike.

Many of the dolphin species recorded in the South-east Marine Region are coastal species so will be well inshore of the seismic vessel and as a result are unlikely to interact with the seismic vessel within the Operational Area. Therefore, small dolphins are unlikely to be at risk of vessel strike during the Otway Basin 2DMC MSS.

Minimising vessel collision is ranked as a high priority action within the Conservation Management Plans for southern right and blue whales, and within the Conservation Advice for fin, sei, and humpback whales. The expected low incidence of vessel strike from the Otway Basin 2DMC MSS will not affect the long-term recovery of these species in accordance with these plans.

The '*National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna*' acts as a guiding framework for identifying the species and areas most at risk and aims to provide appropriate mitigation measures to reduce the risk of ship strike. The National Strategy intends to develop a 'mitigation measures toolkit'. To date this toolkit has not been developed; however, once developed the mitigation measures for cetaceans will fall into three main categories: keeping vessels away from whales, slowing of vessel speeds, and implementation of avoidance manoeuvres (Commonwealth of Australia, 2017).

The master of the support vessel will operate in accordance with the EPBC Regulations Part 8, Division 8.1 in regard to the minimum approach distances and vessel speed for "other craft" and follow the prescribed actions when adult cetaceans and/or calves are present within the caution zone. The support vessel will operate at a constant speed of less than 6 knots and minimise noise, whilst ensuring the vessel does not drift or approach closer to than 50 m to a dolphin or 100 m to a whale.

If the cetacean shows any sign of being disturbed, the vessel must be withdrawn from the caution zone at a speed of less than 6 knots. If an adult whale approaches the support vessel or come within 100 m, the master must disengage the gears and let the whale approach or reduce the speed of the vessel and continue on a course away from the whale.

If an adult dolphin approaches the support vessel or comes within 50 m, the master must not suddenly change course or speed of the vessel.

The master of the support vessel will make all efforts not to let a calf enter the caution zone; however, if a calf does enter the caution zone, then the master will immediately stop the vessel, turn off the vessel's engines, or disengage the gears, or withdraw the vessel from the caution zone at a constant speed of less than 6 knots.

These control measures are included in **Table 44** within the measurement criteria included in **Table 45**.

Due to the restricted manoeuvrability of the seismic vessel, no further mitigation measures are able to be applied to reduce the risk of cetaceans to ship strike from the seismic vessel; however, the seismic vessel will maintain speed and course in the presence of marine mammals, this, in addition to the already low speed of the vessel, allows greater time for cetaceans to detect the vessel, predict its pathway, and avoid a collision or entanglement in the towed equipment. Trained observers will be stationed on-watch for acquisition periods during daylight hours. While this will not minimise the potential for vessel strike, any incidents (i.e. ship strike or entanglement) will be observed and reported. Ship strikes will be reported into the Australian Government National Ship Strike Database (DoEE, 2018x), as is required by the EPBC Act.

Although marine mammals could interact with and become entangled in the towed seismic array, it is highly unlikely that this would occur on account of marine mammals displaying exceptional abilities to detect and avoid obstacles in the water column and there being no loose surface lines associated with the towed equipment (Rowe, 2007). Unlike interactions with fishing gear, there is no food attractant associated with seismic surveys. To our knowledge, there has never been a reported case of a marine mammal becoming entangled in seismic equipment. In addition, the auditory range of many cetaceans overlaps with peak intensities of transiting ships (Allen & Peterson, 2012; Veirs *et al*., 2016), thus cetaceans should have the capacity to acoustically detect an oncoming ship (Allen & Peterson, 2012) and move away from the vessel/s, minimising the likelihood of a ship strike and entanglement.

The presence of the vessels may also act as an attractant to certain species, particularly smaller species of dolphin which may approach the vessel to bow-ride (Wűrsig *et al*., 1998). Bow-riding behaviours have been observed during periods of active seismic acquisition (e.g. Moulton & Miller, 2005).

The risk to cetacean populations arising from the physical presence of the seismic vessel, support vessel, and the towed equipment during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.1.2.3 Pinnipeds

Pinnipeds are at risk from vessel collision and temporary displacement from habitat. **Table 21** provides a summary timeline depicting the expected presence of pinnipeds in the Otway Basin 2DMC MSS Operational Area.

Lalas and McConnell (2016) highlighted that acoustic sources (i.e. noise emissions) are not the only stimulus that New Zealand fur seals respond to during an MSS, with the vessel and towed gear creating physical obstacles that usually generate an avoidance response from the fur seals. This response was observed regardless of the activity state of the acoustic source (Lalas & McConnell, 2016).

Pinnipeds breed in terrestrial colonies, and given the boundary of the Operational Area is no closer than 3 NM to the coast at its closest point, there will be no spatial overlap between pinniped breeding colonies and the Otway Basin 2DMC MSS.

The risk to pinniped populations arising from the physical presence of the seismic vessel, support vessel, and towed equipment during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.1.3 Known and Potential Impacts on Stakeholders and Other Marine Users

The Otway Basin 2DMC MSS Operational Area is relevant to several stakeholders who use this marine environment (see **Section 5.5**) who may be temporarily displaced from the area for a short period of time during the survey period.

Marine users, specifically commercial shipping companies, commercial and recreational fishers, tourist operators and offshore oil and gas facility operators may be temporarily affected by the presence of the survey vessels and towed equipment during the Otway Basin 2DMC MSS. The known and potential risks and impacts to other marine users from the physical presence of the survey vessels and towed equipment include:

- Temporary displacement from the Operational Area in the immediate vicinity of the survey vessels and towed equipment;
- Entanglement of towed equipment and fishing gear;
- Displacement of marine fauna leading to fewer animals for marine-based tourism; and
- Interference with existing Otway gas fields.

Potential effects on catch-rates and larval stages (due to noise emissions) for commercial fisheries are discussed in **Section 7.2.3**. Non-routine (i.e. accidental) events including the addition of navigational hazards associated with lost equipment and environmental effects from a vessel collision are discussed further in **Section 8.2** and **Section 8.3**, respectively.

The comparatively slow speed of the seismic vessel (approximately 4 – 5 knots) and the length of the towed streamer (up to 11 km) restricts vessel manoeuvrability, and other more mobile users will be required to actively avoid interference with the seismic vessel and towed equipment.

The seismic vessel will tow a streamer up to 11 km in length during the Otway Basin 2DMC MSS. Using a conservative vessel speed of 4 knots (7.4 km/hr) it would take just under 1.5 hours for the vessel and streamer to pass. So, this is the period of time that a marine user would be displaced from any specific location within the Otway Basin 2DMC MSS Operational Area.

7.1.3.1 Potential Impacts to Commercial Fishing Operations

A number of different commercial fisheries utilise the waters of the Otway Basin 2DMC MSS Operational Area (**Section 5.5.2**). As a result, there is the potential for some fishing activities to conflict, both spatially and temporally, with the Otway Basin 2DMC MSS. **Table 31** provides a summary timeline depicting commercial fishing seasons within the Operational Area. During the period when the Otway Basin 2DMC MSS is proposed, the Tasmanian scallop fishery is closed, while the rest of the commercially fished species are open.

Commercial fishers that deploy gear on the seabed or suspended within the water column, such as king crab and rock lobster pots or long-lines, could be directly impacted by the Otway Basin 2DMC MSS if the gear is positioned in the path of the seismic vessel and has surface buoy's attached. In this case, deployed fishing gear may become entangled with the towed equipment behind the seismic vessel. Those commercial fishers that use a more mobile form of fishing (i.e. trawlers and seine fishers), may be temporarily displaced from their traditional fishing grounds but have less risk of having their gear lost. Due to the type of gear used, the Tasmanian, South Australian, and Victorian Rock Lobster fisheries, the Victorian Giant Crab Fishery the South Australian Marine Scalefish Fishery, and the SHS and SGSHS Sectors of the SESSF are most likely to be impacted by the presence of the seismic vessel and towed equipment (SETFIA, 2019).

Rock lobster pots are generally deployed in set locations for extended periods of time (or at least overnight) so depending on their deployment location, there is the potential for an interaction with the towed streamer and acoustic array. Those fishers which deploy fishing gear on the seabed may experience more displacement than the mobile trawlers and seine fishers. From discussions with the South Australian Rock Lobster Association (**SARLA**) it was estimated that in South Australia there are approximately 12,000 pots in the commercial rock lobster fishery; however, not all fishers will actively fish their pots, so it is likely to be much less than this number of pots in the water each year.

Within South Australia, the busiest fishing port is Port MacDonnell located approximately 8 km to the closest boundary of the Operational Area, where approximately 40 rock lobster boats fish from with an average pot holding of 80 pots. As a result, in the coastal marine area from Port MacDonnell to the northern boundary of South Australian waters there could be 6,000 pots in the water, each with two surface buoys. From engagement with SARLA, the main fishing season for the Southern Zone of South Australia is from 1 October to the end of May, although most of the fishing is concentrated from October to January. SETFIA (2019) confirmed that recent fishing effort (and therefore pots in the water) has occurred within the Operational Area from the South Australian (Southern Zone) rock lobster fishery.

The 2016/17 Stock Assessment for the Northern Zone and Southern Zone Rock Lobster Fishery (Linnane *et al*., 2018; 2018a) was assessed as part of the assessment process and development of this EP. For the Southern Zone, which is of direct relevance to the Otway Basin 2DMC MSS, over the last 12 fishing seasons, over 80% of the rock lobster catch has come from water depths less than 60 m. Of this catch, 52% came from water depths within the 31 – 60 m depth range. Only a very small proportion of the rock lobster catch in South Australia is taken in water depths greater than 90 m. Fishing effort by the Victorian rock lobster fishery in the Western Zone has also occurred within the Operational Area (SETFIA, 2019); however, an analysis of fished depths was not provided. This is also the case for the Tasmanian rock lobster fishery.

Discussions during engagement with SARLA revealed that the concentration of fishing effort in the shallows largely comes down to economics: where the cost of diesel means that fishing any further offshore becomes uneconomical. Subsequent to this engagement process and based on the importance of coastal waters for the lobster fishery, and SLB wanting to avoid the marine area where the highest density or rock lobster pots are likely to be, the Otway Basin 2DMC MSS Operational Area was reduced by approximately 25,000 km^2 to reduce the spatial overlap between the MSS and the rock lobster fishery.

The area of the Victorian giant crab fishery is the same as that of the rock lobster fishery; however, giant crab is targeted in deeper waters (i.e. 150 – 300 m water depth). As with rock lobster, giant crabs are caught using baited lobster pots.

The South Australian marine and scalefish fishery and the SHS and SGSHS sectors of the SESSF all deploy passive fishing gear into the water column in the form of either demersal long-lines or gill nets. Demersal long-lines are typically 1.5 – 5 km in length and consist of a mainline (with baited hooks attached) laid on the seabed with a marker buoy on the sea surface at each end of the line. Gillnets generally have the top horizontal rope of the net (float line) set 2 m above the seafloor, with marker buoys on the surface at each end of the net. These nets can be up to 6 km long, but are usually shorter (SETFIA, 2019).

The South Australian marine and scalefish fishery overlaps with the Operational Area towards the north-east corner. Less than 150 fishing days per year have been reported within the Operational Area since 1998, with fishing effort lowest in June – August (since 2007). Effort is relatively stable throughout the other seasons (SETFIA, 2019).

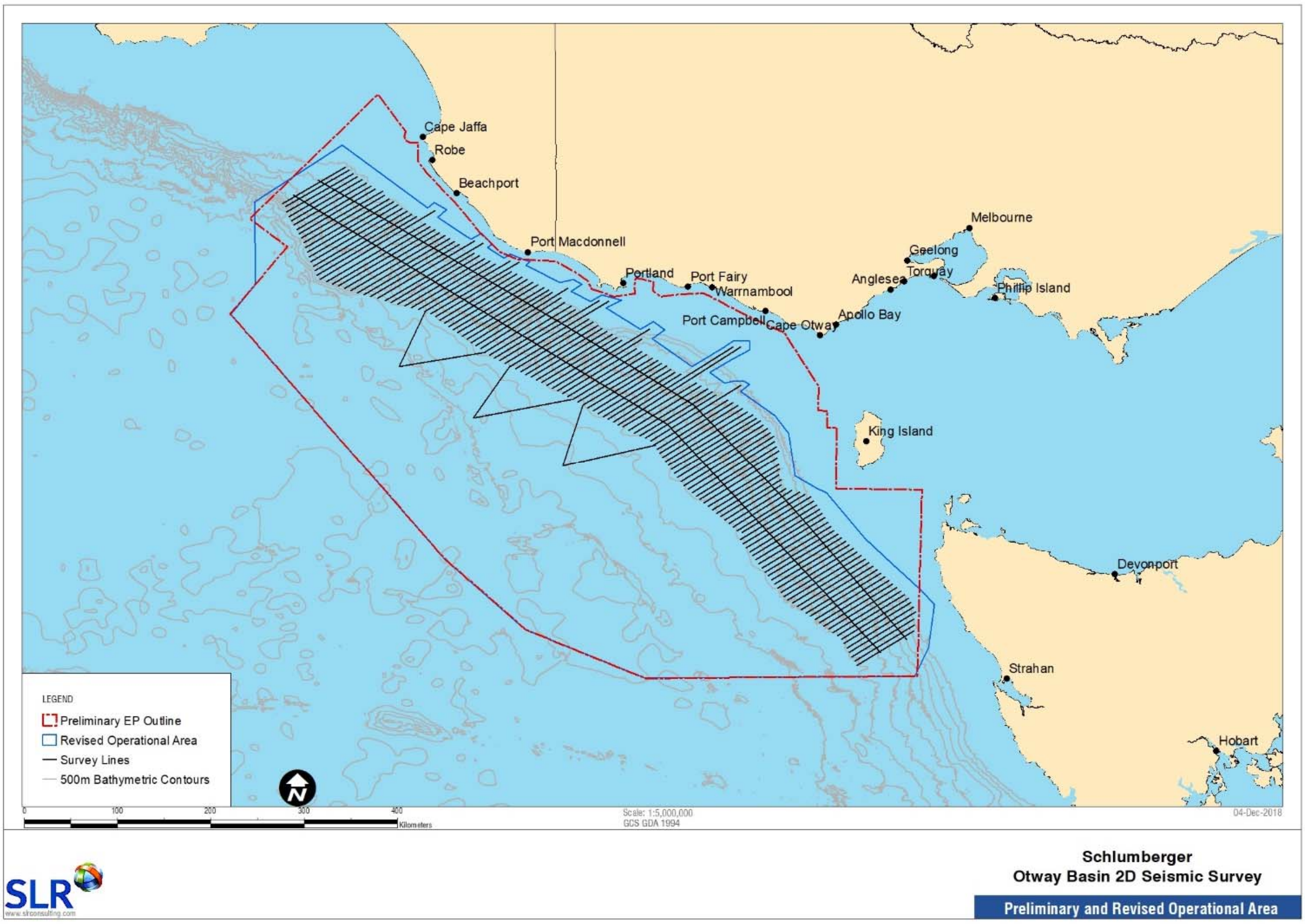
The SHS targets various species using a number of gear types including demersal long-lines. The majority of effort of this sector within the Operational Area takes place in March – April, and October – November, although February and November represent the months within which the highest catch rate occurred (data provided for 2008/09 – 2017/18) (SEFITA, 2019). Depth distribution of catch was not provided by SETFIA (2019).

The SGSHS deploys demersal gillnets and demersal long-lines, with nine to 15 vessels operating within the Operational Area in any one year (since 2008). Although this fishery overlaps with the Operational Area, it is restricted to waters shallower than 183 m, and overlap will only occur when SLB acquire the more northern tie-lines. Monthly effort of the SGSHS within the Operational Area is highest from April to June, and lowest in July to September (SETFIA, 2019).

The concerns raised from stakeholders were also taken in consideration with the sensitivities that had been identified in the area from the literature as part of the EP development (i.e. the Bonney Upwelling) and the stakeholder engagement feedback. As a result of these early discussions and to minimise conflict and disturbance, SLB moved the survey further offshore, where most of the survey lines (98.5%) were proposed for waters deeper than 200 m or beyond the shelf edge.

Figure 59 depicts the changes that were made to the Otway Basin 2DMC MSS Operational Area in September 2018 as a result of the initial stakeholder engagement process and the sensitivities identified in the area, in particular the reductions are noticeable in South Australia, Victoria and towards Bass Strait.

Figure 59 Preliminary and Current Otway Basin 2DMC MSS Operational Area

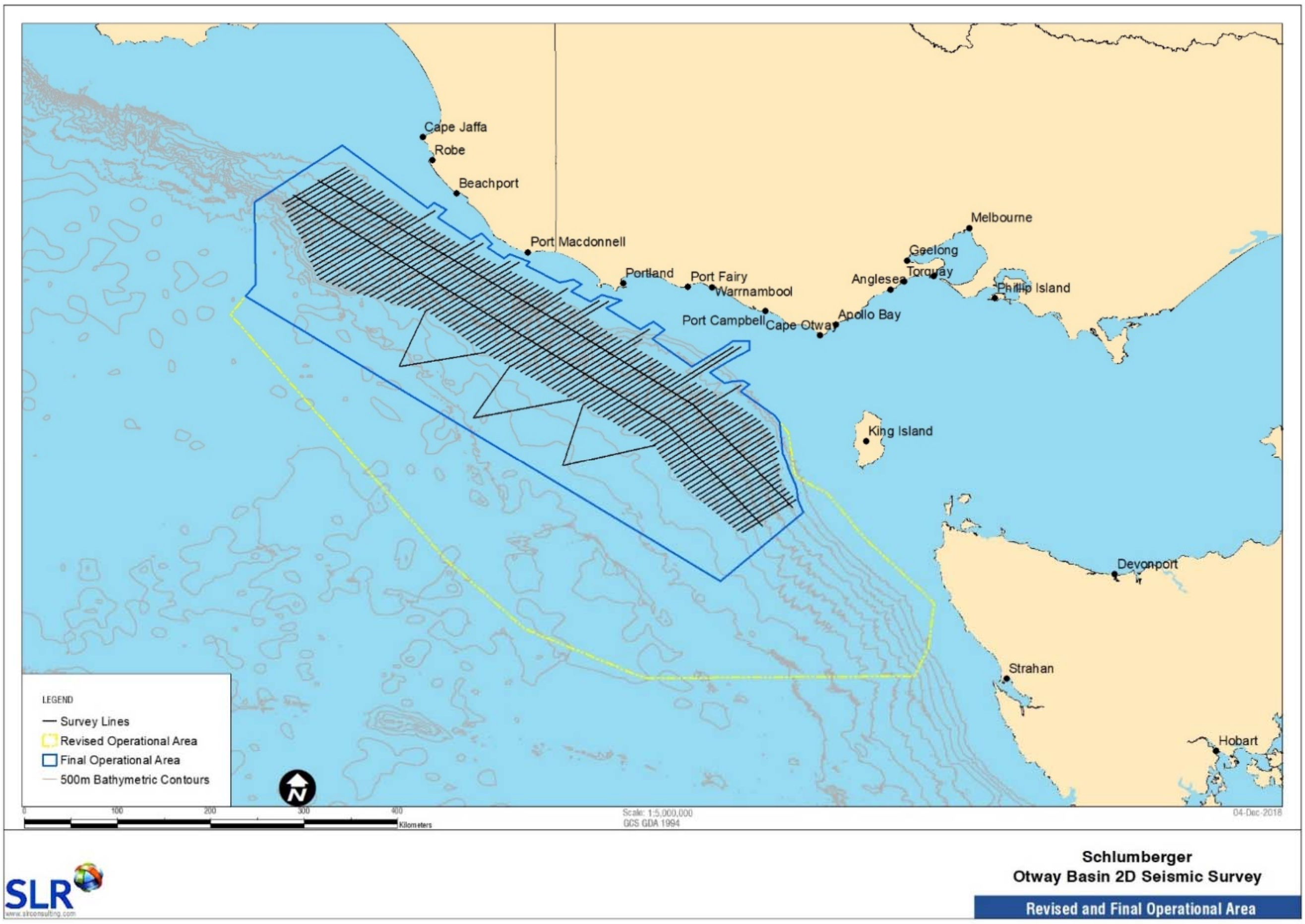


In December 2018, following the extensive planning, research and engagement process that had taken place for the development of the EP for the Otway Basin 2DMC MSS, SLB realised there were sensitivities and concerns over some of the proposed survey lines both environmentally and commercially. At that stage, SLB were also intending to lodge the EP with an acquisition target of Q1 2019 and reducing the size of the survey area would allow the survey to be acquired within the reduced weather window.

As a result, 2,700 lineal km of survey lines was removed from the southeast extent of the proposed programme and the Otway Basin 2DMC MSS Operational Area was further reduced by 73,000 km^2.

Figure 60 shows the reduction from the previous Operational Area (which had been reduced after the initial stakeholder engagement process and identification of sensitivities) and the latest version of the Operational Area. These changes two changes reduced the Operational Area by approximately 100,000 km^2 from what was initially proposed when SLB first commenced stakeholder engagement in August/September 2018 for the Otway Basin 2DMC MSS.

Figure 60 Previously Revised and Final (December 2018) Otway Basin 2DMC MSS Operational Area



To summarise, the revisions that SLB have made to the Otway Basin 2DMC MSS Operational Area and survey design following stakeholder engagement feedback and assessment of sensitivities in the area are:

- Shallowest water depth is 50 m;
- Approximately 100,000 km^2 reduction to the Operational Area;

- 95% of Operational Area is in water depths greater than 200 m;
- 89% of Operational Area in water depths greater than 1,000 m;
- 98 % of survey lines are in water depths greater than 200 m; and
- 91 % of survey lines are in water depths greater than 1,000 m.

The shallowest water depth within the Operational Area is 50 m, and acquisition into 50 m will only occur on a few of the tie lines. The tie lines (see **Figure 61**) are important to the overall project as they will link data from the deep survey lines to previously drilled wells in shallower shelf margins. It was explained to the stakeholders during the engagement process that there is some flexibility with regard to the timing of line acquisition; where SLB is able to work with fishers to minimise conflict as much as possible and provide as much notification as to when the tie lines are going to be acquired.

However, with the revised timing of the Otway Basin 2DMC MSS and the environmental sensitivities happening around that time (i.e. southern right whale breeding season, Bonney Upwelling, blue whale foraging), the available window for the tie line acquisition is confined to two different periods, which are dependent on the commencement of the survey. Following an extensive literature review and identification of the sensitivities, if the survey starts in October 2019, the tie lines will be acquired at the start of the survey (i.e. 15 October to 31 December 2019) or if this is not achievable, the tie lines will be acquired at the end of the survey (i.e. 1 March-30 April 2020). If the tie lines are acquired in 2019, this acquisition will coincide with the peak rock lobster activity, which takes place largely inshore of the Operational Area; however, the actual time the vessel will be present in the inshore waters to acquire the tie lines will be short, so communication with fishers and the 48 hour look aheads will serve to minimise conflict and disturbance. The ongoing engagement process captures this process and SLB are committed to continual engagement with all commercial fishers throughout the Otway Basin 2DMC MSS.

Pending regulatory approval, SLB intend to commence the Otway Basin 2DMC MSS in October 2019; however, this is also dependent on vessel availability. SLB are committed to continual engagement with the fishing industry and licence holders following submission of this EP, which will continue during the planning, mobilisation and acquisition of the MSS in accordance with the ongoing consultation strategy (**Section 4**) so that the fishers are kept fully informed of acquisition scheduling. In accordance with the ongoing consultation strategy, SLB will provide all of the commercial fishing associations and licence holders that request it, with '48-hour look-aheads' of the survey vessels predicted passage and this will be reissued every 24 hours to take into account any changes to the seismic acquisition plan. As part of the fisheries assessment agreement with SETFIA, SETFIA will also provide a SMS service with similar information contained within the 48-hour look-aheads. This will be distributed daily to the relevant fishermen who fish within or near the Operational Area, via their mobile phones to inform those fishers where the seismic vessel will be working. The SMS service will ensure that those fishers who don't have email access on their vessels or don't use email will be able to receive up to date information of where the seismic vessel will be in the next 48 hours. This then helps with planning for their fishing activities over the next few days.

Any obstruction in the water (i.e. surface buoys) is a potential risk to SLBs Otway Basin 2DMC MSS activities if entanglements occur with the propeller or acoustic array, and SLB will do everything possible to manage and mitigate that risk. Effective and early communication has proven the most effective way of reducing these risks to the overall activities to **ALARP** from all the seismic surveys SLB has conducted around the world. It is in SLBs best interest to keep away from areas where there are concentrations of fishing gear such as rock lobster pots, gill nets and long lines – hence moving the inshore boundary of the Operational Area further offshore.

With the ongoing stakeholder engagement and communication process that will be implemented for the duration of the Otway Basin 2DMC MSS, the intention is that commercial fishers will not deploy fishing gear that will remain on the seabed that will be in the path of the predicted vessel path for the next 48 hours, based on the 48-hour look-ahead provided. Being a 2D survey the swath or footprint of the vessel and towed array is relatively narrow compared to a 3D survey so the amount of disturbance to fishing gear in the water is not expected to be high.

However, not all of the inshore waters will be acquired during day light hours (i.e. pots may not be easily visible), and there could be some instances where rock lobster buoys are entangled in the seismic vessel or acoustic array. If this occurs, and licence holders can prove that they have pots missing that is attributable to the Otway Basin 2DMC MSS, SLB will, within reason, provide full replacement of that lost fishing gear. Although there are not expected to be too many survey lines that this would occur for given most will be acquired in deeper waters.

While the seismic vessel is acquiring data, it will be restricted in its ability to manoeuvre, which in most instances prevents active avoidance of fishers and fishing gear in the water. This is why advanced notification, notice to mariners and the presence of support vessels are so important. Out on the water once the survey is operational all vessels will be required to stay clear of the survey vessel and towed equipment until it has passed through. However, given the speed of the seismic vessel, fishers or other maritime users will only be displaced from a specific location for a period of just under 1.5 hours.

SLB are conducting a 2D MSS, where the acquisition plan has a line spacing of 5 km, so the area of displacement is not going to be regionally significant for a long period of time, and once the vessel has passed through that area it will not be back in that area unless an infill line is required, or if the tie line is scheduled for a different period in the acquisition plan.

Trawlers and seine fishers undertake a mobile method of fishing, and although their method of fishing has no fishing gear deployed on the seabed, they may experience some displacement from the Operational Area. However, this will be temporary in nature, with fishing being able to re-commence following the passing of the survey. Furthermore, fishing will be able to continue within the Operational Area in areas outside of the influence of the seismic vessel and towed equipment. The licence holders that actively fish in the Otway Basin 2DMC MSS Operational Area have been identified through the engagement process and continual engagement and notification (e.g. SMS and 48-hour look-ahead plans) will take place with these licence holders and their respective associations to ensure everyone is aware of where the vessel will be throughout the duration of the survey. Likewise, all methods of communication will be made available to the licence holders to contact the survey vessel and support vessel should they need to be in contact at any time.

The Otway Basin 2DMC MSS is primarily a deep-water survey, with acquisition occurring to maximum depths of 5,600 m. During the stakeholder engagement process, it was indicated that the majority of fishing effort occurs in waters shallower than 700-800 m, whilst SETFIA (2019) states that half of the proposed survey occurs in water depths that are too deep for commercial fishing; however as a conservative estimate the 1,000 m contour was used in the assessment of this EP as a guide for where most of the commercial fishing effort takes place inshore of. **Figure 61** highlights the 1,000 m bathymetry contour and confirms that most of the proposed seismic acquisition will occur in water depths greater than 1,000 m; hence the potential for conflict between commercial fishers and the Otway Basin 2DMC MSS is restricted primarily to the inshore coastal zone, and mostly during the acquisition of the tie lines. **Table 43** provides a summary of the different fisheries across the Otway Basin 2DMC MSS Operational Area and defines the species targeted, fishing methods, peak months for fishing and the depths fished when provided. This information presented in **Table 43** has been summarised from the SETFIA (2019) report and it also supports that most of the fishing activity takes place in water depths less than 700 m where a depth is provided (i.e. not reported or confidential).

Table 43 Summary of Fisheries Potentially Affected by the Otway Basin 2DMC MSS

Fishery/Sector		Main species caught in Operational Area	Methods Employed	Peak effort/catch in Operational Area	Depth Fished
South Australian Southern Zone Rock Lobster		Southern rock lobster	Lobster pot	Effort and Catch = October – January and sometimes through to March	40% taken in depths <30 m, and 80% taken shallower than 80 m
Victorian Western Zone Rock Lobster		Southern rock lobster	Lobster pot	Effort and Catch = peak in December or January	Coastal reefs <200 m
Tasmanian Rock Lobster		Southern rock lobster	Lobster pot	Effort and Catch = November – April, peaking in March	Most catch from 0 - 40 m depth, but some from <200 m
Small Pelagic Fishery		Not reported-confidential	Mid-water trawling	Not reported - confidential	Not reported - confidential
Southern and Eastern Scalefish and Shark Fishery	Commonwealth Trawl	Blue grenadier Silver warehou Gould's squid	Danish seine Otter trawl	Effort = January, April, May, October, November Catch = March - May	Danish Seine - <200 m Otter Trawl - < 700 m[1]
	Gillnet and Shark Hook	Gummy shark School shark Common sawshark	Gillnet Longline	Effort = April – June Catch = June	Restricted to waters <183 m
	Scalefish Hook	Blue-eye trevalla Pink ling Hapuku	Drop-line Longline Auto longline	Effort = March – April & October – November Catch = February and November	Restricted to waters <183 m
South Australian Marine Scalefish		Gummy shark Yellow-eye mullet Australian salmon	Longline Minor line Haul seine Mesh nets	Effort = Relatively stable throughout seasons Catch = Inconsistent over time	Not reported

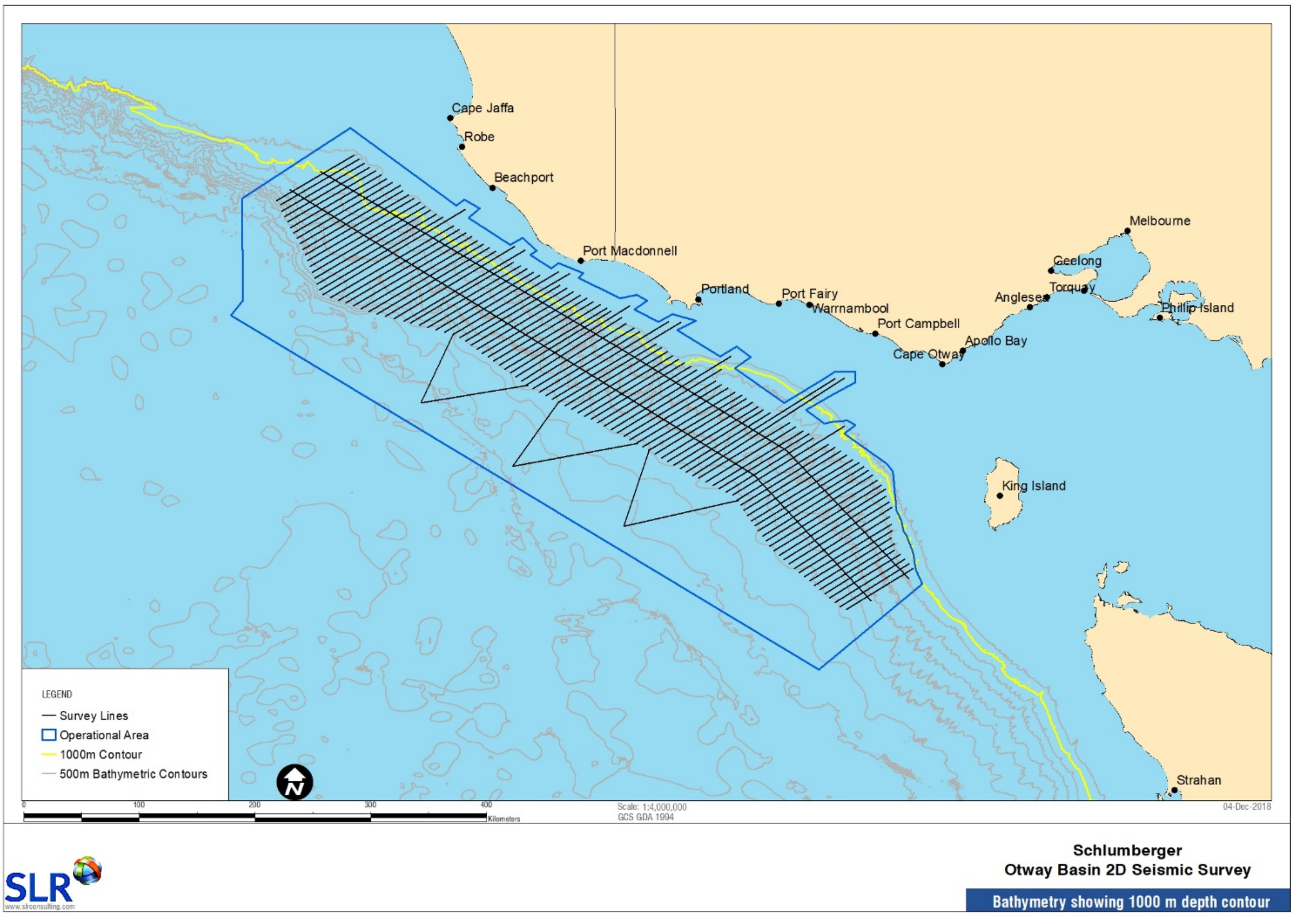
Fishery/Sector	Main species caught in Operational Area	Methods Employed	Peak effort/catch in Operational Area	Depth Fished
Tasmanian Scalefish	Striped trumpeter School shark Jack mackerel Australian salmon Gummy shark	Bottom longline Beach seine Crab pot Drop line Dip net Graball net Handline Lampara/Ring net Shark longline Trolling	Catch = November - April	Fished depths not reported, however, some fishing occurs in waters >110 m
Eastern Tuna and Billfish	Albacore Yellowfin tuna Swordfish Bigeye tuna Striped marlin	Mainly pelagic longline	Not reported - confidential	Not reported - confidential
Western Tuna and Billfish	Albacore Yellowfin tuna Swordfish Bigeye tuna Striped marlin	Mainly pelagic longline	Not reported - confidential	Not reported - confidential
Southern Bluefin Tuna	Southern bluefin tuna	Pelagic longline	Not reported - confidential	Not reported - confidential
Southern Squid Jig	Gould's squid	Squid jig	Effort and Catch = January – June[2]	Not reported - confidential
South Australian Southern Zone Giant Crab	Giant crab	Lobster pot	Not reported - confidential	Not reported - confidential
Victorian Western Zone Giant Crab	Giant crab	Lobster pot	Not reported - confidential	150 – 300 m[3]

Fishery/Sector	Main species caught in Operational Area	Methods Employed	Peak effort/catch in Operational Area	Depth Fished
South Australian Southern Zone Abalone	Blacklip abalone Greenlip abalone	Hand harvest/diving	Effort and Catch = November – December and March - June	Abalone diving restricted to depths ≤30 m
Victorian Ocean General	Gummy shark Snapper King George whiting	Longline Handline	Not reported - confidential	Not reported - confidential
Victorian Wrasse (Ocean)	Bluethroat wrasse Purple wrasse	Not reported	Not reported - confidential	Not reported - confidential
South Australian Charter Boat	Not reported	Not reported	Effort = January and February	Not reported - confidential

Source: SETFIA, 2019

1. Water depth of less than approximately 700 m is based on the exclusion of trawlers from operating in waters within the Deepwater Trawl Closure. This closure aims to be at the 700 m depth isobath, but depth varies significantly in reality. This closure was implemented to protect orange roughy stocks.
2. Based on seasonality of whole Southern squid jig fishery. Seasonality within Operational Area was not able to be reported due to confidentiality.
3. Based on depth across whole Victorian giant crab fishery. Water depths fished within Operational Area were not able to be reported due to confidentiality.

Figure 61 Otway Basin 2DMC MSS Survey Lines and 1,000 m Bathymetry Contours



Aquaculture operations occur outside of the Operational Area and will not be affected by the survey vessels and towed equipment during the Otway Basin 2DMC MSS.

Ongoing consultation with commercial fishing groups will identify potential conflicts and provides opportunity to reduce effects to **ALARP** (see **Section 4** and **Appendix F** for further details on the engagement process).

SLB will provide early notification of the acquisition plan to all stakeholders. As discussed above, these notifications will be ongoing throughout the programme and will be provided every 24 hours. The distribution of these 48-hour look-aheads have worked well in a number of places around the world where SLB operate and have been found to minimise conflict and enable operators to plan their fishing activities more effectively and minimise disruption to their operations. Feedback from fishing stakeholders is that having such detailed information in advance is a clear help in their planning for the next 24 – 48 hours of fishing. It is also envisaged that the same would apply to those fishers in the Otway Basin that also fish within the Otway Basin 2DMC MSS Operational Area.

Throughout the engagement process it was relayed to all stakeholders that there was some flexibility in the survey plan given it covers a large geographic region. Best endeavours will be made by SLB to minimise conflict by working with the commercial fishers in particular on the finalisation of the acquisition plan and adjustment of the survey lines to avoid highly fished areas. Examples were given to stakeholders that this could include the removal of part or all of a line in the survey plan if there was a very good reason, or whether some of the lines should only be surveyed at a certain time of the survey period (i.e. at the start or end of the programme).

As part of SLBs pre-activity notification procedures for the Otway Basin 2DMC MSS a notification schedule will be developed which will include all relevant stakeholders, authorities, and government and state departments. One of the primary notification documents which will reach a wide audience to those maritime users will be the Notice to Mariners; whilst the more focused 48-hour look-aheads will be specifically focused on those groups which SLB have engaged with and have been identified as having an interest within the Otway Basin 2DMC MSS Operational Area.

For the duration of the Otway Basin 2DMC MSS, the survey vessels will comply with the Navigation Act 2012, the COLREGS and UNCLOS. One of the roles of the support vessel will be to assist in informing any vessels that are in the path of the approaching survey vessel that cannot be reached or do not respond to radio communications or signals.

Operational procedures and mitigation measures will be implemented prior to and during the Otway Basin 2DMC MSS to prevent a collision from occurring and to ensure the safety of both personnel and the marine environment. These procedures and measures include AIS, navigation lights, radar, radio contact, and the presence of any warnings by support vessels, etc. (**Table 44**).

Given the seismic vessel during the Otway Basin 2DMC MSS will be continually moving at a speed of 4 – 5 knots throughout the Operational Area at line spacing of 5 km, the impact to fishing activities through displacement from the physical presence of the survey vessels and towed equipment will be transitory in nature. As stated above, SLB removed 100,000 km^2 of the original Operational Area from the shallower waters based on stakeholder feedback as a way of trying to minimise conflict and disturbance. The risk to commercial fishing operations (i.e. displacement) due to the physical presence of the survey vessels and towed equipment during the Otway Basin 2DMC MSS has been assessed as **Moderate** (*Moderate* x *Likely*).

7.1.3.2 Potential Impacts to Commercial Shipping

A high level of commercial maritime traffic is evident in the vicinity of the Operational Area (**Figure 54**), with commercial vessels transiting between major ports in Western Australia, South Australia and Victoria, and/or servicing secondary ports such as Portland (Victoria). Most commercial vessels transiting between South Australia and Victorian ports move within approximately 30 km of the coast, transiting the northern part of the Operational Area. Vessels moving between Western Australia and Victoria transit along a well-defined route that passes directly through the Operational Area, between approximately 38°S and 39°S (**Figure 54**). Commercial vessel traffic reduces with increasing distance from shore.

The presence of the seismic vessel and towed streamer in the Otway Basin 2DMC MSS Operational Area presents a potential navigational hazard to commercial vessels transiting through the area due to the streamer (up to 11 km) being towed behind the seismic vessel, restricting its ability to manoeuvre. However, all commercial maritime vessels transiting through the area will be aware of the survey and any minor deviations that a ship may have to take in its course are unlikely to add significant time delays or cost to commercial shipping companies and would be conducted without compromising navigational safety following the rules of the road at sea and in accordance with the COLREGS.

Pre-activity notification procedures for the Otway Basin 2DMC MSS will facilitate the issuing of maritime warnings and a Notice to Mariners, which will be effective for the duration of the Otway Basin 2DMC MSS. These notifications enable commercial vessel masters to be aware of potential hazards in the area in which they are transiting and to safely plan their courses to avoid possible interference with those hazards such as the Otway Basin 2DMC MSS. The Vessel Masters of the survey vessels will maintain radio contact with all commercial vessels in the immediate vicinity of the area being surveyed within the Operational Area that are detected on radar to ensure they are aware that they are a seismic vessel engaged in seismic activities (and therefore limited in their ability to manoeuvre).

The survey vessels will comply with the Navigation Act 2012, COLREGS and UNCLOS including the display of appropriate day shapes and lighting for vessels restricted in their ability to manoeuvre, maintenance of radio contact between survey vessels and other marine users, and continuous maintenance of a look-out by sight, radar, and AIS (**Table 44**). The presence of a support vessel for the entirety of the survey will also assist with informing any other vessels in the path of the approaching seismic vessel that cannot be raised on radio or by any other means. The end of the streamer has a tail buoy which provides 24 hour visual and radar recognition so that marine users can locate the end of the streamer at all times. It would only be under a worst-case scenario that if all systems failed and every operational procedure and mitigation measure (i.e. AIS, navigation lights, warnings by support vessel, radio contact, etc.) was ignored that there was potential for a collision to occur. Such an unplanned event like a collision at sea is further discussed in **Section 8.3**.

With the presence of the seismic vessel in the offshore marine environment for up to three months, there is the potential that the Otway Basin 2DMC MSS could displace commercial vessels transiting through the area causing them to alter their planned course. However, given the seismic vessel will be continually moving the actual zone of displacement that would influence commercial shipping is likely to be transitory in nature. Therefore, the risk to commercial shipping operations due to the physical presence of the survey vessels and towed equipment during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.1.3.3 Potential Impacts to Oil and Gas Activities

The NOPSEMA 'Activity Status and Summaries' database was searched as part of the preparation of this EP in order to identify if there is the potential that any other MSSs may be operating concurrently with the Otway Basin 2DMC MSS. At the time of preparing this EP, no other MSS has been approved for the Otway Basin; however, two EPs have been approved in the neighbouring Gippsland and South Australia basins.

CGG Services (Australia) Pty Limited (**CGG**) submitted an EP to NOPSEMA for a 3D MSS in the Gippsland Basin offshore Victoria in September 2018. The Operational Area of CGG is located 400 km away from the Otway Basin 2DMC MSS Operational Area; however, it was considered as part of the assessment of this EP for completeness. After re-submitting the EP in December 2018, and providing further information in January 2019, the CGG EP was subsequently accepted on 25 February 2019 and has an operating window of between March 2019 and July 2020.

PGS Australia Pty Limited (**PGS**) submitted an EP to NOPSEMA for a 3D and 2D MSS in the Great Australian Bight in February 2017. The Operational Area of PGS is a significant distance (300 km) away from the Otway Basin 2DMC MSS Operational Area; however, it has been considered as part of this assessment for completeness. After a number of EP resubmissions and submission of further information, NOPSEMA accepted the EP on 14 January 2019. The PGS EP is proposed to be undertaken between September and November 2019 and 2020; which may result in a temporal overlap with SLBs proposed Otway Basin 2DMC MSS.

Spectrum Geo Australia Pty Ltd has submitted an EP to NOPSEMA to conduct a 3D MSS in the Commonwealth waters of the Otway Basin; subsequently called the 'Otway Deep MSS'. This application for the Otway Deep MSS was proposed to run from October 2018 to February 2020 where there was potential to have an overlap with the SLB Otway Basin 2DMC MSS, both temporally and spatially. However, NOPSEMA provided an opportunity to modify and resubmit the EP as they were not reasonably satisfied that the EP met the acceptance criteria set out in the regulations.

3D Oil Limited has recently submitted an EP to NOPSEMA to conduct a 3D MSS in the Commonwealth waters of the Otway Basin, 18 km west of King Island (Tasmania), known as the 'Dorrigo 3D MSS'. This application has been proposed to occur for 35 days between 1 September and 31 October 2019 and is located in close proximity to the eastern boundary of the Otway Basin 2DMC MSS Operational Area. Therefore, there is a potential for an overlap with SLBs proposed EP, both temporally and spatially. However, NOPSEMA has requested further information on 28 February 2019; the result of which is unclear at the time of drafting this EP.

The outcome of the resubmission of EP and submission of further information of the above EPs is unknown; however, this assessment and the measures that will be implemented throughout the Otway Basin 2DMC MSS have been based on the chance that there could be more than one survey operating concurrently in the wider general area (i.e. Otway Basin, Gippsland Basin and Great Australian Bight).

There will be many operational procedures and mitigation measures implemented for the duration of the Otway Basin 2DMC MSS that will minimise the potential for any physical interactions between two MSSs operating concurrently (i.e. entanglement of towed equipment and vessel collision). One of the main measures that will be implemented is a separation distance that will be put in place between two active sources operating concurrently, where the Otway Basin 2DMC MSS will not operate within 40 km of another active MSS.

The potential for cumulative noise effects if more than one MSS occurs in a similar area are further assessed in **Section 9**.

Fixed installations associated with the Otway Basin gas fields (**Figure 55**), have mandatory 500 m PSZs. The line plan of the Otway Basin 2DMC MSS has been designed to avoid any possible overlap with such zones and access agreements are required to enter into any operator's permits. There are a number of tie lines proposed as part of the Otway Basin 2DMC MSS as can be seen from the single lines running into the shallower waters along the inshore edge of the Operational Area. The purpose of these tie lines is to correlate known logged data from down the well bore at these previously drilled wells with contemporary data collected during the Otway Basin 2DMC MSS. These tie lines are the shallowest parts of the survey area and have the greatest potential for impacts with the marine environment and stakeholders. For the survey timing, it is considered out of all of the environmental sensitivities that are present, there are two operational windows that provide the best time to acquire these tie lines to have the least amount of disturbance. The tie lines are proposed to be acquired either at the start of the survey (i.e. 15 October-31 December 2019), or the tie lines will be acquired at the end of the survey (i.e. 1 March-30 April 2020), and additional control measures will be implemented whilst these tie lines are being acquired (**Section 7.2.5**).

Support vessels associated with existing offshore developments mainly operate north of the offshore fields, moving between the coast and offshore facilities. Due to the restricted manoeuvrability of the seismic vessel while towing equipment and presence of the PSZs, the seismic vessel will not transit between gas platforms unless all health and safety requirements such as permits to enter the PSZs have been obtained from the installation managers.

Six petroleum exploration permits have been issued for the Otway Basin (see **Section 5.5.4**). Lattice Energy Limited is planning offshore drilling of up to seven wells during 2018/2019; however, all of the exploration permits are located inshore of the Otway Basin 2DMC MSS Operational Area. Consultation was undertaken with the permit holders in the areas surrounding the Operational Area and no issues were raised by the operators with regard to the Otway Basin 2DMC MSS.

There are no gas installations within the Otway Basin 2DMC MSS Operational Area. In addition, the gas facilities surrounding the Operational Area all have PSZs and other controls in place. As a result, the risk to gas installations from the presence of the survey vessels and towed equipment during the Otway Basin 2DMC MSS has been assessed as **Low** (*Severe* x *Remote*).

7.1.3.4 Potential Impacts to Tourism and Recreation

As discussed in **Section 5.5.5**, the coastal marine areas inshore of the Otway Basin 2DMC MSS Operational Area provide various opportunities for marine tourism and recreational activities such as boating, diving, surfing, and fishing. Given the water depth within the Otway Basin 2DMC MSS Operational Area (>96% in waters deeper than 200 m) it does not provide many opportunities for these activities, due to distance offshore, and exposed and changeable sea and weather conditions. Despite these limitations, some recreational and tourism activities may still occur within the Operational Area, where the Otway Basin 2DMC MSS has the potential to displace marine users from their preferred areas of activity. With the MSS being a 2D MSS the line plan has a line spacing of 5 km, so the actual disturbance to an area will be minimal in terms of physical footprint from the seismic vessel and streamer. Likewise, the vessel will be constantly moving at 4 – 5 knots, so using the more conservative speed of 4 knots (7.4 km/hr) it is estimated it will take just under 1.5 hours for the seismic vessel, the streamer and tail buoy to pass a particular location. Therefore, the temporal and spatial exclusion from any particular location within the Otway Basin 2DMC MSS Operational Area is not considered significant, and given the line plan, the seismic vessel will not be back in that area again, with the next survey line being 5 km away.

The scheduling of the Otway Basin 2DMC MSS overlaps with recreational open seasons for diving for abalone and rock lobster. The presence of the seismic vessel will not displace recreational divers from their dive sites as the Operational Area is located well beyond recreationally diveable depths.

The scheduling of the Otway Basin 2DMC MSS also overlaps with the recreational open season for squid, striped trumpeter, prawns and banded morwong. These species are caught by fishers operating off boats; however, due to the distance offshore of the Operational Area, the seismic survey will not displace these fisheries.

As the Otway Basin 2DMC MSS Operational Area is located 50 km west of King Island and Tasmania, there will be no conflict with the Melbourne to King Island or the Melbourne to Devonport Ocean Yacht Races.

The Melbourne to Hobart (Westcoaster) yacht race tracks down the west coast of Tasmania and has the potential to overlap (both temporally and spatially) with the Otway Basin 2DMC MSS. The race occurs over two days in late December, and with the revised Operational Area being 50 km west of King Island at its closest point to the Tasmanian coastline, it is likely that there will be no conflict given the revision to the Operational Area has resulted in a number of the original survey lines moving further away from the Tasmanian coastline.

Recreational boating activities peak during the summer months, and this increase in activity is likely to occur inshore of the Otway Basin 2DMC MSS Operational Area. Recreational boaties and tourism operators tend to utilise waters surrounding the major ports and settlements along the coastline, such as the sheltered waters of Port Phillip Bay (Victoria) and the relatively inshore waters of the Spencer Gulf and Gulf of St Vincent in South Australia. The Otway Basin 2DMC MSS is proposed to commence during summer months so it is likely there will be a large number of recreational and charter boats out on the water; however, most of these boats are likely to be well inshore of Otway Basin 2DMC MSS Operational Area.

As part of the engagement process all of the recreational fishing representative bodies were contacted, as were the dive and fishing charter operators. Details of the engagement process are provided in **Section 4** and **Appendix F**.

The same measures with regard to the mitigation of risks with the commercial fishing industry and commercial shipping will be in place for the recreational users and tourism operators (i.e. notifications, 5 km line spacing, presence of support vessel, continuous movement of seismic vessel, notification to mariners, 48-hour look-ahead plans, etc.). However, in most cases, the recreational users will have much smaller vessels so are less likely to venture as far offshore where they could come into conflict with the seismic vessel.

Due to the transitory nature of the Otway Basin 2DMC MSS and the 5 km line spacing, tourist operators and recreational users utilising the more offshore waters of the Operational Area will be able to plan activities to avoid overlapping with seismic operations and minimising conflict. The survey vessels will display internationally accepted day shapes and lights and will be in radio contact with all marine users. Details of the navigation hazards associated with the Otway Basin 2DMC MSS will be broadcast daily in a Notice to Mariners, and a 48-hour look-ahead plan will be provided to stakeholders, when requested, every 24 hours. A support vessel will also be present around the survey vessel at all times and will ensure that any marine users in the path of the seismic vessel are informed of the approaching survey vessel if they cannot be reached by radio or other means.

The Otway Basin 2DMC MSS Operational Area is outside the main area where recreational and tourism activities occur in this area. However, where there is overlap there is the potential for these marine users to be displaced from their activities for a short period of time, so as a result the risk to recreational activities and tourism operators from the physical presence of the seismic vessel and streamer has been assessed as **Low** (*Minor* x *Possible*).

7.1.4 Control Measures

Control/mitigation measures that will be implemented during the Otway Basin 2DMC MSS to manage the impacts associated with the physical presence of the seismic vessel and towed equipment have been listed in **Table 44**. The listed control measures that will be adopted are those that have been assessed and it was considered that the sacrifice (in terms of time, cost and/or effort) was not grossly disproportionate to the environmental benefits gained.

Table 44 Assessment of Control Measures for the Physical Presence of Survey Vessels and Towed Equipment

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
24/7 acquisition	P = Yes E = Effective	Where possible, data acquisition will occur 24/7 in order to minimise the total duration of the Otway Basin 2DMC MSS.	Yes	Yes
24-hour bridge and radar watch by qualified watch-keepers to monitor for other marine users	P = Yes E = Effective	The Otway Basin 2DMC MSS will adopt standard flag and class practices for watch-keeping and radio use to ensure that warnings and preventative actions can be readily implemented. This will notify relevant persons of the presence of the seismic vessel and equipment. Watch-keepers will have the relevant qualifications for the task. This practise is compliant with STCW Convention.	Yes	Yes
Compliance with relevant legislation and conventions with regard to maritime safety	P = Yes E = Effective	Vessel Masters will operate vessels in a manner that is consistent with national and international legislation and conventions. These include: The Navigation Act 2012; The COLREGS; UNCLOS; and The STCW Convention.	Yes	Yes
Support vessel present around the survey vessel at all times	P = Yes E = Effective	A support vessel will be present around the seismic vessel at all times to intercept other vessels in the area that are at risk of interacting with the seismic vessel and/or equipment. This is a health and safety requirement and is standard practice for all seismic surveys.	Yes	Yes

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Lights and visual communication at sea	P = Yes E = Effective	The vessels will use standard international safety procedures for radio communication and the display of navigational lights and day shapes including the use of Automatic Radar Plotting Aids (**ARPA**) and AIS. AIS sends and receives ship information including identity, position, course, and speed, and updates as often as every two seconds. The seismic vessel will display day shapes and lights to indicate that the vessel is towing equipment and is restricted in its ability to manoeuvre. Tail buoys will be fitted with a light and radar reflector indicating the end of the streamer.	Yes	Yes
Markings on tail buoy	P = Yes E = Effective	Under COLREGS and the Navigation Act, all possible measures need to be taken to indicate the presence of a towed object. Tail buoy indicates the end of the towed streamer and will be fitted with markings to indicate the presence/location. Markings will include reflective tape, lights, and radar reflector.	Yes	Yes
Avoidance of Exclusion Zones of other marine users	P = Yes E= Effective	Oil and gas installations have established PSZ prohibiting any vessel approaching closer than 500 m without prior approval/provision of a permit. These are established under the OPGGS Act.	Yes	Yes
Temporal and spatial exclusion zones to avoid sensitive areas for marine mammals	P = Yes E= Effective	Potential impacts from the overlap between critical habitat use for marine mammals and the acquisition of tie lines in shallow inshore waters will be minimised by temporally restricting the acquisition window. The tie lines will be acquired either at the start of the survey (i.e. 15 October-31 December 2019), or at the end of the survey (i.e. 1 March-30 April 2020). These periods have been selected to avoid the peak blue whale feeding period and the southern right whale breeding season.	Yes	Yes

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Stakeholder engagement	P = Yes E = Effective	Pre-survey stakeholder engagement allows stakeholder objections, claims, or expectations to be heard and understood and incorporated into the development of the EP (NOPSEMA, 2018). Early identification of issues allows mitigation measures to be developed to reduce the risk to **ALARP** and an **Acceptable Level**. Pre-survey engagement with identified stakeholders is a requirement of the OPGGS Act. Throughout the development of this EP, stakeholder engagement was undertaken using email, phone contact, industry body representatives (i.e. SIV & TSIC) as well as face-to-face meetings. The engagement leading up to the survey and whilst the survey is being acquired will allow for operational changes such as what was discussed with fishers during the initial engagement meetings around flexibility in the survey plan and working with the fishers to minimise conflict, where possible.	Yes	Yes
Ongoing communication with marine users such as through provision of a '48-hour look-ahead' plan, publication of a Notice to Mariners, and daily SMS service to targeted licence holders identified who fish in the Operational Area	P = Yes E = Effective	Communication with marine users allows those potentially affected by the Otway Basin 2DMC MSS to plan activities in a manner that reduces the risk of interactions with the seismic vessel and towed equipment (e.g. commercial fishers can avoid deploying gear in the path of the seismic vessel). Provision of a 'look-ahead' plan allows commercial marine users (e.g. commercial fishers or commercial shipping) to understand the future movements of the seismic vessel and plan accordingly to avoid interactions. Under the Navigation Act 2012, Australian Hydrographic Office (**AHO**) can publish and distribute a Notice to Mariners. This Notice outlines potential hazards and restrictions to marine users. An agreement has been put in place between SLB and SETFIA to have SETFIA manage a SMS system to alert targeted fishers who fish in and around the Operational Area.	Yes	Yes

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Reporting of incidents or near misses between the seismic vessel and other marine users	P = Yes E = Effective	An incident or near miss includes any situation where another vessel intentionally does not respond to warnings threatening the safety of the seismic vessels and where remedial action by the support vessel or avoidance measures by the seismic vessel is required. Standard warnings such as radio communication between vessels are not considered an incident or near miss.	No	Yes
Spatial separation between concurrent seismic surveys	P = Yes E = Effective	Spatially separating concurrent seismic surveys reduces the potential for cumulative noise impacts and also provides a buffer between vessels and equipment so that entanglement of towed equipment or vessel collision is avoided. SLB will implement a 40 km spatial separation between its survey vessel and any other operating seismic vessel in the area.	Yes	Yes
Installation of 'turtle guards' on streamer tail buoy	P = Yes E = Effective	Almost all reported turtle entrapments during seismic surveys are associated with the 'undercarriage' of tail buoys (Ketos Ecology, 2009). 'Turtle guards' are fitted to the front of tail buoys and act to physically exclude turtles from the gap at the front of the tail buoy undercarriage. SLB will ensure that the tail buoy used for the Otway Basin 2DMC MSS has a turtle guard fitted.	Yes	Yes
Acquisition of southeast section of Otway Basin 2DMC MSS Operational Area (i.e. south of Port Fairy) outside of November-December to avoid the humpback whale southern migration.	P = Yes E = Effective	The survey line acquisition schedule will aim to acquire the southeast section of the Operational Area (i.e. to the east of a line due south of Port Campbell) outside of November-December to reduce the potential for collision or displacement of humpback whales by the survey vessel. However, if this is not possible operationally, and the survey has to operate in this region during this time, then an additional MMO will be placed onboard the support vessel for additional observer coverage during November and December.	Yes	Yes

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Recording of marine fauna ship strike and entanglement incidents	P = Yes E = Effective	While recording of any ship strike incidents does not reduce likelihood of an incident occurring, it is a requirement of the EPBC Act and Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009. SLB will have two dedicated MMOs onboard for the duration of the Otway Basin 2DMC MSS and any incidents that occur between the survey vessel and all fauna, including marine mammals and marine turtles will be recorded.	No	Yes
Vessel crew are briefed on marine fauna entanglement and collision risk and reporting requirements	P = Yes E = Effective	All vessel crew will be required to remain vigilant for marine fauna collision and entanglement incidents. SLB will also have two dedicated MMOs onboard for the duration of the Otway Basin 2DMC MSS who will also be on the lookout for any entanglements or risks of collisions.	No	Yes
Vessel master of the support vessel will reduce speed and maintain minimum distances through a 'caution zone' in the presence of cetaceans	P = Yes E = Effective	The support vessel will comply with the EPBC Regulations 2000 Part 8, Division 8.1 in order to reduce the risk of disturbing cetaceans (adult and calf) and avoiding collisions between a cetacean and the support vessel.	Yes	Yes
Towed equipment will be retrieved when the seismic vessel is in transit (e.g. to and from port)	P = Yes E =Effective	Retrieval of towed equipment will reduce the potential for more coastal species interacting with the towed equipment whilst in transit.	Yes	Yes
Acquisition of shallow tie lines will only occur during daylight hours	P = Yes E = Effective	This measure will reduce the potential for interactions with static fishing gear and marine mammals	Yes	Yes
Compensation to fishers for loss or damage to fishing gear that is proven to have occurred as a result of direct impact from the seismic vessel, acoustic array or streamer configuration.	P = Yes E = Effective	This offer of compensation addresses fishing industry concerns that were raised during the stakeholder engagement process about the number of rock lobster pots that could be left in the water.	Yes	Yes

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Restriction on acquisition within Operational Area to water depths greater than 50 m	P = Yes E = Effective	Reducing the Operational Area to exclude water depths less than 50 m was implemented based on stakeholder feedback to minimise potential conflict with certain commercial fisheries (i.e. rock lobster) and recreational activities. While 98% of survey lines occur in water depths greater than 200 m, some tie-lines will come into 50 m. The acquisition of tie-lines into the shallower water will take place either at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey if it is delayed (i.e. 1 March-30 April 2020), which from the extensive literature reviews has been determined to be the periods that these tie lines that will have the least amount of disturbance within the survey period. Additional tie line mitigation measures will be implemented during the acquisition of the tie lines (see **Table 62**). This approach will minimise conflict based on consultation with stakeholders and extensive review of literature on the sensitive marine environments in terms of timing for breeding, feeding and spawning seasons etc.	Yes	Yes
Alternative Control Measures:				
Seismic acquisition will only occur outside of fishing seasons.	P = No E = Effective	As commercial fishing activities occur year-round, SLB are unable to operate outside of all fishing seasons. However, due to the planned timing of the survey, there will be limited temporal overlap with some fisheries.	Yes	Partially
All seismic acquisition will only occur during daylight hours	P = No E: Effective	24/7 operations will occur to minimise the duration of the survey. Acquisition of tie lines will only occur during daylight hours on account of the higher numbers of other marine users and potential for marine mammal sightings along these lines. Limiting all acquisition to daylight hours only extends the duration of the survey. Cost of additional time outweighs the benefit of restricting the entire Otway Basin 2DMC MSS to daytime operations.	Yes	Partially

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Daily contact with marine users to update on survey plans	P = No E = Effective	It would not be possible to contact all marine users on a daily basis, particularly recreational users. If requested, marine users will be notified every 24 hours with the 48-hour look-ahead of vessel movements, a Notice to Mariners will be in place throughout the duration of the survey, and the survey vessels will be contactable on marine radio. As part of the engagement process with the licence holders, those licence holders who were identified as fishing in the Operational Area will be sent an SMS with any update such as a modified look-ahead plan that is suitable for receiving on a mobile phone.	Yes	Partially
Reduction in the length of the towed equipment	P = No E = Limited	The streamer length for the Otway Basin 2DMC MSS is up to 11 km. The acoustic equipment (including streamer length) has been designed to meet the survey objectives and guarantee data quality. With a reduced footprint, the number of survey lines may need to increase in order to obtain data of an acceptable quality. Reducing the length of the towed equipment will reduce the footprint of the seismic survey; however, as the vessel and towed equipment are continuously moving, the benefit to marine users would be minimal and costs would be disproportionate to any benefit gained.	Limited	No
Increase of acquisition line spacing	P = No E = Limited	Although increasing line spacing would reduce the spatial overlap of survey lines with fishing grounds, as well as the overall duration of the MSS, survey objectives would not be met on account of reduced data coverage. Costs would be disproportionate to the benefit that may be gained.	Limited reduction	No
Vessel master of the **seismic vessel** will take evasive action to avoid marine fauna and other users	P = No E = Ineffective	The seismic vessel has limited ability to manoeuvre. It is unlikely any attempt to avoid a collision will have the desired result. The seismic vessel will instead maintain a constant speed and will not deviate from survey lines with the exception of line turns.	Limited	No

Control measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Removal of towed equipment when not in use	P = No E = Limited	Removal of towed equipment when not in use (i.e. during line turns) would temporarily remove the likelihood of an entanglement but is not practical, would increase the overall duration of the survey, and would increase potential for health and safety risks to vessel crew. Costs would be disproportionate to the benefit that may be gained.	No	No
Removal of support vessel	P = No E = Limited	Support vessels are required to avoid interactions with other marine users (i.e. other vessels) as a health and safety requirement. Increased risks associated with the removal of the support vessel are disproportionately higher than the benefit of removing a vessel.	No	No
Avoidance of all commercial shipping routes	P = No E = Limited	Major commercial shipping routes generally based on a direct line from major ports and overlap with the Operational Area. Avoiding these routes would mean that the Otway Basin 2DMC MSS would not meet survey objectives. Mitigation measures such as the use of AIS and radar on the survey vessels, broadcasting of Notices to Mariners, and radio contact with survey vessels will reduce the likelihood of any interactions with commercial vessels. Commercial vessels are able to plot courses and manoeuvre themselves to avoid the survey vessels without compromising their overall transit times. Costs would be disproportionate to the benefit that may be gained.	Limited	No
Use of alternative geological imaging technology that does not require towed equipment	P = No E = Unknown Effectiveness	Alternative technologies are not yet commercially available or have not been proven or demonstrated the ability to meet geophysical data quality objectives, operational safety, and reliability requirements (IOGP, 2017). Costs would be disproportionate to the benefit that may be gained.	Unknown	No

7.1.5 Environmental Performance

The environmental performance outcomes for the management of environmental impacts from the physical presence of the survey vessels and towed equipment are:

- No unplanned incidents with other marine users and concurrent activities (i.e. commercial fisheries, maritime shipping, oil and gas activities, tourism operations, and recreational users); and
- No adverse interactions (such as collision, or entanglement) with marine fauna (i.e. cetaceans, pinnipeds and marine turtles).

It is considered that the above environmental performance outcomes, as a result of the implementation of the mitigation and control measures (**Table 44**), will allow the ongoing environmental performance of the Otway Basin 2DMC MSS to adhere to, or improve on, the **Acceptable Levels** described within **Section 7.1.8** while ensuring that the relevant legislation is complied with in order to avoid any health and safety risks as far as practicable.

The environmental performance standards within **Table 45** have been defined to manage impacts from the physical presence of the survey vessels and towed equipment to **ALARP** and an **Acceptable Level**. Compliance with these standards throughout the Otway Basin 2DMC MSS will assist in achieving the two main environmental performance outcomes.

Table 45 Environmental Performance Standard and Measurement Criteria for Physical Presence of the Survey Vessels and Towed Equipment

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Compliance with relevant legislation and conventions with regard to maritime safety	At all times the Vessel Masters will comply with the requirements of national and international legislation and conventions including (but not limited to) the Navigation Act 2012, COLREGS, and the STCW Convention.	Pre-mobilisation audit and inspection prior to operations beginning, along with crew inductions. Bridge logs.	Vessel Master
24/7 watch keeping by qualified crew members	Qualified crew will maintain watch-keeping 24/7 during the survey in compliance with the STCW Convention.	Pre-mobilisation audit and inspection prior to operations beginning, along with crew inductions. Bridge logs.	Vessel Master
Lights and visual communication at sea	Lighting and communications to maintain compliance with COLREGS and the Navigation Act.	Pre-mobilisation audit and inspection prior to operations beginning, along with crew inductions. Bridge logs.	Vessel Master
Marking of tail buoy	The tail buoy will be appropriately marked including a radar reflector and lights so that its presence is identifiable by other marine users at all times.	Pre-mobilisation audit and inspection prior to vessel leaving port.	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Radio communication	Survey vessels will be contactable by radio at all times	Bridge Communication logs.	Vessel Master
Radar and AIS	The survey vessels will be equipped with Radar and AIS systems which will be operating and monitored at all times for both transmitting and receiving vessel positions.	Pre-mobilisation audit and inspection prior to vessel leaving port.	Vessel Master
Support vessel present at all times	A support vessel will be present around the seismic vessel at all times	Vessel track records confirm movement and location of support vessel. Bridge logs.	Vessel Master
Spatial separation between concurrent surveys	The seismic vessel will maintain at least 40 km separation with concurrent seismic surveys at all times.	Vessel track records as well as AIS track records demonstrate compliance. Communication records between seismic vessels.	Vessel Master Party Chief
Pre-survey communication with relevant stakeholders	All identified existing stakeholders will be consulted with prior to the commencement of the Otway Basin 2DMC MSS. Consultation will be in the form of email and phone contact, as well as face-to-face meetings where possible.	Documentation of consultation records to demonstrate compliance is submitted with this EP application.	SLB Project Manager
48-hour look-ahead plan	When requested, a 'look-ahead plan' will be provided to relevant stakeholders that provides at least 48 hours' notice of the Otway Basin 2DMC MSS schedule.	Documentation of consultation and issuing of 48-hour look-ahead plans demonstrate compliance. Will be issued every 24 hours. Forms part of ongoing consultation strategy	SLB Project Manager
Notice to Mariners	A Notice to Mariners will be issued prior to commencement of the survey detailing planned survey operations.	Record of Notice to Mariners.	Australian Hydrographic Office Vessel Master
	Updating of Notice to Mariners during the survey should changes occur	Record of Notice to Mariners.	Australian Hydrographic Office Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Contact of Recreational fishers and charter boats	All recreational fishing bodies identified as part of the engagement process and those fishing and dive charter operators will be kept updated of the survey and if requested look-ahead plans provided. Representative bodies will also be kept informed to access large numbers of recreational users as well.	Issuing of 48 look-ahead plans demonstrate compliance. Will be issued every 24 hours.	SLB Project Manager
Reporting of any incidents or near misses involving the seismic vessel and other marine users	Any incidents or near misses that threaten the safety of the seismic survey and/or require remedial action by the support vessel will be reported to Australian Maritime Safety Authority	Bridge log. Bridge Communication log. Copy of report to AMSA.	Vessel Master
Installation of 'turtle guards' on tail buoy	Tail buoy will be fitted with protective 'turtle guard' that is appropriate for excluding turtles from entering gaps in the subsurface structure of the tail buoy	Pre-mobilisation inspection prior to operations commencing.	Vessel Master
Record any marine fauna ship strike or entanglement incidents	All observed ship strike and entanglement incidents will be reported to the DoEE. Incidents involving marine fauna will also be reported on the National Ship Strike Database. Two dedicated MMOs will be onboard seismic vessel for duration of survey.	Sighting reports and documentation of any reportable incident. Bridge log.	MMOs and Vessel Master
Vessel master of the **support vessel** will reduce speed and maintain minimum distances in the presence of cetaceans to avoid vessel strikes and reduce disturbance	The Vessel Master of the **support vessel** will maintain a minimum of 100 m from any cetacean The Vessel Master of the **support vessel** will maintain a minimum of 50 m from any dolphin	Bridge log. MMO log (if onboard support vessel).	Support Vessel Master
	If a cetacean approaches closer than the 100 m, the Vessel Master of the **support vessel** will either disengage gears or allow the whale to approach, or reduce speed to less than 6 knots and steer a course away from the whale. If a dolphin approaches closer than the 50 m, the Vessel Master of the **support vessel** must not change course or speed of the vessel suddenly.	Bridge log. MMO log (if onboard support vessel).	Support Vessel Master
	The master of **support vessel** will make all efforts not to let a calf enter the caution zone (either whale or dolphin). However, if it occurs, the Vessel Master will immediately stop the vessel, turn off engines, or disengage gears, or withdraw the vessel from the caution zone at a constant speed of less than 6 knots.	Bridge log. MMO log (if onboard support vessel).	Support Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Vessel crew are briefed on entanglement and collision risk and reporting requirements	All vessel crew are to be briefed on the risk of marine fauna collision and entanglement and the reporting requirements. The presence of MMOs onboard the seismic vessel for the duration of the survey will provide constant reminders to the crew of this requirement.	Induction records outline content of vessel induction and those in attendance.	Vessel Master
Retrieval of towed equipment when the seismic vessel is in transit	Towed equipment will be retrieved and brought onboard the seismic vessel when not required (e.g. vessel is in transit to/from port)	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Bridge log.	Vessel Master
Avoidance of Petroleum Safety Zones of other marine users	The survey vessels will not enter within established PSZ unless by prior arrangement with the installation master and all correct permits are obtained	Vessel records demonstrate compliance.	Vessel Master

7.1.6 Residual Risk of Impact

Following the implementation of the control measures in **Table 44**, the worst-case likelihood of the physical presence of the survey vessels and towed equipment having any impact on marine fauna and marine users is *Likely*, and the worst-case consequences of known risks from the physical presence of the support vessels and towed equipment are considered *Moderate*, based on the discussions within **Section 7.1.2** and **7.1.3**. Therefore, using the risk matrix outlined in **Table 39** (**Section 6.5**), the worst-case residual risk of an impact occurring from the physical presence of the survey vessels and towed equipment, following the implementation of control measures (**Table 44**), is considered to be **Moderate** (**Table 46**). The magnitude of this residual risk is mostly associated with possible interactions between commercial fishing vessels and the Otway Basin 2DMC MSS, with potential overlap in space and time between the Operational Area and fishing grounds.

Table 46 Residual Risk Summary for Physical Presence of Survey Vessels and Towed Equipment

Likelihood	Consequence	Residual Risk
Likely	Moderate	Moderate

7.1.7 Demonstration of ALARP

To demonstrate that any potential impacts from the presence of the survey vessels and towed equipment are managed to **ALARP**, SLB has considered a number of control measures to determine the benefits of their implementation towards risk reduction (**Table 44**), based on a Hierarchy of Controls methodology described within **Section 6.6**, and as summarised in **Table 47**. The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental impacts from the presence of the survey vessels and towed equipment and assessments have been undertaken to ensure that all reasonable and practicable control measures or solutions have not been overlooked. As a result, through the application of industry best practice and/or comparable standards to further control risk reduction, it is considered that any impacts from the presence of the vessels have been reduced to **ALARP**, where the residual risk from adoption of these control measures is **Moderate** (**Table 46**).

Additional control measures were considered as part of the assessment process towards further risk reduction; however, it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 47 Hierarchy of Controls for Physical Presence of Survey Vessels and Towed Equipment

Eliminate	Due to the offshore nature of the Operational Area, the seismic vessel and towed equipment are required for data acquisition and cannot be eliminated. The presence of a support vessel is a health and safety requirement which acts to reduce the risk of collision between the seismic vessel/towed equipment and other marine users and/or entanglement between fishing gear and seismic equipment.
Substitute	Alternative data acquisition methods that do not require towed equipment are not yet commercially available or proven to meet geophysical data quality objectives, operational safety, and reliability requirements.
Reduce	The seismic vessel will operate 24/7 to reduce the duration of the Otway Basin 2DMC MSS. Following consultation with marine users (such as commercial fishers), the Operational Area has been revised to reduce the overall spatial extent and to increase the minimum water depths of the area to be surveyed, while still allowing the survey objectives to be met. The Operational Area has now been reduced by a total of 100,000 km^2.
Mitigate	Control measures have been assessed within **Table 44** to mitigate impacts from the physical presence of the survey vessels and towed equipment to **ALARP** and **Acceptable Levels**. Those measures which are appropriate and are not impractical or unfeasible will be implemented during the Otway Basin 2DMC MSS.

The proposed control measures minimise the risk of impacts from the presence of the survey vessels and towed equipment and are considered appropriate to the localised nature and scale of potential environmental impacts during the Otway Basin 2DMC MSS. The proposed control measures are in accordance with industry best practice. No further practicable controls have been identified to reduce the impact and risks to the marine environment, marine organisms or other marine users from the presence of the survey vessels and towed equipment.

The effects of the physical presence of the survey vessels and towed equipment will be relatively localised and transitory in nature. As a number of mitigation measures will be in place to reduce the likelihood of any effects on marine users and marine fauna, it is considered that the potential impacts from the physical presence of the survey vessels and towed equipment are reduced to **ALARP** and **Acceptable Levels**.

7.1.8 Risk Acceptability

The total elimination of survey vessels and towed equipment from the project cannot be achieved due to the offshore location of the Otway Basin 2DMC MSS, lack of commercially available and proven alternative acquisition methods, and health and safety requirements for a support vessel. Following the implementation of the control measures (**Table 44**), the potential impacts to the marine environment and marine users arising from the physical presence of the survey vessels and towed equipment will be short-term and restricted in extent to within the immediate vicinity of the vessels and equipment. With the 5 km line spacing across the relatively large Operational Area the presence of the vessel will be transitory in nature.

The criteria for risk acceptability are detailed in the following sections. The control measures that will be implemented throughout the Otway Basin 2DMC MSS have been developed in accordance with these criteria in mind. Where uncertainty exists around the criteria or the risk, SLB has taken a precautionary approach.

7.1.8.1 Ecologically Sustainable Development

The management of the impacts associated with the presence of the survey vessels and towed equipment proposed by SLB can be carried out in compliance with principles of ecologically sustainable development as defined within the EPBC Act (outlined in **Section 2.2**). The risk assessment undertaken within this EP has not identified any adverse impacts, and is consistent with the principles of ESD, namely:

- Decision-making processes integrated both long-term and short-term economic, environmental, social and equitable considerations (e.g. moving survey area further offshore to avoid rock lobster fishing areas, reducing Operational Area, removing survey lines, acquiring tie lines during the defined temporal periods (i.e. 15 October-31 December 2019 or 1 March-30 April 2020) to avoid peak periods for feeding, migration and/or breeding of whales;
- No threats of serious or irreversible environmental damage were identified by the risk assessment;
- The principle of inter-generational equity is maintained as potential disturbance impacts from the vessel's presence are relatively localised and of medium-term;
- The conservation of biological diversity and ecological integrity were fundamental considerations in decision-making and development of control measures, for example the installation of turtle guards on the tail buoy will reduce possible impacts to any turtles in the area and retrieval of equipment during transit to and from port will lessen risks of equipment interactions with marine species; and
- The control measures proposed have considered improved valuation, pricing and/or incentive mechanisms – control measures that had environmental benefits that outweighed the costs of their implementation were proposed to be undertaken.

7.1.8.2 Legislative Requirements

The control measures for reducing the risk associated with the presence of the survey vessels and towed equipment throughout the duration of the Otway Basin 2DMC MSS are consistent with the following relevant standards/documents:

- All vessels involved in the Otway Basin 2DMC MSS will comply with the IMO conventions (i.e. STCW, SOLAS);
- All vessels will comply with the relevant ship safety requirements under the Navigation Act 2012:
  - MARPOL;
  - UNCLOS,
  - COLREGS;
  - Marine Order 21: (Safety of navigation and emergency procedures), 2012;
  - Marine Order 28: (Operations standards and procedures), 2012; and
  - Marine Order 30: (Prevention of collisions), 2009;
- SLB will comply with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations;
- Watch-keeping will occur in accordance with the standards set by the '*International Convention on Standards of Training, Certification and Watchkeeping for Seafarers*';
- Support vessels will adhere to the EPBC Regulations 2000 with regard to interacting with cetaceans;

- Minimising vessel collision has been ranked as a high priority action within the '*Conservation Management Plan for the Southern Right Whale*', the '*Conservation Management Plan for the Blue Whale'*, and the Conservation Advice for fin, sei, and humpback whales. During the development of mitigation measures for the Otway Basin 2DMC MSS, the '*National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna*' has been taken into account, reducing the potential for risks associated with ship strike to **ALARP** and **Acceptable Levels** with regard to marine mammals; and
- The '*Recovery Plan for Marine Turtles in Australia*', outlines that the long-term recovery objective for marine turtles is to 'minimise anthropogenic threats' and to 'allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act threatened species list'. In order to meet the long-term recovery objective, interim recovery objectives have been set, including that 'anthropogenic threats are demonstrably minimised'. Vessel disturbance has been assessed as a threat to marine turtles in Australia. Although the Otway Basin would not be considered as 'critical habitat' to marine turtles, the '*National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna*' was taken into account during the development of mitigation measures including the use of best-practice mitigation measures (i.e. turtle guards). The low speed of the seismic vessel and installation of turtle guards on the single tail buoy is considered to further reduce the potential for risks associated with vessel disturbance to **ALARP** and **Acceptable Levels** with regard to marine turtle populations in the Otway Basin 2DMC MSS Operational Area.

7.1.8.3 Internal Context

The proposed management of the impacts and risks from the presence of the survey vessels and towed equipment are within **Acceptable Levels** of SLB's Environmental and QHSE Policy, as shown in **Section 1.2**.

7.1.8.4 Industry Best Practice

The proposed control measures to reduce impacts of the survey vessels and towed equipment follow industry best practice and best practice guidelines for seismic surveys, including:

- The IAGC Environmental Manual for Worldwide Geophysical Operations. Geophysical vessels must exercise care to reduce risk to aquatic life, including marine fauna and other marine users and, where possible minimise interruption to operations and equipment of other marine users; and
- The APPEA Code of Environmental Practice. Details within this document relate mainly to offshore operations such as offshore exploration and/or drilling and production facilities where disturbance to marine fauna and marine users should be reduced to **ALARP** and **Acceptable Levels**. The Code of Environmental Practice emphasises the importance of maintaining public health and safety during all phases of operations. A similar expectation is likely expected of seismic vessels operating in offshore waters.

7.1.8.5 Stakeholder Expectations

Consultation has been undertaken with a large range of stakeholder groups across South Australia, Victoria and Tasmania, as well as with local and State governments. A full breakdown of the stakeholder consultation undertaken, including details of the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** as well as the ongoing consultation strategy that SLB will implement. Full copies of all stakeholder responses as part of the stakeholder engagement programme are provided in **Appendix C,** with a summary provided in **Appendix F**.

In the initial rounds of stakeholder engagement, concerns were raised in particular by rock lobster fishers, in regard to their method of fishing where there are large numbers of pots in the water, where there is the potential for the survey vessel and streamer to collect those pots if they are in the survey path. As a result, following initial rounds of stakeholder engagement, SLB reduced the Operational Area. SLB moved the survey area further offshore, in an effort to minimise conflict and disturbance with the rock lobster fishers.

SLB are committed to ongoing engagement with stakeholders and will provide 48-hour look-aheads during the Otway Basin 2DMC MSS to all stakeholders so that the location of the survey vessel is known for the next 24 hours. This will be updated every 24 hours and will be also supplemented with SMS via mobile phones to key stakeholders who utilise the Operational Area for fishing activities that have been identified through the SETFIA fisheries assessment.

7.1.8.6 Existing Environment Context

Through the development of the environmental impact and risk assessment process, the potential interactions and disturbances were assessed between the seismic vessel and associated array, the Operational Area with which the MSS will be acquired, and the different receptors in the receiving environment. This included the evaluation of the overlap and interactions with the marine environment (i.e. marine reptiles, cetaceans, and pinnipeds), commercial fisheries, recreational fisheries, tourism, other oil and gas activities, and commercial shipping.

The Otway Basin 2DMC MSS has 5 km line spacings, most of which are in relatively deep water (91% in water depths greater than 1,000 m), so the footprint across the Operational Area is relatively small. The survey vessels will be constantly moving at a speed of 4 – 5 knots which assists in reducing the likelihood of a collision with other vessels and marine mammals. In addition, turtle guards installed on the single tail buoy reduces the potential for turtles to become entangled in the towed equipment. As a result, the disturbance to existing users of the marine environment and marine fauna from the physical presence of the survey vessels and towed equipment is likely to be short-term and localised.

It is considered that the proposed control measures in **Table 45** provide appropriate protection to marine fauna and existing users from the potential effects associated with the physical presence of the survey vessels and towed equipment. A number of control measures were considered as part of the assessment process and it was concluded that the addition of any further control measures not already considered would provide little or no additional protection from the presence of the survey vessels and towed equipment while potentially compromising the ability of survey objectives to be met.

7.1.9 Physical Presence Impact Summary

Based on the discussions above, including the potential impacts on the environment and the associated control measures to be implemented, the residual risk of impacts arising from the physical presence of the survey vessels and towed equipment throughout the Otway Basin 2DMC MSS is considered to be **Moderate**.

In accordance with the description of a **Moderate** residual risk ranking (**Table 40**), where additional control measures are not possible to reduce the risk to **Low**, additional management and/or communication measures must be implemented to reduce levels to **ALARP**. Since the **Moderate** risk ranking is mostly associated with potential interactions with commercial fishing operations within the Otway Basin 2DMC MSS Operational Area, ongoing consultation, the communication of survey plans and 48-hour look-aheads, daily SMS's, in association with official Notice to Mariners provide effective measures to reduce the potential residual risk to **ALARP**.

Therefore, residual risk from the physical presence of the survey vessels and towed equipment associated with the Otway Basin 2DMC MSS is considered to be at an **Acceptable Level**.

7.2 Acoustic Disturbance to the Marine Environment

7.2.1 Description of Source of the Noise Impact

Noise will be generated from two sources during the Otway Basin 2DMC MSS: the survey vessels, and the active acoustic source. The active acoustic source generates much higher noise levels than the survey vessels and would dominate overall underwater noise emissions at times when data acquisition is occurring.

7.2.1.1 Vessel Noise

Noise from ships (i.e. propellers, machinery, and the passage of the hull through water) is the dominant anthropogenic sound in marine waters (Gordon & Moscrop, 1996) and adds to the constant ambient noise level in the marine environment. In general, older vessels produce more noise than more modern vessels, and larger vessels produce more noise than smaller vessels (Gordon & Moscrop, 1996). Commercial vessels produce relatively loud and predominantly low frequency sounds, with the exact characteristics' dependant on vessel type, size, and operational mode (**Table 48**). The strongest energy tends to be at frequencies below several hundred hertz, with source levels generally ranging from 180 – 190 dB re 1 µPa (Southall & Hatch, 2008). Despite the presence of many marine mammal species in coastal areas with high levels of shipping, relatively few studies have been carried out on the effects of ship noise on marine mammals (Blair *et al*., 2016).

Table 48 Noise Outputs from a range of Commercial Vessels

Source	Source level	Reference
Fishing trawler	158 dB re 1 µPa	Malme *et al.*, 1988
Tanker (135 m length)	169 dB re 1 µPa	Buck & Chalfant, 1972
Tanker (179 m length)	180 dB re 1 µPa	Ross, 1976
Super tanker (266 m length)	187 dB re 1 µPa	Thiele, 1983
Super tanker (337 m length)	185 dB re 1 µPa	Thiele, 1983
Super tanker (340 m length)	190 dB re 1 µPa	Thiele, 1983
Containership (219 m length)	181 dB re 1 µPa	Buck & Chalfant, 1972
Containership (274 m length)	181 dB re 1 µPa	Ross, 1976
Freighter (135 m length)	172 dB re 1 µPa	Thiele, 1983

Noise emissions from the survey and chase vessels would be similar in level, frequency range and character to noise from general shipping traffic already in the study area, and is not considered to represent a significant additional environmental impact above the noise from normal shipping activities (see **Section 5.5.3.2**).

7.2.1.2 Acoustic Source

The seismic vessel will tow an acoustic array comprised of three sub arrays, with eight acoustic sources per sub-array, providing an overall effective volume of 5,265 in^3 (**Figure 5** & **Table 12**).

These acoustic sources produce short duration, predominantly low frequency noise with high peak source levels. The low frequency noise pulses are directed downwards towards the seafloor and propagate efficiently through the water with little loss from attenuation (i.e. absorption and scattering). Attenuation depends on propagation conditions; in good conditions, background noise levels may not be reached for >100 km, while in poor conditions background levels can be reached within a few tens of kilometres (McCauley, 1994).

Although most of the emitted energy is at low frequencies (10 – 300 Hz), acoustic airgun pulses also contain small amounts of higher frequency energy at 500 – 1,000 Hz (Richardson *et al*., 1995). The low frequency component attenuates slowly, while the high frequency component attenuates more rapidly to ambient levels.

The acoustic pulse from a seismic source forms a steep-fronted wave that is transformed into a high-intensity pressure wave (i.e. a shock wave with an outward flow of energy in the form of water movement) resulting in an instantaneous rise in maximum pressure, followed by an exponential drop in pressure. The environmental effects on animals in the vicinity of a source are defined by individual interactions with these sound waves.

Modelling packages (i.e. Gundalf and Nucleus) calculate the theoretical maximum energy level at 1 m from the source array for a specific configuration. However, actual measured sound levels in the marine environment can be significantly lower than the theoretical source maximum because the cumulative sound pressure levels (energy from all of the acoustic sources activating together) are computed on the assumption that the seismic array is at a point source. In fact, each airgun is much further than 1 m away from all the other airguns in the array configuration, and it is not possible to be only 1 m away from all of the different compressed air elements that make up the array simultaneously. This approach means that the modelled source power levels for the acoustic array will be conservative, resulting in a conservative STLM output due to the inflated acoustic source level. Use of this conservative approach is prudent when assessing the potential risks to environmental receptors.

The emitted sound levels from an acoustic source are influenced by a number of different variables in the marine environment and it does vary for whether the sound levels are being either predicted or recorded in the near-field (close to the source) or far-field (further away from the source). Firstly, the overall volume or capacity of the acoustic source is very influential on the emitted sound levels but so too is water depth, bathymetry, distance from the source, geo-acoustic properties of the seabed, water temperature and time of the year (i.e. whether a thermocline is present or not).

The acoustic array source levels for the Otway Basin 2DMC MSS have been determined by source signature modelling. A range of different acoustic parameters are required to be assessed since the impact thresholds for various species use various different acoustic parameters. Source spectrum, waveform and directivity are detailed in (**Appendix N**).

7.2.1.3 Sound Transmission Loss Modelling

STLM was undertaken by SLR to predict received Sound Exposure Levels (**SELs**) and spread of noise emissions or the 'footprint' of acoustic emissions from the Otway Basin 2DMC MSS and the proposed 5,265 in^3 acoustic array.

Results from this STLM are used to confirm the extents of the Precaution Zones required under the EPBC Act Policy Statement 2.1 and to enable an assessment of the potential risk to marine fauna in the Operational Area based on comparisons with known injury and behavioural onset thresholds. Sensitive marine areas in the surrounding areas to the Otway Basin 2DMC MSS Operational Area have also been considered.

The STLM involves four key components:

- Array source modelling – modelling the sound emissions from individual airguns making up the acoustic array, to determine overall array source level and directivity characteristics;
- Short-range modelling – prediction of the received SELs at distances out to four kilometres. Short range modelling is used to assess impacts in the vicinity of the active source, and whether the proposed mitigation measures and Precaution Zones are adequate to protect marine fauna;
- Long-range modelling – prediction of the received SELs over a range of tens to hundreds of kilometres. This modelling assesses the noise impacts to more distant sensitive marine areas; and
- Cumulative modelling – prediction of the received SELs accumulated due to repeated moving source impulses over a 24-hour period, including infill scenarios.

The STLM methodology addresses the horizontal and vertical directionality of the emissions from the acoustic source based on the specific configuration to be used during the survey. Also considered within the model are the varying water depths and substrate types found throughout the Otway Basin 2DMC MSS Operational Area. The complete STLM report is provided in **Appendix A**, and the results are summarised below.

STLM increases our understanding of the acoustic footprint over a given bathymetric environment with unique environmental parameters (i.e. sound speed profile and geology) for a specific acoustic source proposed for a seismic survey.

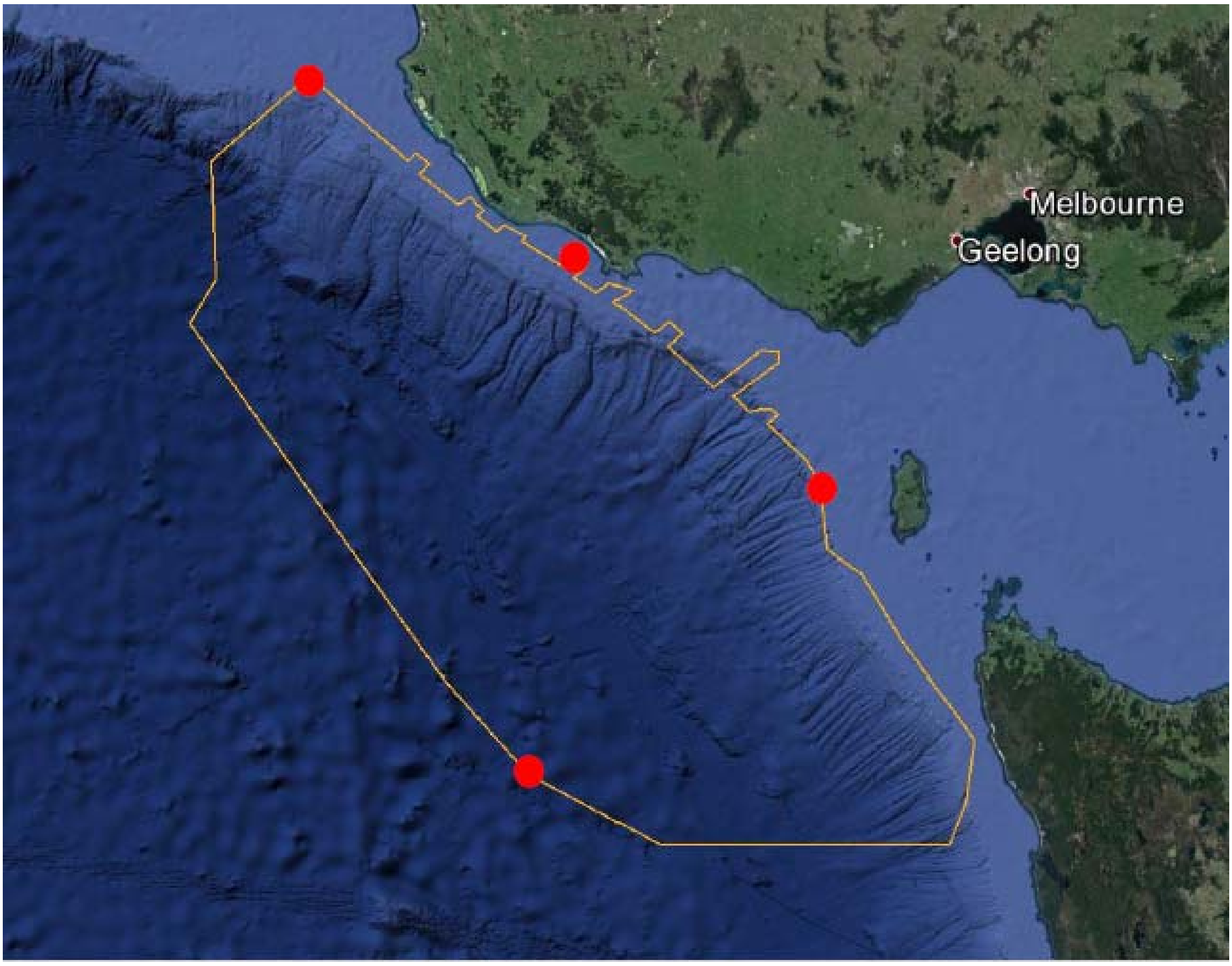
In the case of the Otway Basin 2DMC MSS, STLM was conducted specifically for the discharge of the 5,265 in^3 array, where the upper 1 m of seabed was comprised of well-cemented calcarenite (soft limestone) on top of 100 m of slightly to semi-cemented sand/calcarenite, using a winter sound speed profile for the water column. As described in **Appendix A**, this sound speed profile and seafloor geology represents a worst-case scenario for noise propagation and has been chosen so that in the event of any delays to the programme the predicted impacts are conservative, and representative of source locations and seasons expected to exhibit noise propagation over the greatest distances.

The short-range modelling assumes that the sound speed profiles (i.e. sound speeds at different depths in the water column) and seabed properties are uniform across the entire Operational Area and represent a worst-case for noise propagation. This enables a depth sensitivity analysis to be undertaken across the Operational Area. The locations and scenarios used for short-range modelling are therefore not specific but are representative of the range of conditions present within the entire Operational Area and across the different depth contours. This approach was selected due to the large geographical extent of the Otway Basin 2DMC MSS Operational Area and the large range in bathymetry.

The eight different water depth scenarios included within the short-range modelling throughout the Otway Basin 2DMC MSS Operational Area included: 50 m, 100 m, 200 m, 400 m, 800 m, 1,600 m, 3,200 m, and 4,800 m. In all cases using the winter water column sound speed profile provided worst-case scenarios and conservative model outputs. At other times of the year, different speed profiles through the water column mean noise would be expected to attenuate more with increasing distance from the source and the impacts would be less than those identified in this report.

Four specific long-range modelling locations were selected as shown by the red dots in **Figure 62**. The three inshore locations were included to assess long distance noise propagation in the shallow water regions east and west of the Operational Area, and into Bass Strait. The offshore modelling location represents noise propagation when the sound source is active in the deep-water region.

Figure 62 Long Range STLM Locations



Note: Operational Area is based on the previous version; however, the inshore boundary has not changed to what was modelled. Offshore location is also still valid as it is within water depths of current Operational Area (4,800 m).

7.2.1.3.1 Modelling Outputs and Assessed Parameters

From the STLM assessments a number of different acoustic parameter values were determined as described in in the STLM report (**Appendix A**). The model calculations primarily predict SELs, with results for other parameters derived using conversion factors. The STLM enables calculation of the zones of impact from single and multiple airgun pulses and assessment against threshold values for various species that are defined in the literature (**Section 7.2.2.1**).

The following subsections summarises the different noise metrics and methods used for assessing sound exposure and sound pressure from the STLM results.

Sound Exposure Level

The SEL is an index for accumulated sound energy. SEL can be used to describe the sound energy from a single shot or pulse from the source array. It also enables the integration of sound energy across multiple shots or sound exposures. The time period over which the SEL is accumulated must be specified.

The cumulative exposure (**SEL_{cum}**) is calculated from multiple events over longer time periods than a single shot. There are various time periods that can be used. Common time periods are either 24 hours (DOC, 2016), the duration of an activity (i.e. seismic line or survey (as recommended in Southall *et al*. (2007) and Popper *et al*. (2014)) or the total period that any animals will be exposed (DOC, 2016). For this study, a time period of 24 hours is used. Considering the rate of progress of the noise source and the spacing of the survey lines, this represents a reasonable maximum exposure time for any animals, if an animal remains relatively stationary in a location between two survey lines.

SEL is used as a parameter to assess physiological impacts to many species, such as injury to fish and temporary and permanent hearing threshold shifts in marine mammals.

Root-Mean-Square Sound Pressure Level

Sound Pressure Level (**SPL**) is the decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

The RMS SPL is the Root Mean Square (**RMS**) pressure level in a stated frequency band over a time window containing the acoustic event (DOC, 2016), which is essentially a measure of the average pressure or the effective pressure over the duration of an acoustic event, such as the emission of one acoustic pulse or sweep.

The RMS SPL is used primarily to assess behavioural responses. It is the parameter currently accepted by the U.S. National Marine Fisheries Services (**NMFS**) for assessing marine mammal responses to impulsive noise events. The NMFS RMS SPL threshold for adverse behavioural response is 160 dB re 1 µPa (**Table 62**).

Peak Sound Pressure Level

Pk SPL is the maximum absolute value of the instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal and is properly denoted as p_{max} (DOC, 2016). This is a metric commonly quoted for impulsive sounds, but it does not account for the duration or bandwidth of the noise. Where at high intensities, Pk SPL can be a valid criterion for assessing whether a sound may be injurious, but because Pk SPL does not account for the duration of a noise event, it is a poor indicator of perceived loudness or longer-term impacts.

Pk SPLs are useful for characterising impulsive events but do not account for the total energy of the sound. For application to impact assessments, there are applicable metrics or criteria that are related to the Pk SPL; however, these thresholds are only considered to be applicable in close proximity to the source (i.e. injury ranges) (DOC, 2016).

Peak-to-Peak Sound Pressure Level

Pk-Pk SPL is the difference between the absolute value of the maximum positive and negative instantaneous peaks of the waveform during a specified time interval (DOC, 2016), and is another useful metric for charactering impulsive sounds and potential for injury. There may be different effects between positive and negative peak pressures, where:

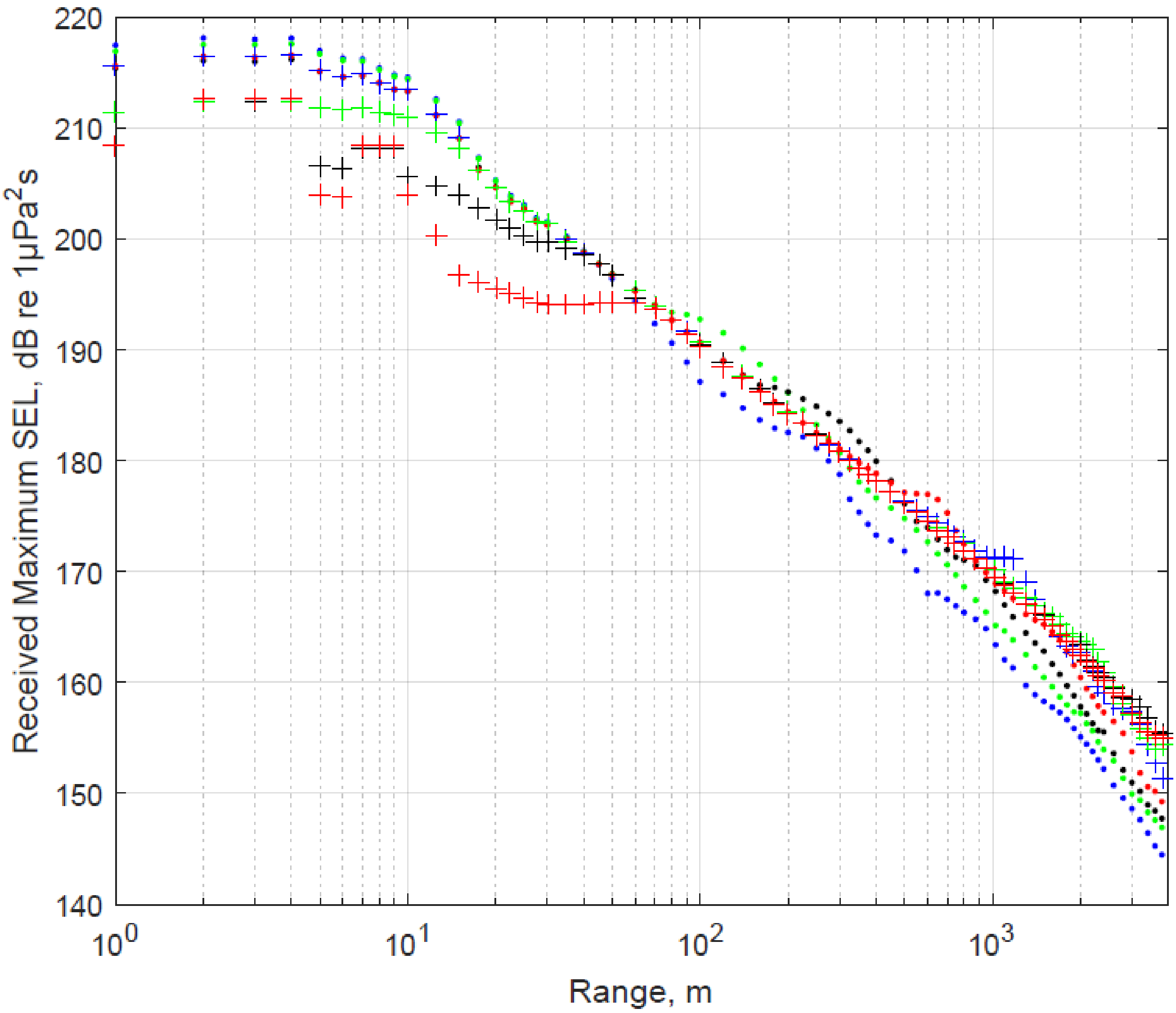
- Negative pressures result in expansion and cavitation; and
- Positive pressures result in compression.

7.2.1.3.2 Short Range Modelling

The maximum received single shot SELs from the acoustic source across all azimuths at the eight different depth ranges has been derived from the short-range modelling and is provided in **Figure 63**. As discussed earlier, the short-range model assumes that the water depth is constant in the vicinity of the source out to the 4 km range modelled. Considering this point, the short-range modelling results show that:

- At locations very close to the array centre (<40 m), the maximum received SEL decreases at increasing water depths. This is due to the weaker acoustic energy reflected directly back up from the seabed in deeper water; and
- At distances further away from the array centre, the maximum received SEL is less in areas of shallower water than in deeper water. This is the result of increased attenuation of acoustic energy with horizontal distance in shallow, caused by more reflections and interaction with the seabed in shallower water.

Figure 63 Maximum Received SELs from the Acoustic Source across all Azimuths at Eight Depth Ranges in Operational Area



Note: 50m (blue '.'), 100m (green '.'), 200m (black '.'), 400m (red '.'), 800m (blue '+'), 1600m (green '+'), 3200m (black '+') and 4800m (red '+')

These results also confirm that at a range of 1 km from the acoustic source the SEL is expected to be greater than 160 dB re 1 µPa^{2}s for 95% of seismic shots so SLB will be required to adhere to the precautionary zone requirements of the EPBC Act Policy Statement 2.1 as defined within **Section 2.2.1.3** and **Figure 2**. This requires an observation zone of 3+ km, a Low-power Zone of 2 km and a Shut-down Zone of 500 m from the acoustic source if any marine mammal enters within these zones. SLB has proposed an extended Shut-down Zone of 2 km as an additional mitigation measure for this survey. These zones will be enforced by two MMOs onboard the seismic vessel for the duration of the Otway Basin 2DMC MSS.

Figure 63 shows the SELs at various distances calculated by short range modelling to a distance of 4 km from the acoustic source in different water depths. To be able to compare these results with RMS SPL and peak impact thresholds in the literature, conversion factors are required. It is noted that converting SEL values to Pk SPL values by using a single constant conversion factor is not technically valid. This is because different frequency components propagate at different speeds, so the difference between SEL and Pk SPL values will be different at different distances from the source (the peak in the waveform becomes more spread out at greater distances). However, simplifying the parameter conversion in this way is required so that comparisons of received levels between studies can be made (McCauley *et al*., 2000). In McCauley *et al*. (2000) thousands of seismic source readings were calculated for correction factors until these corrections were found to be consistent over many kilometres, where a Pk SPL correction factor of +27.3 to +30.5 dB above the SEL value can be applied. For this study the +30.5 dB correction was used to conservatively evaluate effects on marine life based on thresholds in published literature.

The maximum modelled noise levels for all acoustic parameter are shown in **Table 49** for increasing horizontal distance from the acoustic source. Results are shown for the two extremes of water depths considered to demonstrate the range of predicted noise levels in different parts of the Operational Area. The maximum received noise levels shown are the highest noise level predicted for any depth in the water column, in any horizontal direction from the source. The directivity of the source means noise levels in other directions or at other depths in the water column will be less than or equal to the value shown in **Table 49**.

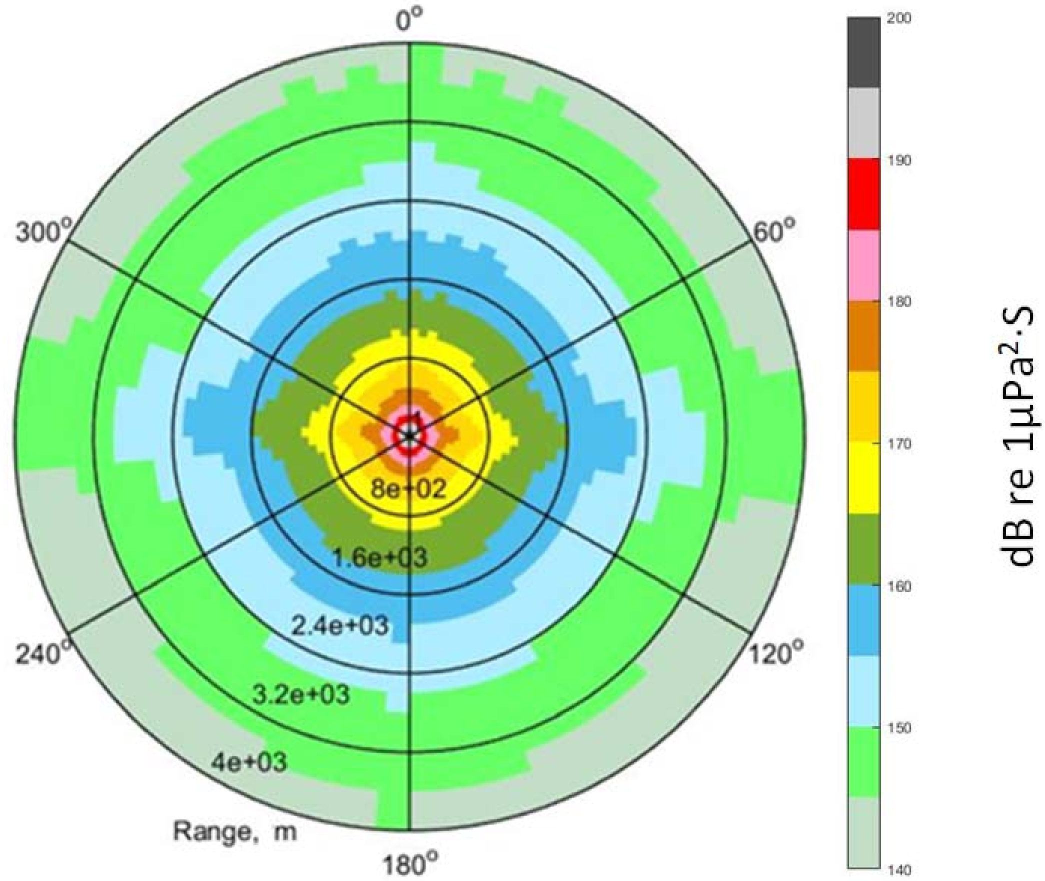
Table 49 Predicted Maximum Received SELs and SPLs for all Azimuths for 5,265 in^3 Acoustic Source

Horizontal distance from the source array	The predicted maximum levels across the water column for all azimuths - 50 m and 4,800 m water depth cases							
	SEL, dB re 1 µPa2·s		Pk SPL, dB re 1µPa		Pk-Pk SPL, dB re 1µPa		RMS SPL, dB re 1µPa	
	50 m	4,800 m	50 m	4,800 m	50 m	4,800 m	50 m	4,800 m
5 m	217	212	239	234	247	242	235	230
10 m	215	204	237	226	245	234	233	222
20 m	205	196	227	218	235	226	223	214
50 m	197	194	219	217	227	224	215	212
80 m	191	193	213	215	221	223	209	211
100 m	187	190	209	212	217	220	205	208
200 m	183	184	205	206	213	214	199	200
500 m	172	176	194	198	202	206	185	189
800 m	166	172	188	194	196	202	177	183
1,000 m	164	170	186	192	194	200	174	180
2,000 m	155	163	177	185	185	193	164	172
4,000 m	145	155	167	177	175	185	152	162

The sound radiation from the acoustic source array has strong angle and frequency dependence. Both vertical and horizontal source directivity is accounted for in the STLM. In the horizontal plane a large amount of higher frequency energy is radiated in the cross-line direction (what would be 90° and 270° from the streamer) as a result of the acoustic source configuration (**Appendix A**). **Figure 64** shows the horizontal plane directivity in terms of maximum SEL. By 2 km from the acoustic source, or the Shut-down Zone that SLB will be working to, the SEL will be less than 160 dB 1 µPa^2 s in the cross-line direction, and around 155 dB 1 µPa^2 s or less in most other directions.

The beam patterns that have been identified in the STLM (**Figure 64** and **Appendix A**) are characteristic of an acoustic array with wide spacing between elements or in the case of the Otway Basin 2DMC MSS, wide spacing between the sub-arrays.

Figure 64 Maximum SELs across the Water Column as a Function of Azimuth and Range from the Centre of the Array



Note: 0-degree azimuth corresponds to the in-line direction. Radius range is in a log scale (m) out to 4 km from the acoustic source.

7.2.1.3.3 Long Range Modelling

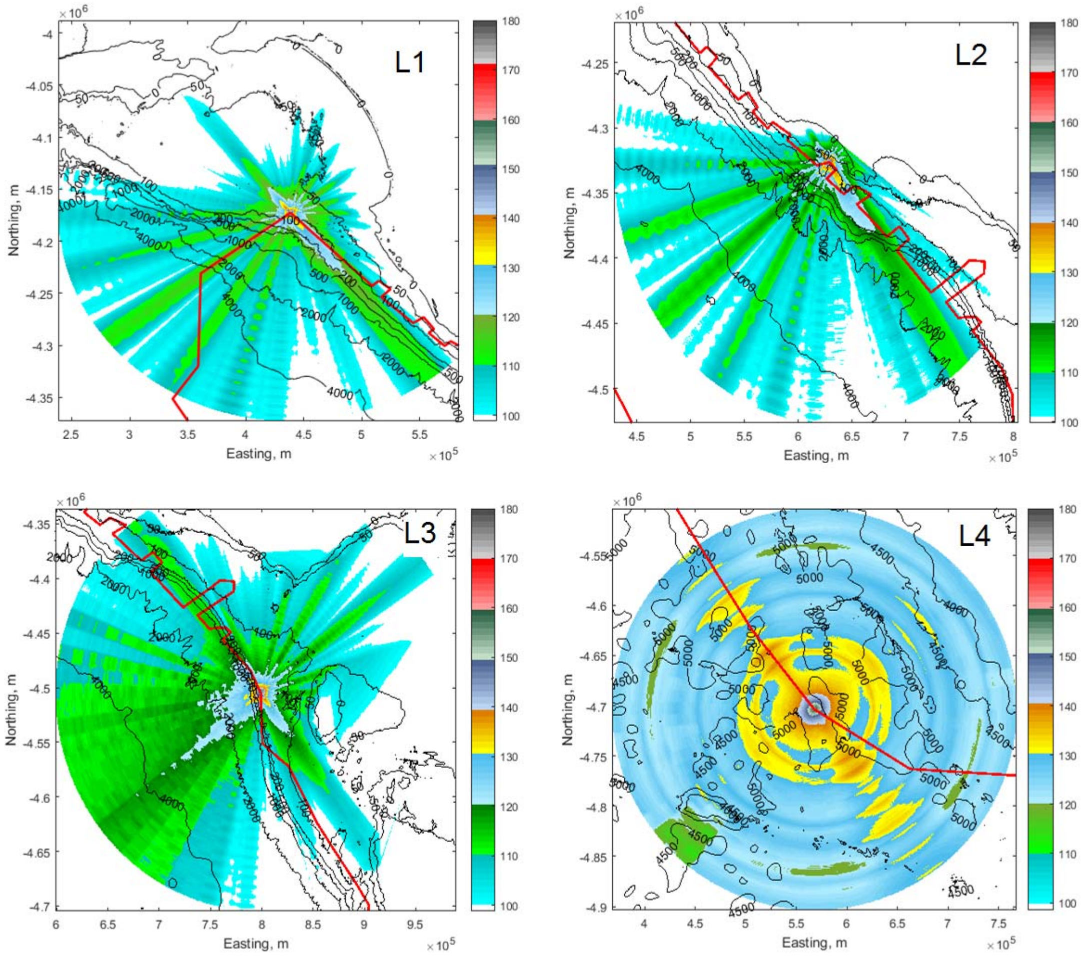
Long-range modelling predicts the received SELs over a range of tens to hundreds of kilometres from the source location, in order to assess the noise impact from the Otway Basin 2DMC MSS on the relevant far-field sensitive areas. The long-range modelling results are illustrated in **Figure 65** (see also **Appendix A**) and indicate that the received noise levels at far-field locations vary significantly at different angles and distances from the source. This directivity of received levels is due to a combination of the directivity of the source array, and propagation effects caused by bathymetry and sound speed profile variations.

For long range modelling, variations in topography, such as the presence of canyons, are automatically accounted for by the inclusion of the seabed bathymetry data along the propagation path. There are some limitations to the accuracy of this approach; however, the inshore portion of the Otway Basin 2DMC MSS Operational Area has variable bathymetry upslope which causes rapid attenuation as the sound travels into inshore waters. This means that the area exposed to high noise levels immediately around the array source is less in inshore waters (Locations L1, L2 and L3 in **Figure 65**) relative to locations in deeper water offshore (L4 in **Figure 65**).

The acoustic propagation modelling method used for the long-range modelling is usually referred to as N x 2D because it involves running a two-dimensional (range-depth) model along multiple azimuths. This is a common method of acoustic propagation modelling and is usually of more than adequate accuracy; however, its accuracy is limited by ignoring out of plane effects and will be reduced in situations where the bathymetry is very steep, and sound is propagating almost parallel to the contours. Several research groups are experimenting with fully three-dimensional parabolic equation models, but these have not yet reached a point of efficiency and maturity where they can be used for operational modelling.

The long range STLM results shown in **Figure 65** confirm the strong and complicated directionality of the SELs due to a combination of the directionality of the acoustic array which produces the maximum amount of radiated energy in the cross-line direction and also due to the effects of bathymetry.

Figure 65 Modelled Maximum SEL (Maximum Level across Water Column) Contour for Source Locations L1, L2, L3 and L4 to a Maximum Range of 200 km, Overlaid with Bathymetry Contour Lines

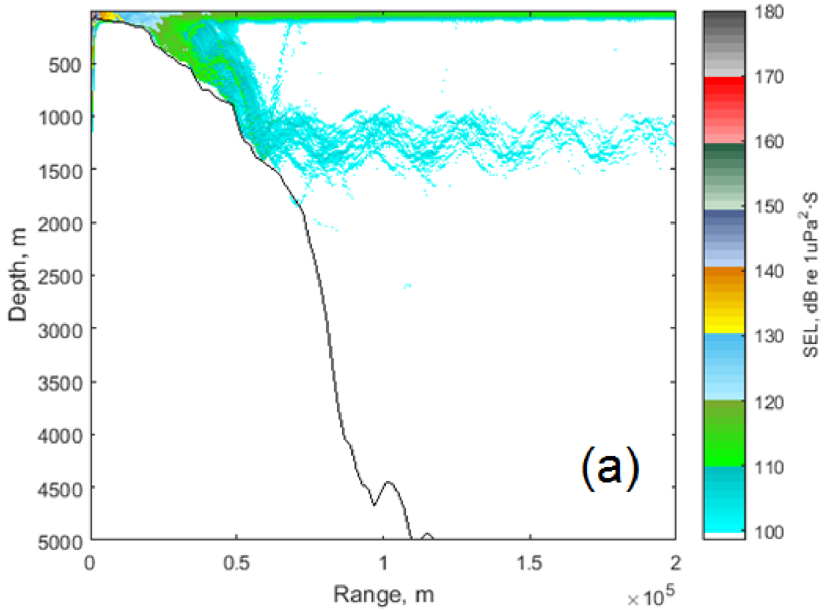


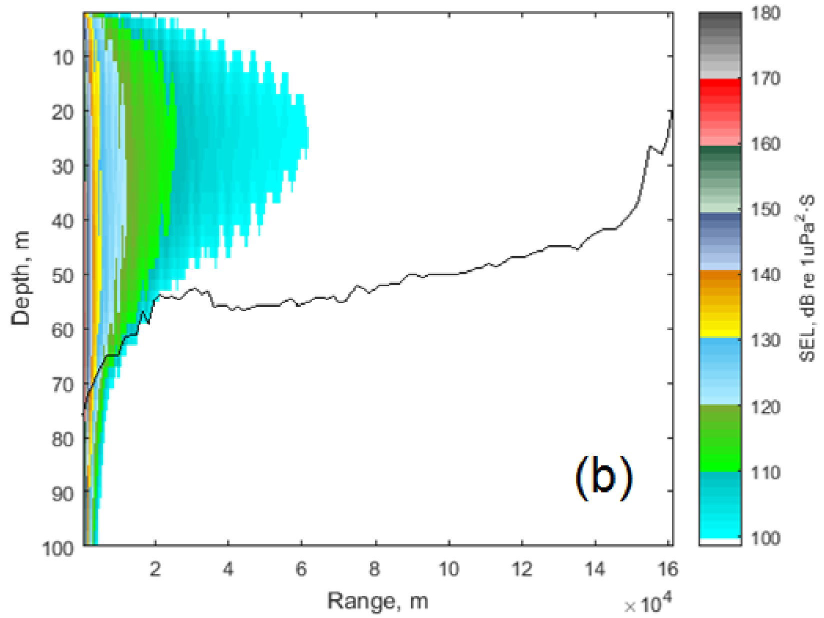
Noise propagation is enhanced downslope, in the inline direction to deeper waters. As sound levels travel downslope, direction rays are flattened on each subsequent seabed reflection, reducing the number of seabed interactions and therefore attenuation rate. A reduction in sound speed with increasing depth results in downward refraction, where the highest sound levels occur in the lower portion of the water column. For sound travelling upslope from the acoustic source, the rays steepen on each subsequent seabed reflection, increasing the attenuation rate and distributing the sound energy more evenly through the water column.

These propagation effects mean that noise levels are highest mid-water column, but can be considerably lower near the surface, especially within a few kilometres of the source array. The zones of impact identified in this assessment are conservatively based on the maximum noise level anywhere in the water column, but impacts will be less to animals physically present nearer the surface.

Figure 66 illustrates these different propagation effects over long distances by showing a cross-sectional example of the variation in noise level with depth and increasing distance from the source. This figure is plotted for two example modelled propagation lines from long range propagation location L1 (**Figure 62**). This location is on the edge of the continental shelf. To the north of the array source the water becomes shallower, closer to the shore. To the south of the array source the water deepens. The increased distance of propagation into deeper water can be clearly seen, with SEL levels remaining above 100 dB 1 µPa^2 s out to 200 km in a depth channel between 1,000 to 1,500 m deep. In contrast, noise propagating towards shore drops to below 100 dB 1 µPa^2 s at all depths over a distance of about 60 km. While noise levels in the direction towards shore are also highest in mid water column, the long-distance channelling of noise is not present.

Figure 66 Example Modelled SELs vs Range and Depth along the Propagation Path towards Deeper Water (a) and towards Shallower Water (b) from the Source Location L1





Note: Black Line shows the Seabed Depth

7.2.1.3.4 Cumulative Modelling

The acoustic array will generate impulsive noise every 12 seconds during active data acquisition, moving horizontally a distance of 25 m between each noise pulse, and covering a total distance in the order of 180 km in 24 hours. The received peak and RMS noise levels do not change for repeated impulses, except as a result of the changing distance from the moving noise source. The SEL parameter describes accumulated sound energy, so each successive noise pulse increases the cumulative SEL.

Cumulative modelling accounts for the moving noise source and has been undertaken by accumulating the received noise exposure at a representative stationary location from successive pulses generated over two consecutive survey lines (5 km apart), over a time period of up to 24 hours. 24 hours is a reasonable limit to place on cumulative SEL and is recommended for impact assessment purposes by many guidelines, such as NMFS (2016). For this survey, a maximum of two survey lines 5 km apart could feasibly be completed in any 24-hour period. The next line would be another 5 km away, so would contribute considerably less to cumulative impacts at the representative stationary location than the first two adjacent lines. Therefore, considering a 24-hour period for cumulative noise corresponds well to the proposed movement of the survey vessel past a particular receiving location.

In the event that data acquisition is halted temporarily, an infill line may be required. **Section 3.4.3** identifies that in this scenario a minimum delay of five hours would occur before resuming data acquisition at the same location, with some overlap. This possibility is considered by identifying the increased zones of impact resulting from a double-dose exposure (plus 3 dB in SELcum) within 24 hours affecting any particular location. With reference to the noise propagation with distance effects calculated using the short range model (**Figure 63**); doubling the exposure dose to complete an infill line at any individual location is expected to result in an increase in the cumulative SEL zone of impact distance by a factor of 1.4.

This approach to cumulative modelling is inherently highly conservative for marine mammal species with the ability to move away from the noise source. For less mobile species, this approach represents the worst-case cumulative effect to assess multiple noise exposures from this survey. Cumulative effects due to other projects or noise sources over a larger area and time scale are discussed in **Section 9.**

The cumulative impacts of noise are species specific. Details of the cumulative modelling are provided in **Appendix A.** The extents of impacts of cumulative noise exposure including scenarios for infill lines are described in the following sections on a species-specific basis.

7.2.2 Known and Potential Impacts to Environmental Receptors and Exposure Criteria

Noise exposure thresholds are indicative noise levels at which there is potential for certain effects (e.g. mortality, temporary hearing impairment, injury, behavioural changes) to occur to marine fauna when exposed to those levels of noise. When noise exposure thresholds are published, the response of that particular animal being exposed to that level of noise is generally defined for a single noise exposure or for cumulative exposure to successive events. Threshold criteria have been selected within this EP for different fauna to assist in determining and assessing potential impacts to marine fauna. The threshold criteria are based on current relevant scientific literature, accepted industry and international standards and is considered to be appropriate for this assessment process.

Generally speaking, a high intensity external stimulus such as an acoustic disturbance will elicit a behavioural response in animals; typically, avoidance or a change in behaviour. The duration and intensity of an animal's observed response is impacted by the nature (continuous or pulsed), source (visual, chemical or auditory) and the intensity of the stimulus, as well as the individual's species, gender, reproductive status, health and age.

Behavioural responses are instinctive survival mechanisms that serve to protect animals from injury. Consequently, animals may suffer temporary or permanent physiological effects in cases when the acoustic disturbance is too high, or the animal is unable to elicit a sufficient behavioural response (e.g. swim away fast enough).

Depending on the exposure level and sensitivity threshold of each species, the effects of acoustic disturbance can include:

- Physiological effects – changes in hearing thresholds – Temporary Threshold Shift (**TTS**) or Permanent Threshold Shift (**PTS**), damage to sensory organs or traumatic injury; (**Section 7.2.2.1**);
- Behavioural effects (and related impacts) – displacement/avoidance, disruption of feeding, breeding or nursery activities etc. (**Section 7.2.2.2**);
- Perceptual effects (auditory masking) – interference with communication (**Section 7.2.2.3**) and detection of predators/prey; and
- Indirect effects – behavioural changes in prey species that affects other species higher up in the food chain and could lead to ecosystem level effects (discussed throughout **Section 7.2.2** as relevant, in particular see **Section 7.2.2.1.1, 7.2.2.2.2, 7.2.2.2.5, 7.2.2.2.8, 7.2.2.4.2,** and **7.2.3.3**).

The following subsections go through each of the different marine receptors that are likely to be present in the Otway Basin 2DMC MSS Operational Area and a risk assessment is undertaken on those species being exposed to the acoustic disturbance from the Otway Basin 2DMC MSS. Threshold criteria for behavioural disturbance, TTS, PTS and other injuries are discussed in the following subsections and then summarised in **Table 64**. These thresholds for each of the different receptor types have been used to inform the impacts within this EP. **Table 64** provides a summary of the maximum distance from the acoustic source at which these thresholds would occur.

7.2.2.1 Potential Physiological Impacts

Underwater noise, such as that produced during an MSS, has the ability to cause lethal and non-lethal physiological trauma or injury in marine organisms (Gordon *et al*., 2003).

Of particular concern with regard to MSSs and marine organisms is the potential for auditory damage from the acoustic release. Tissue damage to sensory organs from MSS acoustic releases have been experimentally studied in captive/captured fish, cephalopods and invertebrates, while shifts in hearing thresholds have been experimentally observed in some small pinnipeds and small cetaceans and hypothesised based on observed effects in terrestrial animals. To date there is no direct evidence of damage to the ears of marine mammals from MSS acoustic releases (Gordon *et al*., 2003).

The following provides a discussion on the potential physiological effects of a MSS on marine organisms.

7.2.2.1.1 Zooplankton

In comparison to fish and mammals, less research has been conducted on the effects of seismic outputs on zooplankton. This is because zooplankton do not have hearing structures although they can detect changes in pressure (Richardson *et al.,* 2017). Zooplankton are generally the same density as the surrounding water column and as such, it is assumed that pressure changes associated with seismic activity will not cause physical damage (Parry & Gason, 2006).

Until recently, most studies have shown that exposure to emitted sound levels from a seismic survey has no significant adverse effects on the abundance or mortality of zooplankton (e.g. larval fish (Dalen *et al*., 2007, Payne *et al*., 2009); crabs (Pearson *et al*., 1994); or scallops (Parry *et al*., 2002)). In studies where an impact has been observed, it has generally been limited and localised, with lost individuals quickly being replaced due to rapid generational turnover rates. For example, Payne *et al.,* (2009), Kostyuchenko (1973), Matishow (1992) and Booman *et al*., (1996) have reported physiological/pathological effects occurring in larval fish species exposed to an acoustic source up to 5 m away, and mortality occurring when exposed to an acoustic source up to 3 m away. Further studies have reported no adverse effects to zooplankton at individual (e.g. Dalen & Knutsen, 1987; Bolle *et al*., 2012) and population (Saetre & Ona, 1996) levels.

However, in 2017 McCauley *et al*. published the first large-scale field experiment investigating the impact of seismic activity on zooplankton and found that impacts were not as limited and localised as previously reported. In this study, the health of the plankton community in relation to exposure to a single 150 in^3 acoustic source was assessed using sonar surveys, net tows for zooplankton abundance, and counts of dead zooplankton both before and after seismic exposure. Community composition included copepods (71%), cladocerans/water fleas (15%), euphausiid/krill larvae (*Nyctiphanes australis*) (4%), appendicularians (5%), and 'other' (5%). Key findings presented by McCauley *et al*. (2017) were:

- There was a statistically significant lower abundance of zooplankton after exposure, with a median 64% decrease one hour after exposure;
- A 50% reduction in zooplankton abundance was detected within 509 – 658 m of the source. The SEL at this range was 156 dB 1 µPa^2 s^{-1};
- The range at which no impact was detected on zooplankton abundance was 973 – 1,119 m; where the SEL was 153 dB 1µPa^2 s^{-1};
- Impacts were observed out to the maximum 1.2 km range sampled, which was more than two orders of magnitude greater than the previously assumed impact range of 10 m;
- There were two to three times more dead zooplankton post-seismic exposure;

- There was 100% mortality in krill larvae at all distances sampled post-seismic exposure;
- Sonar backscatter showed a 'hole' in the plankton community up to 30 m deep that followed the prevailing track of the seismic source and was detectable from 15 minutes after exposure;
- Statocyst damage was hypothesised to be the cause of zooplankton mortality; and
- Flow on effects to marine food webs should be considered as an outcome of this study.

APPEA were concerned by these findings and commissioned further research into the effects of seismic sound on plankton. Scientists from the Commonwealth Scientific and Industrial Research Organisation (**CSIRO**) were engaged to critically review the methodologies and findings of the McCauley *et al.* (2017) experiment and to simulate the large-scale impact of a seismic survey on zooplankton in the Northwest Shelf region of Western Australia, based on the mortality rate associated with seismic noise exposure reported by McCauley *et al.* (2017).

With respect to the review, Richardson *et al*. (2017) examined the following three questions (with brief explanations taken from Richardson *et al*. (2017) shown in italics):

6. Why was there no attenuation of the impact with distance?

   "There is no consistent decline in the proportion of zooplankton that are dead as distance increases, or as received level decreases. This lack of a clear attenuating impact warrants further investigation."

7. Why was there an immediate decline in abundance?

   "The decline in zooplankton abundance is perplexing. If zooplankton were killed, they would not immediately sink from the surface layers, or be rapidly eaten. A drop in abundance would be more likely once the dead zooplankton either sunk to the bottom or were removed by predation."

8. Was there sufficient replication to be confident in the study findings?

   "The conclusions in McCauley et al. (2017) study were based on a relatively small number of zooplankton samples. A total of 24 samples were collected: 2 tows each sampling time x 3 distances from the gun (0 m, 200 m, 800 m) x 2 levels (Control, Exposed) x 2 replicate experiments (Day 1, Day 2). This means that there were only 12 samples collected under conditions exposed to the airgun, 6 on each day of the 2 experiments. 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 more dead zooplankton – although this is relatively unlikely it cannot be discounted because of the relatively few samples collected and only two replicate experiments conducted."

Following their review of McCauley *et al*. (2017), Richardson *et al*. (2017) investigated the spatial and temporal impact of a large-scale seismic survey on zooplankton on Australia's Northwest Shelf during summer via hypothetical simulation. The mortality rate associated with seismic exposure reported by McCauley *et al*. (2017) was applied alongside other natural/typical variable values. The survey area was 80 km by 36 km in water 300 – 800 m deep and the survey was conducted over 35 days. The key results of this study were:

- **Simulations that included ocean circulation** showed that the impact of the seismic survey on zooplankton biomass was greatest in the *Survey Region* (the survey acquisition area plus a 2.5 km impact zone) where 22% of the zooplankton biomass was removed. Biomass increased with increasing distance from the Survey Region and there was no discernible effect on the entire Northwest Shelf Bioregion. The time to recovery (to 95% of the original level) for the *Survey Region* and *Survey Region + 15 km* was 39 days (38 – 42 days) after the start of the survey and 3 days (2 – 6 days) after the end of the survey (Richardson *et al*., 2017); and

- **Simulations with no ocean circulation** showed a much greater impact of the seismic survey on relative zooplankton biomass: 0.65 for the *Survey Region*; 0.78 for the *Survey Region + 15 km*; 0.97 (0.97 – 0.97) for the Survey Region + 150 km. There was no discernible effect on the entire *Northwest Shelf Bioregion*. The time to recovery for the *Survey Region* from the start of the survey was 64 days (49 – 100 days) and from the end of the survey was 26 days (Richardson *et al*., 2017).

Overall, the results showed that zooplankton populations were substantially impacted within the seismic survey area out to a distance of 15 km. Impacts were barely discernible within 150 km of the survey area and there was no apparent effect at a regional scale. The simulation showed that, following exposure, there was a rapid recovery of zooplankton populations due to their fast growth rates and the dispersal and mixing of individuals from inside and outside of the impacted region (Richardson *et al*., 2017).

It is important to put the results from Richardson *et al*. (2017) into context in order to be able to understand how they might be relevant to the Otway Basin 2DMC MSS. For the Otway Basin 2DMC MSS, a 5,265 in^3 acoustic source is proposed to complete the MSS which covers up to 14,000 lineal kilometres with line spacing 5 km apart, for an active data acquisition period of three months. In comparison, the Richardson *et al*. (2017) survey modelled a 3,200 in^3 acoustic source over an area of 2,900 km^2 for 35 days. Hence, the source size, survey area and survey duration for this survey are significantly greater than what was modelled by Richardson *et al*. (2017). Without conducting sophisticated modelling, it is impossible to predict how widely zooplankton in the vicinity of the Operational Area will be affected. It may seem reasonable to assume that some mortality will occur at a larger distance from the source, over a larger area, and over a greater period of time than what was modelled by Richardson *et al.* (2017); however, other factors, such as the configuration of the sound source, time of year, bathymetry and substrate type, are also important in determining the potential impact of emitted sound on zooplankton. Likewise, the 5 km line spacing will mean that the acoustic source is not concentrated in any particular area of the Operational Area for a significant period of time, and given the seismic vessel is continually moving at 4 – 5 knots, this will have no regional impact on zooplankton communities.

The CarbonNet study (detailed in **Section 7.2.2.1.4**) assessed zooplankton communities in Australia's Gippsland Basin before and after a seismic survey. Ten sites were sampled during the pre-survey period, consisting of six sites occurring within the survey area and four reference sites. During the post-survey period, three sites were sampled near the survey line, as well as three reference sites. Post-survey sampling occurred within three days of acquiring the last survey line. Copepods, cladocerans and salps dominated the pre-survey samples, whereas the dinoflagellate *Noctiluca scintillans* dominated the post-survey samples. There was a high level of variance among samples and no lobster or scallop larvae occurred in any of the samples. Mortality rates were high in both pre- and post-survey samples and the high proportion of dead cladocerans was contributed to their delicate structure being destroyed by the sampling process rather than attributable to any MSS impacts.

Table 50 provides a summary of the threshold values derived from the McCauley *et al.* (2017) study which was the first study to show a much larger effect of seismic on zooplankton than has been previously found. Threshold values for fish eggs and larvae are also provided and are based on Popper *et al.* (2014). This technical report presents the findings of a working group which was established to develop noise exposure criteria for fishes and turtles based on peer-reviewed and grey literature presenting data on the exposure of these animals to various sound sources. Although very few peer-reviewed papers discuss the responses of fish eggs and larvae to man-made sound, the working group separated these life stages out for special consideration due to their vulnerability, reduced mobility and small size (Popper *et al.,* 2014). The results for (adult) fish are discussed later in this section and threshold values are presented in **Table 53**.

The thresholds presented in **Table 50** are related to distances from the acoustic source for the Otway Basin 2DMC MSS derived from the STLM, and these thresholds are summarised in **Table 64** for all receptors.

Table 50 Noise Exposure Criteria and Zones of Impact for Mortality and Potential Injury for Zooplankton, Fish Eggs and Larvae

Zooplankton, Fish Eggs & Larvae	Mortality and potential injury threshold levels	Maximum threshold distance (m)
Based on Popper *et al.*, (2014) for fish eggs and larvae	Pk SPL: >207 dB re 1 µPa	130 – 250
	SEL_{24hr}: >210 dB re 1 µPa^2.s	30 (~40 with an infill line)
Based on McCauley *et al.,* (2017) for zooplankton	Pk-Pk SPL: 178 dB re 1 µPa	2,700 – 4,500

Note: The SEL24hr value represents impact from multiple pulses with the associated distance representing the zone of cumulative impact (maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels) for normal data acquisition and infill lines.

In other studies, Sætre and Ona (1996) examined the mortality rates for fish larvae and fry (taken from Booman *et al*., 1996) for five fish species (cod, saithe, herring, turbot and plaice) to investigate the consequences that seismic-induced mortality may have at the population level. They took a conservative approach and estimated that the number of larvae killed during a typical seismic survey (>10 days) was 0.45% of the total larvae population. However, when compared with the high natural mortality rates for each species (e.g. cod and herring eggs/larvae have a natural daily mortality of 5 to 15%) the impacts of seismic surveys on these zooplankton at a population level were considered to be negligible.

The underwater noise threshold levels for mortality in plankton and fish eggs and larvae are provided in **Table 50**. The predicted zone of impact from both single pulses and cumulative exposure to the acoustic source proposed for the Otway Basin 2DMC MSS has been determined by STLM and is provided in **Table 50**. These zones of impact are presented as 'maximum threshold distances', with the distance range for Pk SPL and Pk-Pk SPL thresholds representing the variance in the predicted zone of impact over the range in water depths throughout the Operational Area; where the largest threshold distance corresponds to the deepest water (i.e. 4,800 m) and the smallest threshold distance corresponds to the shallowest water (i.e. 50 m).

The key points from **Table 50** can be summarised as follows:

- The modelling predicts that exposure to a single pulse of the acoustic source could elicit mortality and potential injury in zooplankton out to 4,500 m from the source, while fish larvae and fish eggs would experience mortality and potential injury out to distances of 250 m from the source in deep water, or out to 130 m from the source in shallow water; and
- Cumulative exposure to multiple pulses from the moving noise source or infill lines does not increase the potential for mortality or injury to zooplankton, fish eggs and larvae, as even if an infill line is required, the peak noise effects result in threshold exceedances over greater distances than the cumulative noise effects.

The survey design of the Otway Basin 2DMC MSS will contribute towards minimising adverse effects since the survey lines are relatively long, with each line taking approximately 11 hours to complete and spaced 5 km apart. This means that the survey vessel will not be continuously passing through the same part of the Operational Area. Even if an infill line is required, most individual locations will only be affected by the active noise source on one day, or two days in total for locations crossed by the longer lines at 90 degrees to the majority of the survey lines.

When assessing the acoustic effects of seismic survey activity on zooplankton and fish eggs and larvae, the naturally high mortality rates (>50% per day in some species) of marine fish eggs and larvae must be considered. In addition, the high energy nature of the offshore marine environment in the Operational Area (**Section 5.1.3**) will help promote rapid recovery of zooplankton populations on account of dispersal and mixing. Consequently, the residual risk to zooplankton physiology on a population level arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

The potential for flow-on effects to marine food webs from changes in zooplankton abundance and distribution are discussed in **Sections 7.2.2.2.2, 7.2.2.2.5, 7.2.2.2.8, 7.2.2.4.2, 7.2.3.3**.

7.2.2.1.2 Scallop Larvae

Concerns were raised during the stakeholder engagement process (**Section 4** and **Appendix F**) about the effects of seismic surveys on scallops, particularly on the larval stages in the water column.

In 2002, ESSO Australia commissioned a study conducted by the Victorian Marine and Freshwater Institute to address, amongst other things, the concerns of Bass Strait scallop fishermen that seismic activities might increase the mortality of larval scallops (Parry *et al*., 2002). This study tested the effects of seismic surveys on plankton, with special attention to the effects on bivalves (including scallop) larvae. A BACI (Before, After, Control, Impact) survey design was used whereby plankton samples were collected before and after (immediately behind and 2 km away from) the transit of the seismic survey vessel (maximum source strength was 211 dB re 1 µPa @ 1 m at a frequency of 50 Hz). The results showed that there was no significant difference between the number of bivalve larvae found in samples collected before and after the seismic vessel had passed. There was also no evidence that seismic exposure caused changes to planktonic taxa in the surface waters (up to 20 m depth) in Bass Strait. It is important to note that the number of bivalve larvae detected was low and therefore only a large impact on their abundance would have been detected (Parry *et al.*, 2002). However, other experimental studies suggest that impacts on plankton are unlikely to occur at distances of more than 10 m from an acoustic source (Parry *et al*., 2002; see **Section 7.2.2.1**).

In another study, New Zealand scallop larvae were experimentally exposed to seismic pulses (160 dB re 1 µPa @ 1 m at 3 second intervals) in order to assess the effect of noise on early larval development (Aguilar de Soto *et al*., 2013). Within one hour of fertilisation scallop larvae were suspended at a depth of 1 m within a tank containing seawater. The effects of noise exposure at 24 to 90 hours of development were investigated and compared to a control group (which experienced no anthropogenic noise). Of the experimental larvae, 46% showed abnormalities in the form of malformations, such as localised bulges in soft tissues. No malformations were observed within the control group. This study provided the first evidence that continual sound exposure causes growth abnormalities in larvae.

Despite indicating larval vulnerability, it is important to put the results of the Aguilar de Soto *et al*. (2013) study into context. The experimental study was restricted to newly fertilised larvae that were exposed to sound pulses of 1.5 seconds duration every three seconds (over a period of 24 – 90 hours). In contrast, the Otway Basin 2DMC MSS will have a shot-point interval of 12 seconds and exposure time will be much shorter since the source is constantly moving and will pass most acquisition lines only once. This study used pulse duration of 1.5 seconds whereas the pulse duration for a seismic array is typically around 30 milliseconds.

Field-based studies carried out by Pearson *et al*. (1994) and Parry *et al*. (2002) have reported no evidence of delayed development, increased mortality, or reduced abundance in bivalve or decapod larvae when exposed to more realistic noise impulse scenarios.

The Bass Strait scallop fishery, which has a 3,000 tonne catch limit, sits approximately 285 km from the Otway Operational Area. Although this fishery is a reasonable distance away from the proposed activity, during consultation, industry representatives reported that the spawn that feed this fishery come from Victoria/South Australia waters. Scallops reproduce via broadcast spawning, whereby individuals release sperm first followed by eggs (Minchin, 2003). Once external fertilization has occurred, the larvae stay in the water column for 30 days (Ovenden *et al*., 2016) before settling, assuming the sediment is suitable for their recruitment. Spawning for the Australian commercial scallop (*Pecten fumatus*) occurs in winter/spring (June to November) (Dredge *et al*., 2016; Sause *et al*., 1987) and peak settlement of larvae occurs in mid-late September (Hortle & Cropp, 1987). There is some very limited evidence for a smaller, autumn peak in spawning for scallop populations in Bass Strait (Coleman, 1988). The timing of spawning (winter/spring), and the timing of the proposed survey (October 2019) is at the end of the peak spawning season (September) and towards the end of the peak larval settlement period (mid-late September). So, with the 30-day period that the scallop larvae remain in the water column and the commencement of the Otway Basin 2DMC MSS, it is likely that most of the scallop larvae will have settled to the seabed, mostly in the coastal waters, inshore of the Operational Area. As such, and in accordance with Day *et al*. (2016a) and the zooplankton discussions in **Section 7.2.2.1.1,** the residual risk to scallop larvae arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Possible*).

7.2.2.1.3 Rock Lobster Larvae

Due to the logistical and financial difficulties of field-based experiments, most scientific investigations into the impact of seismic outputs on rock lobster (and other marine invertebrate) larvae have been confined to laboratory environments. However, these do not replicate a real-world context and extrapolating results from laboratory conditions to field environments does not provide an accurate understanding of how larvae are affected by seismic signals in real world surveys.

In 2016, Day *et al.* published an in-situ study (Day *et al*., 2016a,b) on the impact of seismic source exposure on the embryonic development of southern rock lobster (*Jasus edwardsii*) larvae. This experiment was conducted in Storm Bay in Southern Tasmania, over a shallow limestone reef platform with uniform depths of 10 – 12 m. Here, egg-bearing female rock lobsters were exposed to signals from three seismic source configurations at various distances (45 in^3 airgun and 150 in^3 air gun high pressure experiments, and a 150 in^3 low pressure experiment), all of which exceeded SELs of 185 dB re 1 $\mu Pa^2 \cdot s$. The maximum and median cumulative SELs estimated in the three experimental regimes were 192 and 191 for the 45 in^3 experiment, 193 and 192 for the 150 in^3 low pressure experiment and 199 and 197 dB re 1 $\mu Pa^2 \cdot s$ for the 150 in^3 high pressure experiment.

Specifically, berried female rock lobsters were randomly allocated into control and exposed treatments and placed in situ in lobster pots. Seismic source runs were made starting at 1 – 1.5 km from the line of pots with the source run towards and over the pots, with total air gun exposures of 24.3, 17.2 and 23.3 minutes, for 126, 112 and 110 shots for the 45 in^3, 150 in^3 low pressure and 150 in^3 high pressure experiments. Control runs emulated the exposure runs with the source deployed and pressurised but not operated. Following the control and exposure runs, the lobster pots were recovered, and the rock lobsters were kept in holding tanks until hatching, which occurred a mean 87±2, 79±2 and 79±3 days post-exposure in the 45 in^3, 150 in^3 low pressure and 150 in^3 high pressure experiments, respectively.

Once hatched, the effects of the exposure treatments on rock lobster embryonic development were assessed by examining the number, morphology, energy content and competency of hatched larvae.

The results showed that:

- There were no mortalities of the adult berried female lobsters in either control or exposed treatments for any of the three experiments;

- All females had successful hatches with no incidence of loss or removal of the egg bundle;
- Lobsters in both treatments over all three experiments hatched over the course of a 5 – 6-day period, with a peak in the number of larvae hatched around days 3 – 4;
- There were no morphological abnormalities in any of the hatches;
- There were some differences in larval body length between control and exposed larvae in the 45 in^3 experiment (exposed larvae were approximately 1.5% longer than control larvae), but not in the other two experiments;
- There were no differences in larval width between treatments for all three experiments;
- There were no differences in length-to-weight and width-to-weight ratios between treatments for all three experiments;
- There were no significant differences between the dry masses of any of the treatments;
- Larval energy content did not differ between treatments in any of the exposure levels; and
- There was no difference in larval competency (i.e. activity test results) between treatments in any of the exposure levels.

The results dismiss concerns that exposure to seismic signals will result in egg bundle loss, decreased fecundity, comprised larvae and/or morphological abnormalities. The concern that exposure will result in abnormal larval morphology, cannot be immediately dismissed, as the exposed larvae from the 45 in^3 experiment were found to be significantly longer than control larvae. However, the larval size falls within the range for Stage I larval length of *J. edwardsii* (Lesser, 1978) so it is likely that the observed length difference is not biologically significant.

Overall, the results of the Day *et al.* (2016a, b) study found no differences in the quantity or quality of hatched rock lobster larvae and these authors concluded that seismic air gun exposure during early-stage embryonic development does not negatively affect rock lobster larvae. However, other life stages were not investigated in this study so concern over the potential effects of seismic outputs on other life stages cannot be dismissed.

The SEL_{cum} levels in this experiment emulate exposure levels equivalent to those of a large commercial air gun array passing within a few hundred metres and certainly within 500 m of the experimental site (Day *et al.,* 2016a, b). These values are similar to, and often higher than, other published values (Day *et al*., 2016a, b) and are similar to the shallow water SEL_{cum} levels modelled for the Otway Basin 2DMC MSS. As such, in accordance with the results from this study, residual risk to rock lobster larvae arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.2.2.1.4 Benthic Invertebrates

Marine invertebrates are most sensitive to the vibrational component of sound; the anatomical structures involved in detecting the pressure component of sound have not been found in these organisms. As such, benthic invertebrates are unlikely to suffer serious adverse physiological effects from exposure to seismic acoustic outputs. Many marine invertebrates have mechanoreceptors (sensory hairs or organs), which bear some resemblance to vertebrate ears, and are sensitive to sound. For example, in crustaceans, the main vibration receptors are in the statocysts and the walking legs (Aicher *et al*., 1983). McCauley (1994) reported that for many benthic species, these receptors will perceive seismic acoustic outputs, but this will only occur within a few metres from the sound source.

Carroll *et al*., (2017) provided a summary of the potential impacts of low frequency sound on the physiological responses of marine invertebrates based on a review of the relevant literature (**Table 51**). **Table 51** indicates evidence of physical and physiological effects occurring in decapods and bivalves at realistic SELs. However, this evidence is limited to one study (Day *et al*., 2016a) which is discussed below. A number of other studies reported possible responses, conflicting or anecdotal results, or showed evidence of no response (Carroll *et al*., 2017; **Table 51**).

Table 51 A Summary of the Potential Impacts of Low Frequency Sound on Marine Invertebrates

	Bivalves		Decapods	
Physical				
Air bladder damage				
Otolith/Statocyst damage			1	2
Organ/tissue damage	2		1	
Mortality/abnormality	3	1	3	
Physiological				
Metabolic rates*			4	
Stress bio-indicators	1	2	7	
Immune response			1	
Energy stores	1			
Behavioural				
Startle response	2		2	
Sound avoidance			1	
Predator avoidance	1		3	
Foraging			1	
Reproduction			1	
Bioturbation	1		1	
Key				
	No response at either realistic or unrealistic exposure levels			
	Response at realistic exposure levels			
	Response at unrealistic/unknown exposure levels			
	Possible response (conflicting results)			
	No data, has not been tested			

Notes: *Includes proxies for metabolic rate such as food consumption, growth, respiration, developmental rate

Numbers represent the number of studies reporting the result (as reported by Carroll *et al*., 2017).

Impacts are classified according to the sound exposure treatments as realistic (i.e. short bursts of low-frequency sound at a distance of >1 – 2 m) or unknown/unrealistic (i.e. long duration and/or short distance of <2 m to sound source, nearfield sound exposure in aquaria).

Source: Table adapted from Carroll *et al*., (2017) Of particular relevance to the Otway Basin 2DMC MSS, Day *et al*. (2016a) examined the impacts of seismic surveys on the physiology of southeast Australian scallop and rock lobster species. Exposure experiments were carried out in a field setting selected to emulate the natural habitats of each species. These authors found that adult rock lobsters (*J. edwardsii*), which were exposed to seismic sound levels up to a maximum SEL of 186 dB re 1 µPa^2.s did not show any increase in mortality, even at close proximities to the sound source. However, there was evidence of sub-lethal effects occurring following seismic sound exposure; specifically, impairment of reflexes involved with tail control and righting, damage to the sensory hairs of the statocysts (balance organ), and a reduction in numbers of haemocytes (indicative of reduced immune response function).

The study concluded that seismic surveys are unlikely to result in immediate large-scale mortality in the southern rock lobster fishery and, on their own, do not appear to result in any degree of mortality. The ecological impacts of the sub-lethal effects were not examined and therefore the existence and/or magnitude of any potential impacts on catch rates are not known. It is important to note that this study was undertaken at water depths of 10 – 12 m, which is significantly shallower than the Otway Basin 2DMC MSS Operational Area.

In another study focusing on rock lobster (*J. edwardsii*), Fitzgibbon *et al*. (2017) examined the impact of seismic acoustic exposure on the haemolymph physiology and nutritional condition of this species and found no effect of seismic exposure on 24 haemolymph biochemical parameters, hepatopancreas index or survival. However, this study did report evidence of:

1. A chronic negative impact on immune competency for up to 120 days post-exposure;
2. A potential immune response to infection after 365 days post-exposure; and
3. Chronic impairment of nutritional condition 120 days post-exposure.

These authors concluded that the biochemical hematological homeostasis of *J. edwardsii* is reasonably resilient to seismic acoustic signals; however, exposure may negatively influence the rock lobster's nutritional condition and immunological capacity. The impact of these results at an ecological level is not known.

With respect to scallops, Day *et al*. (2016a, 2017) reported that repeated exposure to a seismic acoustic source, where maximum sound levels were in the range of 181 to 188 dB re 1 µPa^2 s, SEL caused physiological damage, changes in behaviour and reflexes, and increased the risk of mortality (although mass mortality of scallops did not occur during the experiment). The authors report that, compared with unexposed scallops, the daily mortality odds were found to be 0.1%, 1.2% and 1.3% higher in scallops exposed to 1, 2, and 4 acoustic passes, respectively. Injured scallops did not recover over the four-month period of the experiment. The authors state that, given the compromised physiological condition of the exposed scallops, it is likely that they would have reduced tolerance to subsequent environmental, nutritional and pathological stressors. Again, longer term ecological effects of these results were not examined. For the Otway Basin 2DMC MSS, only one pass of each survey line will take place (two in isolated infill scenarios), and each survey line will be approximately 5 km apart, so the benthic invertebrates will not be exposed to more than one pass of the acoustic source. In addition, given the water depth of the Otway Basin 2DMC MSS, and the fact that 98% of the survey lines are in water depths greater than 200 m, there is unlikely to be too many scallops living on the seabed in that depth, with most commercial and recreational scallop fishing being conducted well inshore of the Otway Basin 2DMC MSS Operational Area. During the engagement process it was discussed that most of the scallops are living in water depths of less than 80 m of water, although from further investigation they are known to live down to 120 m.

Concerns were also raised during the engagement process by the Tasmanian Scallop Industry and Bass Strait Scallop Industry (**Section 4** and **Appendix F**) about the effects of seismic surveys on the larval stages of scallops while they are in the water column. The potential effects on scallop larvae are discussed above.

In another southeast Australian study, Przeslawski *et al*. (2016) examined the short-term impacts of marine seismic surveys on scallops in the Gippsland Basin and found no adverse effects on mortality, or any negative physiological effects in the variables measured (scallop shell size, adductor muscle diameter, gonad size and stage). However, this study did not examine any long-term sub-lethal effects.

In 2010, the Tasmanian Aquaculture and Fisheries Institute (**TAFI**) conducted a study to assess the immediate impact of seismic surveys on the survival and health of commercial scallops in Bass Strait following seismic surveys in the area. The results showed that in the two months post-survey, there were no impacts on the survival, health, abundance, size frequency distribution, macroscopic gonad and meat condition of the scallops (Harrington *et al*., 2010).

Further field-based studies on adult scallop populations revealed no evidence of increased mortality due to seismic acoustic exposure up to ten months after exposure (Parry *et al*., 2002; Przeslawski *et al*., 2016), or rock lobsters up to eight months after exposure (Payne *et al*., 2007; Day *et al*., 2016a). However, La Bella *et al*. (1996) found that hydrocortisone, glucose and lactate levels were significantly different between venerid clams (*Paphia aurea*) that were exposed to seismic outputs (at a distance of 7.5 m), and those which were not exposed to seismic outputs (Controls). This result suggested evidence of stress on this species of clam as a result of exposure to the acoustic noise.

In February 2018, CarbonNet carried out a 14-day seismic survey in Australia's Gippsland Basin (CarbonNet, 2018). As part of their EP, CarbonNet committed to completing pre- and post-survey offshore habitat assessments to determine if there were any effects on key biological receptors (i.e. commercial scallops, southern rock lobster, finfish, and zooplankton) which could be attributable to the survey. An Advisory Panel was established to ensure that the assessments were conducted in a scientifically robust manner with appropriate methodologies and interpretation of the results. This Panel consisted of representatives from regulatory agencies, academia and the fishing industry. With respect to scallops, the results showed that the number of scallops (commercial and doughboy) found at the 36 sites within the survey area and in the surrounding environment, was very low; less than 10 scallops were reported per 100 m transect. As such, the study could not make any conclusions regarding the effect of the MSS on scallops. For rock lobsters, ten sites (six sites within the survey area and four reference sites) were monitored at known or potential areas of rock lobster habitat. The results showed that 81 individuals were obtained during the pre-survey assessment compared to 122 individuals post-survey. It was concluded that the increased number post-survey was most likely attributable to seasonal effects rather than any effects of the MSS.

Variable effects of underwater noise have been reported for other shellfish and crustacean species, with findings ranging from no impacts to physical and/or physiological changes. Examples of effects of seismic surveys on other benthic invertebrate species include:

- Blue mussels (*Mytilus edulis*) exposed to a seismic source with a source level of 223 dB re 1µPa at distances of 0.5 m or greater (Kosheleva, 1992; Dalen, 1994) showed no physiological effects;
- Shell damage was associated with high intensity seismic source exposure for one of three species of mollusc exposed to a source level of 233 dB re 1µPa at a distance of 2 m; whereby the Iceland scallop (*Chlamis islandicus*) suffered splits to the shell (Matishov, 1992);
- Exposed scallops (*Pecten fumatus*) had significantly lower haemocyte levels (a proxy for circulation, immunity and stress) in response to seismic exposure when compared to control scallops. Day *et al.* (2016a, 2017) noted that the ecological implications of these changes warrant further investigation, although it seems that exposed scallops could suffer from a depressed immune response; and

- The Royal Society of Canada (2004) reported that research has shown that macroinvertebrates (e.g. scallops, sea urchins, mussels, periwinkles, crustaceans, shrimp, and gastropods) suffer very little mortality below sound levels of 220 dB re 1 µPa@1 m, while some show no mortality at 230 dB re 1 µPa@1 m. The potential for physiological damage of shellfish varies with the species exposed and the exposure circumstances (e.g. source level and duration, etc.).

The threshold levels for potential impacts to scallop and rock lobster are provided in **Table 52**. The STLM has determined the zones of impact from the acoustic source for the Otway Basin 2DMC MSS, based on these maximum threshold levels and these distances are also provided in **Table 52**. The maximum threshold distances provided are relevant to the shallower water depths where scallop and rock lobster may be present.

Three different parameters have been assessed for acoustic impacts to these species. These different parameters are used to review the distances of impacts generated by different effects, being the total energy contained in a single pulse (per-pulse SEL), the peak to peak rapid change in sound pressure level from a single pulse (Pk-Pk SPL), and also the cumulative impacts of multiple pulses (SEL_{24}) including a worst-case infill line scenario. The resulting zone of impact is determined by the largest identified threshold distance, which is the result of cumulative exposure to multiple acoustic pulses, i.e. the SEL_{24} threshold of 192 re 1 µPa^2.s. The resulting maximum threshold distance of 350 m corresponds to the distance from the noise source at which the noise levels would not result in any increase in rock lobster or scallop mortality. As discussed in **Section 7.2.2.1.2** and **7.2.2.1.3** above, impacts to scallop and rock lobster larvae would also be ***Low*** at these noise levels.

These thresholds are included in the exposure criteria threshold summary in **Table 64** for all receptors.

Table 52 Noise Exposure Criteria (Day *et al.,* 2016a) and Zones of Potential Impacts of Seismic Exposure to Scallop and Rock Lobster

Scallop and rock lobster	Potential impacts threshold levels	Maximum threshold distance
Based on Day *et al.* (2016a) - thresholds are noise levels confirmed not to increase mortality and negligible effect on larvae	Per-pulse SEL: 186 dB re 1 µPa^2.s (impact due to total energy in a single pulse)	120 m
	Pk-Pk SPL: 209 dB re 1 µPa (impact due to rapid change in sound pressure)	240 m
	SEL_{24}: 192 dB re 1 µPa^2.s (impact due to cumulative energy from multiple pulses)	350 m (490 m with infill line)

Due to the absence of sound pressure-detecting structures in benthic invertebrates and the large separation distances between the seismic source and the seabed across most of the Otway Basin 2DMC MSS (89% of the Operational Area is in water depths greater than 1,000 m), the residual risk of physiological impacts to benthic species from seismic sound exposure has been assessed as **Low** (*Minor* x *Unlikely*).

The effects of acoustic surveys on catch rates and fisheries which may manifest as a result of the adverse physiological responses discussed in this section are assessed in **Section 7.2.3**.

7.2.2.1.5 Fish

Indications of a stress response to vessel noise include increased production of stress hormones and alterations to regular heart-rate. An increase in the secretion of the stress hormone cortisol has been demonstrated in captive fish subjected to exposure to simulated boat noise (Wysocki *et al*., 2007). Increased cardiac output (associated with an increase in heart rate and decrease in stroke volume) was measured in response to exposure to vessel noise, with effects increasing with increasing vessel noise (Graham & Cooke*,* 2008). Elevated motility of several blood parameters has also been observed in response to vessel noise, indicating increased muscle activity caused by stress (Buscaino *et al*., 2010). A TTS may also occur in response to noise generated by vessels, as was demonstrated in fathead minnows by Scholik and Yan (2002) following two hours of exposure to playback of vessel noise at 142 dB re 1 µPa @ 1 m.

Although effects of noise on fish have been demonstrated in the above studies, it is important to note that the studied fish were captive animals and therefore unable to avoid the noise emission as would be possible in the wild. Furthermore, the Operational Area is already utilised by a number of marine users (e.g. shipping, commercial and recreational fishing vessels) and subject to vessel noise emissions.

In terms of the noise generated from the seismic survey itself, and as discussed in **Section 7.2.2.2.2**, fish will typically move away from a loud acoustic source if they are uncomfortable with the noise, thereby minimising their exposure and the potential for any physiological effects (Vabø *et al*., 2002; Pearson *et al*., 1992; Wardle *et al*., 2001; Hassel *et al*., 2004; Boeger *et al*., 2006). The studies and information discussed in this section can therefore be interpreted as a 'worst-case scenario' for fish that remain in close proximity to the seismic source and undertake no avoidance behaviours. Demersal fish may exhibit higher fidelity to specific sites (e.g. rocky reefs); these 'site attached' species may be more prone to disturbance than pelagic species (Wardle *et al*., 2001).

Sound can affect fish physiology in a number of ways including increased stress levels (Santulli *et al.*, 1999; Smith, 2004; Buscaino *et al*., 2010), temporary or permanent threshold shifts (Smith, 2004; Popper *et al*., 2005), and/or damage to sensory organs (McCauley *et al*., 2003). Not all species will be affected equally when exposed to the same acoustic source under the same conditions. For example, Popper *et al*. (2005) exposed three different fish species to a series of acoustic seismic releases and found that two of the species experienced TTS while the third showed no evidence of an impact.

It is difficult to measure the physiological effects of seismic exposure on fish *in situ* and consequently, many studies are conducted under laboratory conditions or by deploying caged individuals in the field (Carroll *et al*. 2017) and applying experimental underwater seismic acoustic outputs. There are limitations associated with these approaches which are discussed in **Section 7.2.2.2.2**. Due to these limitations, caution must be taken when relating the relevance of the findings of laboratory and caged field experiments to actual seismic exposure in open-water conditions.

The CarbonNet study (detailed in **Section 7.2.2.1.4**) assessed fish abundance pre- and post- seismic survey in Australia's Gippsland Basin by deploying baited remote underwater video stations across ten sites (six sites within the survey area and four reference sites). The results showed that 637 individual fish were observed pre-survey compared to 523 individuals post-survey. In contrast, species richness was lower pre-survey (39) compared to post-survey (43). Based on the results, no conclusion could be made regarding the impact of the survey on fish.

In 2003 and 2004, Fisheries and Oceans Canada ran workshops focusing on the documented effects of seismic noise on marine fauna, which were attended by scientific experts and regulators. Following the workshops, teams of scientists prepared major literature reviews of experimental and field studies, and international standards and mitigation methods. With respect to seismic impacts on fish physiology and mortality, the key conclusions from the workshops were:

- There were no documented cases of fish mortality upon exposure to seismic sound under field operating conditions; and
- Exposure to seismic sound was considered unlikely to result in direct fish mortality.

The workshop conclusions indicated that, under experimental conditions, sub-lethal and/or physiological effects have sometimes been observed in fish exposed to seismic acoustic outputs. However, experimental designs have made it impossible to determine the sound intensity responsible for the observed effects, as well as the biological significance of the results. Further field experiments attempting to target these issues have been inconclusive. As such, it was concluded that the current information was inadequate to evaluate the likelihood of sub-lethal or physiological effects under field operating conditions. The ecological significance of these effects, where they occur, could range from trivial to important, depending on their nature.

A Working Group (Popper *et al*., 2014) was established to re-examine these same issues and reported that there was still a lack of directly relevant data on the effects of seismic noise on fish. Additionally, there were no documented cases of fish kills during seismic surveys or in experimental studies (Popper *et al*. 2014). An output from this Working Group was the development of threshold sound levels for which harm to fish species is likely to occur. These thresholds, presented in **Table 53**, are based on the sound exposure guidelines for fish proposed by the ANSI Accredited Standards Committee S3/SC 1, Animal Bioacoustics Working Group. The guidelines are derived from data from several sources. The mortality and recoverable injury guidelines for fishes are based on predictions derived from effects of impulses since there are no quantified data for seismic acoustic sources. The Working Group defined the criteria for injury as: mortality and mortal injury: immediate or delayed death; recoverable injury: injuries, including hair cell damage, minor internal or external haematoma, etc.

Popper *et al*., (2014) stress that the nominal thresholds for fish injury and mortality presented in **Table 53** should not be used as firm criteria and must be applied cautiously. These thresholds can greatly over-estimate the level of potential impact if taken at worst-case effect for a listed range of potential effects and may increase error in an impact assessment. For example, Wagner *et al*. (2015) exposed gobies to six seismic discharges at an average peak SPL of 229 dB re 1 µPa. This was at a level greater than the mortality and potential mortality threshold listed in **Table 53**. Results showed that no mortality or significant physiological effects were observed in the 60 hours following exposure; however, longer term sublethal effects were not investigated.

As indicated in **Table 53**, studies generally show that physiological effects of seismic acoustic exposure are greater in fish which have a swim bladder than in those which do not (Casper *et al*., 2013). However, there are also a number of studies reporting no physiological effects from seismic exposure on fish which have a swim bladder. For example, Hastings *et al*. (2008) exposed different reef fish species to seismic acoustic outputs and examined the effects on hearing. These authors reported that no hearing loss occurred following sound exposures up to 190 dB re 1 µPa s SEL_{cum} for one species in which the swim bladder was connected to the ear, and in three species where it was not. Importantly, no studies have linked the mortality of fish, with or without swim bladders, to seismic noise (Popper *et al*., 2014).

Table 53 Noise Exposure Criteria (Popper *et al*., 2014) and Zones of Impact (Maximum Distances from Source to Impact Threshold Levels) for Mortality and Impairment of Fish, Fish Eggs and Fish Larvae

	Mortality and potential mortal injury		Impairment					Behaviour
	Criteria	Maximum threshold distance (m)	Recoverable injury		Temporary Threshold Shift		Masking	
			Criteria	Maximum threshold distance (m)	Criteria	Maximum threshold distance (m)		
Fish with no swim bladder (particle motion detection)	>213 dB Pk SPL	75 – 130	>213 dB Pk SPL	75 – 130	>>186 dB SEL_{24hr}	1,000 – 3,500 (1,400 – 4,900 with infill line)	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
	>219 dB SEL_{24hr}	10	>216 dB SEL_{24hr}	10				
Fish with swim bladder that is not involved with hearing (particle motion detection)	>207 dB Pk SPL	130 – 250	>207 dB Pk SPL	130 – 250	>>186 dB SEL_{24hr}	1,000 – 3,500 (1,400 – 4,900 with infill line)	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
	210 dB SEL_{24hr}	30	203 dB SEL_{24hr}	150				
Fish with swim bladder that is involved with hearing (primarily pressure detection)	>207 dB Pk SPL	130 – 250	>207 dB Pk SPL	130 – 250	186 dB SEL_{24hr}	1,000 – 3,500 (1,400 – 4,900 with infill line)	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
	207 dB SEL_{24hr}	50	203 dB SEL_{24hr}	150				
Fish eggs and fish larvae*	>207 dB Pk SPL	130 – 250	(N) Moderate (I) Low (F) Low	-	(N) Moderate (I) Low (F) Low	-	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
	>210 dB SEL_{24hr}	30						

Notes: Peak sound pressure levels (Pk SPL) dB re 1 µPa; SEL dB re 1 µPa ^{2}·s. Cumulative sound exposure level ($SEL24_{hr}$) dB re 1 µPa ^{2}·s. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F). *See zooplankton subsection (above) for further discussion on fish eggs and larvae.

SEL24hr values represent impact from multiple pulses with associated distances representing zones of cumulative impact (maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels) including infill lines.

Woodside (2007) conducted a comprehensive investigation to assess the effects of a seismic survey on reef fish in Western Australia. Water depths during this study ranged from 20 – 1,100 m and the study used a seismic source with a source volume of 2,005 in^3. This study assessed fish diversity and abundance, coral health, and pathology changes in sensitive auditory tissues. Sound loggers and remote underwater video were deployed, and fish exposure cages were utilised to contain captive reef fish. The study report indicated that no temporary or permanent threshold shifts were detected in any species and identified no long-term impacts on fish populations.

McCauley *et al*. (2003) examined the effects of seismic source exposure on snapper (*Pargrus auratus*); a species whose distribution includes the Otway Basin 2DMC MSS Operational Area. This controlled exposure experiment simulated a seismic vessel approaching then moving away, during which caged fish were exposed to seismic outputs that exceeded 180 dB re 1 μPa^2-s. Fish were sacrificed after the experiment so that their ear structures could be examined for any damage. This study found that a small number (2.7%) of the total number of sensory hair cells sustained severe damage in several of the exposed fish even two months after exposure. While this result could represent permanent auditory damage, the authors note that the caged fish had no ability to escape the sound field; hence, could have been exposed to seismic outputs much greater than those of wild fish in the vicinity of a survey vessel.

Hastings *et al*. (2008) exposed four tropical fish species (a hearing specialist and three species of hearing generalists) to a cumulative seismic exposure of 190 dB re 1μPa^2.s using a 2,055 in^3 acoustic array. These authors found no evidence of physiological injury, even in the hearing specialist species, which was sensitive to a broader range of frequencies of sound than the other three species.

Santulli *et al*. (1999) exposed sea bass (*Dicentrarchus labrax*) to seismic emissions and found significant changes in cortisol, glucose, lactate, AMP, ADP, ATP and cAMP levels in different tissues after exposure, indicating a primary and secondary stress response. However, no mortality or physical trauma was observed, and biochemical parameters returned to normal values within 72 h post-exposure. Radford *et al*. (2016) also found that sea bass exposed to playbacks of recordings of impulsive seismic survey noise showed increased ventilation rates, indicating a stress response. However, this response was temporary, and those fish exposed to the playbacks for 12 weeks ceased to display increased ventilation rates or differences in stress, growth or mortality in comparison to the control group.

Scholik and Yan (2002) reported that a hearing threshold shift in fathead minnows was directly correlated to the sound frequency and duration of exposure. A temporary threshold shift was observed after one hour of exposure to white noise at >1 kHz; however, no threshold shift occurred at 0.8 kHz. Seismic surveys typically use an acoustic source that operates at a significantly lower frequency (2 – 250 Hz) than that used to demonstrate an effect in this study.

Sverdrup *et al*. (1994) found that exposure of Atlantic salmon (*Salmo salar*) to experimental seismic noise resulted in significant change in adrenaline and cortisol levels, and Popper *et al*. (2005) observed varying degrees of threshold shifts in northern pike, broad whitefish and lake-chub when fish were exposed to a 730 in^3 acoustic source. In this latter study, despite varying amounts of threshold shift, recovery of all species occurred within 24 hours post-exposure.

A review of the potential impacts of low-frequency seismic sound on the physical and physiological attributes of fish is provided by Carroll *et al*. (2017) and a summary of this is shown in **Table 54**. In accordance with the above discussion, **Table 54** shows that studies have reported varying results; the majority demonstrate no evidence of physical or physiological responses at either realistic or unrealistic exposure levels. Others however, report evidence of otolith/inner ear damage, temporal threshold shifts and stress bioindicators when exposed to low-frequency seismic sound at realistic exposure levels (**Table 54**).

Table 54 A Summary of the Potential Impacts of Low Frequency Sound on Fish

<table>
<tr><th></th><th colspan="6">Adult/juvenile fish</th></tr>
<tr><td colspan="7">Physical</td></tr>
<tr><td>Swim bladder damage</td><td colspan="6">2</td></tr>
<tr><td>Otolith/inner ear damage</td><td colspan="3">1</td><td colspan="3">1</td></tr>
<tr><td>Temporal Threshold Shift</td><td colspan="3">1</td><td colspan="3">2</td></tr>
<tr><td>Permanent Threshold Shift</td><td colspan="6">1</td></tr>
<tr><td>Organ/tissue damage</td><td colspan="6">3</td></tr>
<tr><td>Mortality</td><td colspan="6">8</td></tr>
<tr><td colspan="7">Physiological</td></tr>
<tr><td>Metabolic rates</td><td colspan="6"></td></tr>
<tr><td>Stress bio-indicators</td><td colspan="2">1</td><td colspan="2">1</td><td colspan="2">1</td></tr>
<tr><td>Metamorphosis/settlement</td><td colspan="6"></td></tr>
<tr><td colspan="7">Behavioural</td></tr>
<tr><td>Startle/alarm response</td><td colspan="3">2</td><td colspan="3">6</td></tr>
<tr><td>Sound avoidance/migration</td><td colspan="2">4</td><td colspan="2">9</td><td colspan="2">1</td></tr>
<tr><td>Other changes in swimming</td><td colspan="6">1</td></tr>
<tr><td>Predator avoidance</td><td colspan="6"></td></tr>
<tr><td>Foraging</td><td colspan="6"></td></tr>
<tr><td>Reproduction</td><td colspan="6"></td></tr>
<tr><td>Intraspecific communication</td><td colspan="6"></td></tr>
<tr><td colspan="7">Key</td></tr>
<tr><td></td><td colspan="6">No response at either realistic or unrealistic exposure levels</td></tr>
<tr><td></td><td colspan="6">Response at realistic exposure levels</td></tr>
<tr><td></td><td colspan="6">Response at unrealistic/unknown exposure levels</td></tr>
<tr><td></td><td colspan="6">Possible response (conflicting results)</td></tr>
<tr><td></td><td colspan="6">No data, has not been tested</td></tr>
</table>

Notes: Numbers represent the number of studies reporting the result (as reported by Carroll *et al.,* 2017)

Impacts are classified according to the sound exposure treatments as realistic (i.e. short bursts of low-frequency sound at a distance of >1 – 2 m) or unknown/unrealistic (i.e. long duration and/or short distance of <2 m to sound source, nearfield sound exposure in aquaria).

There is no data for elasmobranchs (Carroll *et al.,* 2017)

Source: Table adapted from Carroll *et al.,* (2017)

During the Otway Basin 2DMC MSS there is potential for the acoustic source to induce temporary physiological effects on fish species that remain in close proximity to the acoustic source. Most pelagic fish are expected to avoid the area if sound levels become uncomfortable. The moving nature of the source and the use of soft starts also provide an opportunity for fish to move away from the source before being exposed to a full power noise impulse.

The key points from the STLM results in **Figure 55** indicate that:

- The modelling predicts that exposure to a single pulse of the acoustic source at full power could elicit mortality or recoverable injury in fish out to 250 m from the source in deep water, or out to 130 m from the source in shallow water;
- Cumulative exposure to multiple pulses from the moving noise source or infill lines does not increase the potential for mortality or recoverable injury to fish, as even if an infill line is required the peak noise effects result in threshold exceedances over greater distances than the cumulative noise effects; and
- There is potential for cumulative exposure to cause TTS at distances out to 1,000 m in shallow water, or out to several kilometres in deeper water. Completing an infill line increases the zones of potential TTS due to cumulative noise exposure, to a maximum of almost 5 km in deep water.

Benthic 'site-attached' fish species are typically less mobile and are unlikely to move far to avoid seismic disturbance. However, since the Operational Area is located in water depths greater than 50 m, with the vast majority (89% of the Operational Area and 91% of the survey lines) in water deeper than 1,000 m there is limited potential for benthic 'site-attached' species to come within close range of the seismic source where the more severe physiological effects would be more likely to occur. Based on all of the literature provided above the residual risk to fish physiology arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.2.2.1.6 Cephalopods

As described in **Section 5.2.4** and **5.5.2**, cephalopods that could be found in or around the Otway Basin 2DMC MSS Operational Area include six species of cuttlefish, seven species of squid, and thirteen species of octopus, none of which are listed as EPBC threatened fauna. Of these, there is only one commercially fished species, Gould's squid, which is the target species for the Southern Squid Jig Fishery.

Gould's squid (*Nototodarus gouldi)*, also known as Arrow Squid, can be found to depths of 800 m but are most abundant over the continental shelf at depths of 50 – 200 m. They are known to aggregate near the seabed during the day and move into the water column at night to feed.

Given their pelagic lifestyle, where they spend the daytime near the seabed and then rise to the surface waters to feed at night, there is the potential for squid and cuttlefish to come near the acoustic source during the Otway Basin 2DMC MSS. Octopus, on the other hand, are primarily reef dwelling benthic species so are less likely to be encountered in concentrations of significance in the Operational Area (see **Section 5.1.5**).

Acoustic trauma has been observed in captive cephalopods. Andre *et al*. (2011) exposed four species (two squid, one octopus and one cuttlefish species) to low frequency sounds with SELs of 157 ± 5 dB re 1 µPa (peak levels at 175 re 1 µPa). All exposed animals exhibited changes to the sensory hair cells (statocysts) responsible for balance, with damage becoming more pronounced in animals continuously exposed for up to 96 hours. This study estimated that trauma effects could occur out to 1.5 – 2 km from an operating acoustic source.

Similarly, Fewtrell (2003) found that southern calamari squid (*Sepioteuthis australis*) were able to detect acoustic noise at approximately 158 dB re 1 µ Pa, or at a distance of 2.1 km from a 2,678 in^3 acoustic source, although no trauma examination was conducted. However, Fewtrell (2003) did conclude that seismic survey noise of up to 192.4 dB re 1 µ Pa (0.2 km from a 2,678 in^3 acoustic source) is not lethal for *S. australis*.

Carroll *et al*. (2017) undertook a literature review on the physiological and physical effects of marine seismic surveys on fish and invertebrates, including cephalopods (**Table 55**). Carroll *et al*. (2017) categorised relevant studies into the presence or absence of a response from cephalopods depending on the level of exposure. The level of exposure was determined to be either "*realistic*" for seismic surveys (i.e. few short bursts of low frequency sound at >1 – 2 m), or "*unrealistic / unknown*" (i.e. continuous sound exposure, >100 bursts of near-field sound exposure in aquaria).

Table 55 A Summary of the Potential Impacts of Low Frequency Sound on Cephalopods

	Cephalopod
Physical	
Otolith/statocyst damage	3
Organ/tissue damage	1
Mortality/abnormality	1
Physiological	
Metabolic rates*	1
Stress bio-indicators	1
Immune response	
Energy stores	
Behavioural	
Startle response	5
Sound avoidance	1
Predator avoidance	
Foraging	
Reproduction	
Bioturbation	
Key	
(green)	No response at either realistic or unrealistic exposure levels
(red)	Response at realistic exposure levels
(yellow)	Response at unrealistic/unknown exposure levels
(blue)	Possible response (conflicting results)
(grey)	No data, has not been tested

Notes: *Includes proxies for metabolic rate such as food consumption, growth, respiration, developmental rate

Numbers represent the number of studies reporting the result (as reported by Carroll *et al*., 2017).

Impacts are classified according to the sound exposure treatments as realistic (i.e. short bursts of low-frequency sound at a distance of >1 – 2 m) or unknown/unrealistic (i.e. long duration and/or short distance of <2 m to sound source, nearfield sound exposure in aquaria).

Source: Table adapted from Carroll *et al.*, (2017)

Carroll *et al*. (2017) found no studies that had used "*realistic*" exposure levels and five that had used "*unrealistic / unknown"* exposure levels, including Andre *et al*. (2011), described above. Three had found damage to the statocyst (Andre *et al*. 2011, Solé *et al*. 2013, 2013a), one found respiratory suppression (Kaifu *et al*., 2007), and another found wider ecosystem consequences / stress bio-indicators (Solan *et al*., 2016).

Keevin and Hempen (1997) provide a literature review of the effects of underwater noise on aquatic invertebrates. The studies, most of which took place in the 1940s and 1950s, often lacked good experimental design such as adequate sample size, control, and measurements of pressures at distance from the blast. While cephalopods were not present in any of the studies, shrimp, crab and oysters featured most often. Nonetheless, Keevin and Hempen (1997) conclude that invertebrates are insensitive to pressure related to underwater noise. This is plausible since they speculate that this could be due to the lack of gas containing organs, such as a swim bladder, which has been implicated in the mortality of fish in similar experiments.

The effect of seismic surveys on cephalopod larvae and eggs is unknown, although larvae and juveniles are most often found in shallow coastal waters (AFMA, 2018j), which are mostly outside the Otway Basin 2DMC MSS Operational Area.

Squid are generally short-lived, fast growing species with high fecundity rates and studies have shown that arrow squid can produce eggs year-round (Virtue *et al*., 2011). So, if there was any potential for loss in recruitment over a three-month period, then the squid's life history traits (mentioned above) mean they are well adapted to disturbance and the populations would not be at the same risk as those species which only spawn once a year.

Given there is no information or exposure thresholds on squid eggs or larvae, we have assessed the effects of sound levels produced from the STLM on fish eggs and larvae, which have been used as a proxy for squid eggs and larvae. It is considered that these sensitive life stages will be somewhat similar for assessing the potential physiological impacts from acoustic disturbance. Although it is acknowledged there are differences between squid eggs and fish eggs and where they are within the water column.

The Pk SPL threshold for mortality and potential mortal injury to fish eggs and larvae is >207 dB re 1µPa. From the modelling results, this equates to a maximum horizontal distance from the acoustic source of 130 m in the 50 m water depth modelled, and 250 m in the 4,800 m water depth modelled.

The survey design of 5 km line spacing's that SLB have proposed, with long line lengths which will take approximately 11 hours to acquire will also assist in reducing any focused effects in a given area, and at this spatial scale would be at the levels that would not cause any population effects to fish eggs or larvae as a result of their life history traits. Given this is the closest threshold we have to apply to the eggs and larvae of squid we would expect similar zones of impact to apply to squid eggs and larvae.

Using the mortality criteria for fish eggs and larvae, zones of impact were determined by comparison of the predicted received levels to the noise exposure criteria. In this instance we have used the zones of impact for immediate impact from single pulses of noise exposure, to the maximum horizontal distance from the acoustic array.

This, combined with the finding that a relatively high SEL, was found to be non-fatal to squid, and that larvae and juveniles are most often found in shallow coastal waters, suggests that there is no anticipated long-term risk to squid populations presented by the Otway Basin 2DMC MSS.

There is no evidence to suggest that other cephalopod species are more prone to physiological impacts from underwater noise then squid, consequently, the residual risk to cephalopod physiology arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Unlikely*).

7.2.2.1.7 Marine Reptiles

As described in **Section 5.2.5**, five species of turtle have been reported in southern Australian waters (i.e. South Australia, Victoria, Tasmania) and two of these species; the leatherback turtle (*Dermochelys coriacea*) and the loggerhead turtle (*Caretta caretta*) have distributions which may include the Otway Basin 2DMC MSS Operational Area (DoE 2018g; DoE 2018h). Both species are migratory and have an EPBC Act listing status of endangered.

Nelms *et al*. (2016) conducted a thorough literature review of studies carried out world-wide to investigate the behavioural and physical impacts of seismic surveys on turtles. Nelms *et al*. (2016) found that all species investigated (including loggerhead and leatherback turtles) have a hearing range that overlaps with the peak amplitude low frequency sound produced during seismic surveys (10 – 500 Hz). This suggests that turtles will be sensitive to acoustic energy, although no studies have assessed physical (tissue) damage to hearing structures. One study (Gurjao *et al.*, 2005), looked for evidence of turtle mortality during 2D seismic surveys off the coast of Brazil. Of the eight dead turtles found in the vicinity, five appeared to have been recently caught and damaged by fishermen and had subsequently died. The authors do not speculate as to the cause of death for the other three dead turtles and did not say whether any post-mortems were conducted.

The noise exposure criteria for effects of seismic outputs on sea turtles are presented in **Table 56**. These are based on the working group technical report by Popper *et al.* (2014) which states that as there are few data available on the hearing abilities of sea turtles, their use of sounds, and their vulnerability to sound exposure, threshold values are based on extrapolations from other animal groups.

Table 56 Noise Exposure Criteria (Popper *et al*., 2014) and Zones of Impact (Maximum Distances from Source to Impact Threshold Levels) for Mortality and Potential Injury for Sea Turtles

<table>
<tr><th rowspan="2"></th><th colspan="2">Mortality and potential injury</th><th colspan="3">Impairment</th><th rowspan="2">Behaviour</th></tr>
<tr><th>Criteria</th><th>Maximum Threshold Distance (m)</th><th>Recoverable injury</th><th>Temporary Threshold Shift</th><th>Masking</th></tr>
<tr><td rowspan="2">Sea turtles</td><td>>207 dB Pk SPL</td><td>130 – 250</td><td rowspan="2">(N) High
(I) Low
(F) Low</td><td rowspan="2">(N) High
(I) Low
(F) Low</td><td rowspan="2">(N) Low
(I) Low
(F) Low</td><td rowspan="2">(N) High
(I) Moderate
(F) Low</td></tr>
<tr><td>210 dB SEL_{24hr}</td><td>30 (~40 m with infill line)</td></tr>
</table>

Notes: Peak sound pressure levels (Pk SPL) dB re 1 µPa: Cumulative sound exposure level (SEL_{24hr}) dB re 1 µPa^2.s. All criteria are presented as sound pressure since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

The SEL24hr value represents impact from multiple pulses with the associated distance representing the zone of cumulative impact, including for an infill line scenario.

Acute noise from seismic surveys is considered in the Recovery Plan for Marine Turtles in Australia 2017-2027 (Commonwealth of Australia, 2017a). This report acknowledges that loggerhead turtles are known to be sensitive to sounds of between 100 – 400 Hz, and that very little is known of the impact of noise on marine turtles. The report also indicates that "*Given that the impacts of noise are unknown, a precautionary approach should be applied to seismic work, such that surveys planned to occur inside important inter-nesting habitat should be scheduled outside the nesting season*." There is no threat risk assessment for turtles within the South-east Marine Area in Appendix B of the Recovery Plan for Marine Turtles in Australia 2017-2027 (Commonwealth of Australia, 2017a).

While the endangered leatherback and loggerhead turtles are known to migrate through the Otway Basin 2DMC MSS Operational Area and the known hearing range of turtles suggests that seismic survey noise is potentially harmful (although there is currently no evidence to show that this is the case), there is no evidence to suggest that the Otway Basin 2DMC MSS Operational Area supports biologically important habitat that is considered critical to the survival of marine turtles located within the South-east Marine Area (National Conservation Values Atlas).

On this basis, there is no anticipated long-term risk to turtle populations presented by the Otway Basin 2DMC MSS. Consequently, the residual risk to marine reptile physiology arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Moderate* x *Rare*).

7.2.2.1.8 Cetaceans and Pinnipeds

Marine mammals are highly vocal and are dependent on sound for almost all aspects of their lives; foraging, reproduction, communication, detection of threats, and navigation, and as a result, are particularly sensitive to anthropogenic noise (Weilgart, 2007). Marine mammals may suffer lethal and sub-lethal physiological effects (e.g. damage to body tissues resembling decompression sickness in humans, damage to hearing, and chronic stress (Gordon *et al*., 2003)) when exposed to high intensity underwater noises at close range. The sound intensities that would result in such effects are largely unknown for most species, with current knowledge of traumatic thresholds based on only a few experimental species (Richardson *et al*., 1995; Gordon *et al*., 2003).

The likelihood that exposure to shipping noise would be sufficient to permanently damage the hearing of marine mammals is remote (Southall & Hatch, 2008); however, long-term exposure may induce a stress response similar to that found in humans that live near busy roads or airports (Evans *et al.*, 2001).

The first evidence of chronic stress in whales in response to vessel noise was demonstrated by Rolland *et al.* (2012) in North Atlantic right whales. Vessel traffic was reduced in the Bay of Fundy, California following the events of September 11, 2001, resulting in a corresponding reduction in background noise level. This reduction in noise was associated with decreased baseline levels of stress-related faecal hormone metabolites in the right whales (Rolland *et al*., 2012). Although no other factor was found that could explain the difference, the results must be interpreted with caution as analysis was based on a non-repeatable event, sample sizes are relatively small, and there are no comparable acoustic recordings from the Bay of Fundy in years other than 2001 (Rolland *et al*., 2012).

Although tissue damage by shock waves from explosives has been demonstrated on terrestrial animals, pressure pulses from acoustic sources have longer rise times and are less likely to cause damage than explosives. There is no pathological evidence to date of acute physical damage to marine mammals from seismic sources or seismic surveys (Gordon *et al*., 2003); however, one incident of severe behavioural distress, followed by ataxia has been noted for a pantropical spotted dolphin in close proximity to a seismic array, suggesting a link between acoustic exposure and physiological damage (Gray & van Waerebeek, 2011).

Chronic stress and physiological changes can supress the immune system, compromising the health of an animal (Weilgart, 2013). Increases in stress hormones have been observed in captive beluga whales and bottlenose dolphins exposed to sound emissions from an acoustic source (Romano *et al*., 2004).

Exposure to high intensity noises can result in a ‘threshold shift’; that is changes in the ability of an animal to hear, usually at a certain frequency, whereby sensitivity to one of more frequencies is lost (Southall *et al*., 2007). Threshold shifts can be temporary, with recovery after minutes or hours, or be permanent. A TTS is more common in marine mammals as their mobile, free-ranging nature means they are usually able to avoid areas in which SELs would be dangerously high. However, exposure to sounds that can cause a TTS usually can cause a PTS if an animal is repeatedly exposed for a sufficient length of time (Gordon *et al*., 2003). It is believed that to cause immediate serious permanent physiological damage to marine mammals, SELs need to be very high (Richardson *et al*., 1995).

Marine mammals can be split into ‘hearing groups’ (**Table 57**) based on their generalised hearing range (Southall *et al*., 2007). Outside of this hearing range, the risk of auditory impacts from sound is unlikely (NMFS, 2016). The US National Oceanic and Atmospheric Administration (**NOAA**) produced a table of un-weighted thresholds for the onset of TTS and PTS in cetaceans based on their assigned hearing (**Table 57**).

Table 58 lists the PTS onset thresholds for pinnipeds also based on NMFS (2016). NMFS (2016) is a technical guidance document based on the compilation, interpretation and synthesisation of scientific literature to produce acoustic thresholds which assess how human-caused sound affects the hearing of marine mammals. The acoustic thresholds cover the onset of both TTS and PTS. These are levels that, if exceeded, will likely result in temporary or permanent changes in marine mammal hearing sensitivity (NMFS, 2016). Key literature contributing to the calculation of these thresholds includes studies discussed throughout this section, as well as Finneran (2016) which describes the rationale and steps used to define proposed numeric thresholds for predicting auditory effects on marine mammals exposed to anthropogenic sound. In relation to low frequency cetaceans (i.e. baleen whales) it is noted that there is no hearing-group specific data for TTS onset due to impulsive noise exposure. The thresholds applied by NMFS have been inferred from studies of other cetaceans.

Table 57 PTS and TTS Threshold Levels for Individual Cetaceans Exposed to Impulsive Noise Events (NMFS, 2016) and Zones of Impact (Maximum Distances from Source to Impact Threshold Levels)

Hearing group	PTS and TTS threshold levels – impulsive noise events							
	Injury (PTS) onset				TTS onset			
	Pk SPL		Weighted SEL24hr		Pk SPL		Weighted SEL24hr	
	Pk SPL (dB re 1µPa)	Maximum threshold distance (m)	Weighted SEL24hr (dB re 1µPa2.s)	Maximum threshold distance (m)	Pk SPL (dB re 1µPa)	Maximum threshold distance (m)	Weighted SEL24hr (dB re 1µPa2.s)	Maximum threshold distance (m)
Low frequency cetaceans – baleen whales	219	45 – 50	183	450 – 1,200 (630 – 1,680 with infill line)	213	80 – 130	168	>5,000 (>7,000 with infill line)
Mid-frequency cetaceans – most dolphins, toothed whales, beaked whales	230	8 – 16	185	-	224	12 – 27	170	10
High-frequency cetaceans – porpoises, pygmy and dwarf whales	202	275 – 400	155	20	196	380 – 760	140	500 – 1,000 (700 – 1,400 with infill line)

Note: Weighted SEL24hr values represent impact from multiple pulses with associated distances representing zones of cumulative impact (maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels), including infill line scenarios.

Table 58 The PTS and TTS Threshold Levels for Individual Pinnipeds Exposed to Impulsive Noise Events (NMFS, 2016) and Zones of Impact (Maximum Distances from Source to Impact Threshold Levels)

Hearing group	PTS and TTS threshold levels – impulsive noise events							
	Injury (PTS) onset				TTS onset			
	Pk SPL		Weighted SEL24hr		Pk SPL		Weighted SEL24hr	
	Pk SPL (dB re 1µPa)	Maximum threshold distance (m)	Weighted SEL24hr (dB re 1µPa2.s)	Maximum threshold distance (m)	Pk SPL (dB re 1µPa)	Maximum threshold distance (m)	Weighted SEL24hr (dB re 1µPa2.s)	Maximum threshold distance (m)
Phocid Pinnipeds (Underwater)	218	12 – 55	185	10	212	80 – 140	170	200 – 500 (280 – 700 with infill line)
Otariid Pinnipeds (Underwater)	232	8 – 12	203	-	226	10 – 22	188	10

Note: Weighted SEL_{24hr} values represent impact from multiple pulses with associated distances representing zones of cumulative impact (maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels), including infill line scenarios.

All Australian marine mammals are fully protected under the EPBC Act, so the potential for causing physiological damage during any MSS is taken extremely seriously. This is particularly important for those species that have a threat classification; of which the following have been identified as having a 'moderate to high likelihood' of being encountered during the Otway Basin 2DMC MSS (see **Section 5.2.6.1**): southern right whales (*vulnerable*), pygmy blue whales (*vulnerable*), sei whales (*vulnerable*), fin whales (*vulnerable*) and humpback whales (*vulnerable*).

The risk of TTS to whales during the Otway Basin 2DMC MSS is largely reduced by compliance with the EPBC Act Policy Statement 2.1; where the Shut-down Zones prevent the possibility of TTS from short-term exposure for all species. However, the hearing sensitivity of baleen whales means that there is potential for TTS to occur over distances out to 5 to 7 km from the acoustic source, if an individual whale remains in one area and is exposed to repeated noise impulses over a 24-hour period. In a 24-hour period two survey lines could be completed, and the survey vessel could travel around 180 km in total; hence cumulative exposure of this nature is highly unlikely.

However, in the worst-case infill scenario with a line repeated at a specific location after a minimum five-hour delay, an animal would need to remain in the vicinity of that specific infill location (within around 7 km of the active source) for at least five hours to risk TTS. With reference to the discussion on behavioural impacts to cetaceans (**Section 7.2.2.2.5**), behavioural disturbance to marine mammals is anticipated at distances of 2.5 km (50 m water depth) to 4.5 km (4,800 m water depth) from the active source. Therefore, although a theoretical potential for TTS in baleen whales has been identified based on STLM, in practice this risk is minimal because an individual animal would be expected to move away from the active source during the soft start or as the survey vessel approaches with an active source.

The risk of injury or permanent hearing damage to whales during the Otway Basin 2DMC MSS is minimised largely by compliance with the EPBC Act Policy Statement 2.1; the management measures to be implemented are detailed in **Section 3.4.7** and **Table 66**.

The underwater noise threshold levels for TTS and PTS in low, mid and high frequency cetaceans are provided in **Table 57**. The predicted zones of impact from a single pulse of the acoustic source for the Otway Basin 2DMC MSS have been determined by STLM and are also provided in **Table 57** along with the predicted zones of cumulative impact which have been modelled over a 24 hour period and for a scenario where an infill line is required at a particular location, commencing a minimum of five hours after the original data acquisition attempt. These zones of impact are presented as 'maximum threshold distances', with the distance range representing the variance in the predicted zone of impact over the range in water depths throughout the Operational Area; where the largest distance corresponds to the deepest water (i.e. 4,800 m) and the smallest distance corresponds to the shallowest water (i.e. 50 m). For the purpose of this EP, the single pulse and the cumulative modelling results are both used to assess the potential zones of impact on marine mammals, with the larger threshold distance having the greatest influence on the formulation of ecological conclusions.

Whales, as defined by the EPBC Act Policy Statement 2.1 include baleen whales and larger toothed whales, (e.g. sperm whales, killer whales, false killer whales, pilot whales and beaked whales). For the purpose of interpreting the STLM results it is important to note that baleen whales are classified as low frequency cetaceans, while the larger toothed whales are typically mid-frequency cetaceans. The only high frequency whale species predicted to be present in the Operational Area is the pygmy sperm whale.

The key points from **Table 57** can be summarised as follows:

- The STLM predicts that exposure to a single pulse of the acoustic source could elicit PTS (i.e. permanent hearing damage) for baleen whales that approach to within 45 – 50 m of the acoustic source, and that in the event that baleen whales are present within 450 – 1,200 m of the active source line they could also experience PTS due to cumulative exposure over a 24-hour period;
- Temporary hearing damage (i.e. a TTS) could occur if baleen whales were exposed to a single pulse at a distance of 80 – 130 m, or for whales remaining at one location for an extended time period within around 5 km of an active survey line, or around 7 km if an infill line is required. Because this distance is larger than the anticipated behavioural disturbance zone, animals are expected to move away in practice and for this reason TTS in baleen whales is unlikely;
- Mid-frequency cetaceans that approach to within 8 – 16 m could suffer PTS from a single pulse, but no potential for PTS due to cumulative SEL exposure has been identified for these species. A TTS could occur if mid-frequency cetaceans are within 12 – 27 m of the active source; and
- High-frequency cetaceans within 275 – 400 m of the active source could suffer PTS from a single pulse, and TTS could occur due to cumulative exposure if high-frequency cetaceans are present within 500 – 1,000 m of the line of the active source, or out to 1,400 m if they remain present in this zone when an infill line is required.

Given the control measures that will be implemented during the Otway Basin 2DMC MSS, in particular the 2 km Extended Shut-down Zone, it is extremely unlikely that any whale will approach close enough to the acoustic source during periods of full operational power for severe physiological effects (PTS or permanent injury) to occur. The potential for temporary hearing damage to individual baleen whales has been identified, although this would only occur if a whale goes undetected inside the Extended Shut-down Zone or if they remain in the general vicinity (5,000 – 7,000 m) of the active source for a period of more than 5 hours. The residual risk to whale physiology arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Moderate* x *Rare*).

The EPBC Act Policy Statement 2.1 does not require any shut-downs for smaller dolphins or pinnipeds, so any of these species that make close approaches to the active acoustic source could theoretically be subject to physiological effects. The STLM results for high-frequency cetaceans (**Table 57**) apply to small dolphin species and the predicted zone of impacts for pinnipeds are provided in **Table 58**. These results clearly indicate some potential for threshold shifts to occur; however, generally marine mammals move away from the seismic vessel as the generated sound levels gradually increase (Weir & Dolman, 2007). Consequently, the residual risk to the physiology of small dolphins and pinnipeds arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Moderate** (*Catastrophic* x *Rare*).

7.2.2.1.9 Elasmobranchs

The white shark is a protected species listed as Vulnerable and Migratory under the EPBC Act and is listed as protected under Fisheries Management Regulations in the coastal waters of Tasmania, South Australia, and Victoria. The Otway Basin 2DMC MSS Operational Areas overlaps with the BIA for the white shark (**Figure 21**) and there is a recovery plan in place that identifies actions to ensure this species long term viability and survival.

Within the Australian Marine Parks within and surrounding the Operational Area, the white shark is identified as using the areas for foraging, and have been identified as likely to be within the Operational Area during the Otway Basin 2DMC MSS; however, this is outside the high distribution area of South Australia (**Figure 67**).

In Australia, the principal current threats to the recovery of white sharks included mortality from incidental bycatch or illegal catch from fisheries (both commercial and recreational) and from shark control activities (such as beach meshing or drum-lining for the east coast population; DoEE, 2018y). Other potential recovery threats include illegal trade for shark teeth, jaws and fins, and ecotourism impacts (such as cage diving). Acoustic impacts were not identified as a threat to the recovery of the white shark (DoEE, 2018y).

In South Australia, Great White Sharks are a tourist attraction (via boat, plane and shark cage diving), where cage diving is primarily focused around the Neptune islands at the entrance to the Spencer Gulf (to the northwest of the Operational Area).

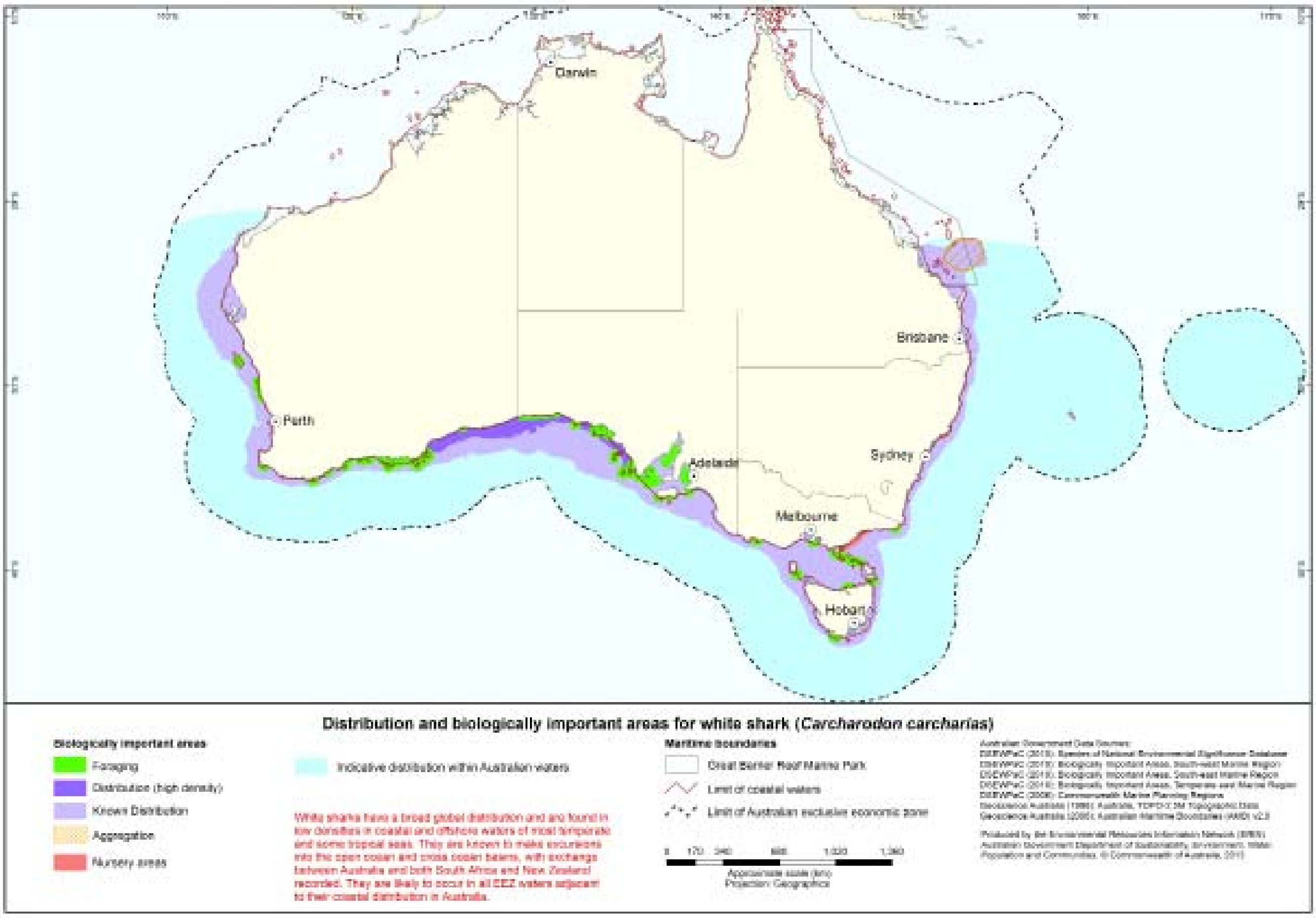
Very little research has been undertaken on the effects of acoustic noise or seismic surveys on elasmobranchs. Sharks differ to bony fish in that they have no swim bladder or other gas filled chambers that can act as secondary hearing organs in the body, so are unlikely to respond to changes in pressure like bony fish may due to the physiological differences (Myrberg, 2001; Casper, 2011). As a result, sharks cannot detect pressure changes associated with sound waves (Carrol *et al*., 2011). The lateral line system of shark also does not respond to normal acoustic stimulus and is not able to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg, 2001).

Seismic survey activities frequently incur shark attacks to streamers deployed from the vessel and to the PAM hydrophones, although the specific reason for these attacks is not known it is considered it is the electromagnetic fields that attracts the sharks to bite. SLB have had a number of shark bites to streamers during previous MSSs in both New Zealand and Australia, indicating that sharks will approach an active acoustic source. Likewise, MMO's often make observations that are recorded in their MMO reports of sharks (such as blue sharks and mako sharks) on the surface in close proximity to the seismic vessel while the source is active.

Consequently, the residual risk to elasmobranch physiology arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Rare*).

It is highly unlikely that underwater noise emissions from the acoustic source, either within or outside the Operational Area, would result in any lethal or sub-lethal injuries leading to immediate or delayed mortality or physiological effects on shark species, including the white shark. The use of soft starts prior to commencing the MSS will allow any sharks in close proximity to move away from the acoustic source if they are not comfortable with the frequencies, which will mitigate the risk of impacts on sharks.

Figure 67 Distribution of White Sharks



Source: DSEWPC, 2013

7.2.2.1.10 Seabirds

Since high intensity acoustic disturbances such as those from an MSS have the potential to cause physiological harm to marine mammals and fish, it is reasonable to assume that seabirds could also suffer physiological damage. Seabirds resting on the sea surface are typically startled by an approaching seismic vessel and would therefore be displaced from the immediate vicinity of the acoustic source, limiting their exposure to seismic emissions. Birds on the sea surface are unlikely to suffer physiological effects as the Lloyd Mirror effect means that noise levels at the surface are lower than those deeper in the water column (Carey, 2009).

Physiological damage might only occur to those seabirds within the Operational Area that exhibit diving behaviours (i.e. Australasian gannet, little penguin, common-diving petrels, and shy albatross (**Table 59**)) and which are in extremely close proximity to the acoustic source. Due to their largely aquatic existence and lack of flight ability, little penguins are expected to be more susceptible to effects from seismic surveys than other seabirds (Pichegru *et al*., 2017).

However, birds such as the little penguins chase small bait fish as their prey, and it is likely that these small fish would be displaced from the immediate vicinity of the active acoustic source. Seabirds are expected to detect this change in fish distribution and cease any foraging, which would in turn reduce their exposure to any potential physiological effects.

To date there is limited evidence of effects of seismic surveys on seabirds, with all documented effects limited to behavioural effects (see **Section 7.2.2.2.7**).

Table 59 Diving Seabirds within the Otway Basin 2DMC MSS Operational Area

Species	Dive parameters
Australasian gannet	Dive to a maximum depth of 23 m and remain submerged for up to 42 seconds; however, most dives are to depths of 2 m and for less than 6 seconds (Green *et al*., 2009).
Little penguin	Mean recorded dives from Bass Strait colonies ranged from 5.4 – 10.9 m for 13.2 – 28.6 seconds (Hoskins *et al*., 2008). Areas of enhanced productivity are known to influence foraging (as referenced in Poupart *et al*., 2017).
Common diving petrel	Carry out dives to average depths of 31 ± 6 m (Bocher *et al*., 2000)
Shy albatross	Have been reported to dive to depths of up to 7.4 m, with the majority of dives within the first 3 m of the water column (Hedd *et al*., 2008).

Consequently, the residual risk to seabird physiology arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Rare*).

7.2.2.2 Potential Behavioural Impacts

Behavioural responses are a demonstrable change in the activity of an animal in response to a disturbance (Nowacek *et al.,* 2007) and include movement away from an area in order to avoid a disturbance, or a change in normal behaviours such as diving, respiration, and swimming speed. In addition to avoidance response, some animals may be attracted to areas of disturbance. The most commonly observed behavioural response to active seismic operations is avoidance, which has been widely documented for marine mammals (e.g. Goold, 1996; Stone & Tasker, 2006; Thompson *et al*., 2013) and fish (e.g. Engas *et al*., 1996; Slotte *et al*., 2004), and which can lead to the displacement of animals from preferred habitat.

Displacement from an area can lead to relocation into sub-optimal or high-risk habitats, resulting in negative consequences such as increased exposure to predators, decreased foraging or mating opportunities, alterations to migration routes etc. Displacement could also have indirect effects, for instance feeding activities of predators could be disrupted by the displacement of prey species which could lead to energetic consequences.

Discussions on the behavioural impacts from vessel noise and the acoustic source on marine fauna are provided in the subsections below for each environmental receptor. Where possible, discussions have paid particular focus to species that have been identified to be potentially present within the Operational Area through the development of this EP. Perceptual impacts (i.e. changes in vocalisations and masking) are discussed in **Section 7.2.2.3** while physiological impacts have been addressed in **Section 7.2.2.1**.

7.2.2.2.1 Benthic Invertebrates

Exposure to seismic sound can elicit various behavioural responses in benthic invertebrates. Hawkins *et al*. (2015) reports that, at lower sound levels, behavioural responses are more likely to occur than physical and/or physiological responses. Behavioural responses are, however, the most difficult to monitor *in situ* and consequently, many studies investigating the effects of seismic operations on the behaviour of benthic invertebrates are conducted under laboratory conditions or by deploying caged individuals in the field (Carroll *et al*. 2017). The limitations of these approaches are discussed in **Section 7.2.2.2.2**.

Behavioural responses have the potential to adversely affect a population by, for example, reducing foraging and/or predator avoidance rates. Conversely, they may elicit responses that are brief and pose no overall risk (e.g. a startle response). Research has shown that avoidance behaviours to sound have longer-lasting effects on populations than startle responses. For example, in the former, individuals may move away from an area where seismic surveys have occurred.

Carroll *et al*. (2017) provided a summary of the potential impacts of low frequency sound on the behavioural responses of marine invertebrates based on a review of the relevant literature (**Table 51**). For decapods, foraging, reproduction and bioturbation response at unrealistic or unknown exposure levels were each reported by one study; three studies reported a possible response, conflicting or anecdotal results with respect to predator avoidance; two studies reported a possible response, conflicting or anecdotal results for startle response; and one study reported no response to sound avoidance. Studies which examine the behavioural responses of marine decapods and bivalves to seismic acoustic exposure are discussed below.

In Tasmanian waters, a field experiment was conducted to assess the behavioural responses of rock lobsters (*J. edwardsii*) to a 150 in^3 acoustic source (Day *et al*., 2016a). The study found that seismic exposure significantly increased righting time in lobsters that had been placed on their backs. Ecologically, this could potentially increase predation rates of exposed individuals; whilst it was raised during engagement that if response time of rock lobster became sluggish following seismic exposure, this could have an influence on their commercial value if they did not appear in prime condition when exported live to international fish markets. In comparison, Payne *et al*. (2007) reported no differences in righting time in the American lobster (*Homarus americanus*) 9, 65, or 142 days after exposure to an acoustic source, suggesting no immediate or long-term effects on predator avoidance behaviour for this species.

Payne *et al*. (2008) found that when the American lobster was exposed to a seismic acoustic source, a significant increase in food intake occurred for several weeks after the exposure under both laboratory and field conditions. In the laboratory, the acoustic source reached an average peak-to-peak pressure of around 202 dB with a peak energy density of 144 – 169 dB re 1 µPa^2/ Hz; in the field, the average exposure reached 227 dB peak-to-peak and had an average peak energy density of 187 dB re 1 µPa^2/ Hz. The authors hypothesised that this may have been due to an increase in stress.

Christian *et al*. (2003) examined the behaviour of snow crabs before, during and after exposure to seismic outputs and observed that, in the laboratory, they reacted slightly when sharp sounds were made near them. However, in the field, caged crab showed no readily visible reactions to the 200 in^3 acoustic source 50 m above them. Tagged crabs did not undergo any large-scale movements out of the area.

For decapods, alarm response to sound have been shown to be highly localised, with alarm behaviour occurring only when they were <10 cm away from the sound source (Goodall *et al*., 1990) and they have shown no such behaviour in response to seismic sound at distances of 1 m or more (Goodall *et al*., 1990; Christian *et al*., 2003).

There is a lack of information with regards to the behavioural effects of seismic surveys on shellfish. As reported by Carroll *et al*. (2017) (**Table 51**), two studies have shown evidence of a startle response in bivalves at realistic sound exposure levels (Day *et al*. 2016a; Roberts *et al*. 2015), although only one of these studies used seismic outputs as the sound source. Day *et al*. (2016a) reported that scallops exposed to seismic outputs display a distinctive flinching response, an increase in burial rate and were slower at righting themselves than control scallops. It is possible that the slowed righting response could lead to higher predation rates; however, the ecological implications of this are not clear. No energetically costly responses, such as swimming, have been observed in scallops as a result of exposure to an acoustic source.

The Otway Basin 2DMC MSS Operational Area has relatively deep waters throughout, where more than 96% of the Operational Area has water depths greater than 200 m. This water depth not only determines what benthic invertebrate species are living within the Operational Area, but it also provides a large separation distance between the seismic source and the seabed. The typical distances between the acoustic source and the seabed within the Otway Basin 2DMC MSS Operational Area are far greater than most of the scientific experiments conducted in the literature to assess potential effects of seismic on marine receptors, as referenced within this EP. As such, the residual risk for behavioural impacts to benthic invertebrate species from exposure to seismic sound has been assessed as **Low** (*Minor* x *Unlikely*).

The effects of acoustic surveys on catch rates and fisheries which may manifest as a result of behavioural responses discussed in this section are assessed in **Section 7.2.3**.

7.2.2.2.2 Fish

Fish have demonstrated avoidance responses to vessels, which include both vertical and horizontal movements, as well as altering schooling behaviours. Behavioural changes of fish as a result of vessel noise have been interpreted as an anti-predator behaviour (as referenced in Skaret *et al*., 2005).

Bluefin tuna are present within the Otway Basin 2DMC MSS Operational Area and studies have shown that they alter their schooling behaviour when subjected to an external noise source from an approaching vessel. When schools of bluefin tuna are captured they are held in large oceanic pens, and when they are in the presence of boat noise, it was found that they were less coherent compared to when vessel noise was not present. This was evident by a number of individual fishes increasing their vertical movements towards the surface or bottom of the pens (Sara *et al*., 2007). However, regular schooling behaviour of the bluefin tuna returned following the passing of the vessel (Sara *et al,* 2007), therefore long-term effects to fish are only likely to occur in areas of high vessel traffic.

Avoidance behaviour in the form of horizontal and vertical movements away from vessel noise was demonstrated in herring (Vabø *et al*., 2002) and Atlantic cod (Handegard *et al*., 2003); however, no avoidance attributable to vessel noise was observed in spawning herring by Skaret *et al*. (2005). The lack of avoidance led the authors to suggest that sensitivity of fish to vessel noise is dependent on the behavioural state of the animal (e.g. actively feeding fish have relaxed predator vigilance). Avoidance behaviours to vessel noise are likely to be short-lived, with regular behaviours continuing following the passage of the vessel.

In preparing this EP, a number of behavioural studies were reviewed. In general, little indication of long-term behavioural disruption was apparent as a result of exposure to acoustic noise. Short-term responses were relatively common and included startle responses (Pearson *et al*., 1992; Wardle *et al*., 2001; Hassel *et al*., 2004; Boeger *et al*., 2006); modification in schooling patterns and swimming speeds (Pearson *et al*., 1992; McCauley *et al*., 2000; Fewtrell & McCauley, 2012); freezing (Sverdrup *et al*., 1994); and changes in vertical distribution in the water column (Pearson *et al*., 1992; Fewtrell & McCauley, 2012). Evidence of habituation was observed through a decrease in the degree of startle response (Hassel *et al*., 2004).

Behavioural responses of fish to acoustic disturbance vary depending on species traits, particularly sensory systems and the presence or absence of a swim bladder. Species which have swim bladders (or other gas-filled chambers) are generally more sensitive to sound exposure and more likely to suffer adverse effects from such exposure.

Species that do not have swim bladders or gas-filled chambers (e.g. sharks, skates, rays, jawless fishes, some flatfish, some gobies, some tuna and others) are less sensitive to sound and less likely to experience adverse effects; these species detect particle motion rather than sound pressure. In general, most fish with swim bladders are sensitive to sound frequencies between 50 and 500 Hz; seismic survey acoustic outputs are generally <200 Hz (McCauley *et al*., 2000). However, due to the huge range of physiology and sensory systems among animal groups, the impacts of sound on marine organisms cannot be generalised among species.

Experimental approaches to examining the effects of seismic surveys on fish behaviour typically involve exposing caged individuals to an acoustic source in either a laboratory or, less commonly in a field setting. As mentioned above, it is important to appreciate the limitations of caged laboratory and field experiments investigating fish behaviour. Laboratory experiments often apply intensities or durations of sound exposures that are unlikely to be encountered in the field, particularly for simulated seismic signals in tanks (Gray *et al*. 2016), whereby restricting the applicability of their results. Caution must therefore be exercised when interpreting results from captive studies as variability in the study design (i.e. source level, line spacing, timeframe, geographic area etc.) and the subjects (species, wild or farmed, demersal or pelagic, migrant or site-attached, age, etc.) often make it difficult to draw overall conclusions and comparisons. Furthermore, such studies typically only provide information on the behavioural responses of fish during and immediately after the onset of noise (Popper & Hastings, 2009). Beyond this, all behavioural observations are potentially biased by the fact that the subjects are constrained and may be unable to exhibit avoidance behaviours which would be possible in the wild.

Studies generally report short-term and localised impacts of acoustic disturbance on fish behaviour, with normal behaviour returning within approximately one hour after the removal of the acoustic source (McCauley *et al*., 2000; Pearson *et al*., 1992; Wardle *et al*., 2001).

The only evidence of a long-term behavioural effect from a seismic survey was noted by Slotte *et al*. (2004) who investigated the distribution and abundance of herring and blue whiting during a commercial 3D seismic survey off the Norwegian coast. During this study fish distribution was mapped acoustically within the seismic area and in the surrounding waters (up to 30 – 50 km away). The acoustic abundance of pelagic fish was consistently higher outside the seismic area than inside which the authors interpreted to be an indication of long-term displacement.

Pelagic fish tend to dive deeper (McCauley *et al*., 2000) and swim faster in more tightly cohesive groups (Fewtrell & McCauley, 2012), while reef species will return to the reef for shelter as the seismic vessel approaches and resume normal activity once the vessel has passed (Woodside, 2007; Colman *et al*., 2008). In addition to these findings, other studies have failed to detect any changes, e.g. Peña *et al*. (2013) observed no changes in swim speed, direction or school size of herring in response to a six hour exposure to a full-scale 3D seismic survey, and McCauley *et al*. (2000) found fish to generally show little evidence of increased stress from exposure to seismic signals unless restricted from moving away from the source, and no significant increase in blood cortisol concentrations (i.e. no increase in stress – see **Section 7.2.2.1.5**). Hassel *et al*. (2004) also found evidence of habituation to underwater noise through time.

In 2007, Woodside engaged a team of more than 20 specialists in the fields of underwater acoustics, coral reef ecology and reef fish biology to design and execute comprehensive investigations into the impacts of seismic airgun noise on (amongst other things) fish behaviour (Woodside, 2007). Behavioural observations of free-swimming fish showed that at close range, airgun noise emissions appeared to cause prominent, short-term effects on fish behaviour. As the vessel approached, fish ceased normal behaviours and moved downward from the water column towards the seabed. Fish began to feed and behave normally again within 20 minutes after the survey vessel had passed. Once the vessel had travelled beyond a distance of ~1.5 km fish numbers and behaviour had returned to normal baseline levels (Woodside, 2007). For caged fish, agitation levels increased with increasing received sound exposure level for the three holocentrid (squirrel fishes and soldier fishes) species studied but were not detectable for the bluestripe seaperch. Alarm responses were too infrequent to analyse (Woodside, 2007). Sonar observations of free-swimming fish showed that individuals tended to move deeper into the water column on approach of the operating seismic array consistently out to 400 m 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 seismic array and stayed significantly closer to the seabed out to 63 minutes post-exposure (Woodside, 2007). The overall conclusion from the behavioural seismic acoustic exposure experiments was that there was minimal impact on fish behaviour and that any changes that were observed were short term and unlikely to have caused any significant biological or ecological impacts (Woodside, 2007).

The Gippsland Marine Environmental Monitoring project was developed in Australia in 2015 to provide a more ecologically realistic view of the impact of seismic surveys on (amongst other things) fish behaviour (Przeslawski *et al*., 2016). A component of this project involved monitoring the behaviour of unrestrained fish before, during and after the April 2015 seismic survey in Gippsland Basin, Bass Strait. The study monitored multiple sites in an experimental and control zone, with tiger flathead, gummy shark and swellshark individuals being tagged and released. The results showed little evidence of behavioural changes induced by the seismic survey in the species studied. Individuals of both shark species moved in and out of the monitored areas across the study period, and gummy sharks were detected returning to the experimental zone during the period of seismic survey operations. The tiger flathead did show increased swimming speed during the seismic survey period, probably indicating a startle response, but if so the range of movement was not sufficient to generate a significant difference in displacement (travel) across the monitored array. The flathead also showed a change in diel movement patterns after the survey had ended; however, it is possible that this was consistent with the increase in movement events that have been previously reported for some species prior to seasonal departures (Andrews *et al*., 2010).

Demersal fish, particularly those exhibiting territorial behaviour and site fidelity, may be less likely to move to avoid sound sources than pelagic species (Wardle *et al*., 2001). However, Miller & Cripps (2013) found no significant effect of seismic surveys on fish species from the family Pomacentridae (site-attached coral obligate fish species), with respect to diversity, abundance and direct and indirect morality. Other studies (e.g. Woodside, 2007) exposing caged reef fish to the seismic outputs have found no evidence of direct mortality, soft tissue damage, or hearing threshold shifts. The majority of fish species likely to be in the Otway Basin 2DMC MSS Operational Area are pelagic species, and there are no threatened demersal species present.

Behavioural studies show little indication of long-term behavioural disruption or population level effects in pelagic and/or migratory fish (McCauley, 1994). The only evidence of a long-term behavioural effect from a seismic survey was noted by Slotte *et al*. (2004) as discussed above in regard to the distribution and abundance of herring and blue whiting during a commercial 3D survey off the Norwegian coast.

Carroll *et al*. (2017) produced a summary of the potential impacts of low-frequency seismic sound on fish behaviour (**Table 54**) based on a review of the relevant literature. In accordance with the above discussion, the summary showed that there were a number of studies reporting startle/alarm responses and/or sound avoidance/migration behaviours when exposed to low-frequency seismic sound at realistic exposure levels. However, other studies showed no such responses at either realistic or unrealistic exposure levels and another study reported conflicting results (**Table 54**).

With respect to acoustic threshold levels that may elicit behavioural responses in fish, McCauley *et al*. (2000) found that fish species may actively avoid sound levels of 161–168 dB re 1µPa rms (~175 – 183 SPL peak), which corresponded to a horizontal distance of ~15 km from the 4,120 in^3 array used in the study. Fewtrell & McCauley (2012) observed significant increases in alarm responses of fish to seismic outputs exceeding 147 – 151 dB re 1 µPa. These authors reported an increased in the occurrence of alarm response with increasing noise level. Conversely, Wardle *et al*. (2001) examined reef fish behavioural responses to seismic outputs with a measured peak level of 210 dB re µPa at 16 m and 195 dB re µPa at 109 m and observed no changes in behaviour.

Exposure criteria thresholds for fish based on all relevant literature are summarised within **Table 64**, and the STLM outputs have been used to determine at what distances away from the acoustic source these thresholds.

The pelagic fish species occurring within the Otway Basin 2DMC MSS Operational Area (**Section 5.2.3**) are generally highly mobile and are likely to move away from the acoustic source if sound levels become uncomfortable. As such, some short-term distributional changes for fish are possible during the Otway Basin 2DMC MSS. However, any effects are expected to be short-lived and fish are expected to resume normal behaviour in the days following acoustic exposure and are expected to move back to their normal habitats once the vessel has passed. Given the large line spacing, the vessel will not be concentrated in any particular area within the Otway Basin 2DMC MSS Operational Area for a long period of time and it has been estimated that the seismic vessel and the entire extent of the streamer and tail buoy will have passed through a particular area in under 1.5 hours.

Pelagic fish that target zooplankton as prey could be subject to indirect effects associated with changes to the abundance and distribution of zooplankton (see Section **7.2.2.1.1**). These potential flow-on effects to marine food webs are expected to be spatially restricted to within a few kilometres of the survey vessel with baseline conditions resuming relatively quickly after the survey line is complete (see Richardson *et al*., 2017). The energetic consequences of a small shift in foraging habitat will be negligible for predatory pelagic fish.

In addition, the deep-water bathymetry of the Otway Basin 2DMC MSS Operational Area means that noise exposure will be minimised for benthic fish species. Consequently, with the implementation of the control measures (**Table 66**) the residual risk of behavioural disruption to fish species and the consequences to fisheries from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.2.2.2.3 Cephalopods

Behavioural changes have been documented for cephalopods (squid and octopus species) in response to acoustic disturbance. Caged cephalopods that were exposed to acoustic sources demonstrated a startle response above 151 – 161 dB re 1 µPa and tended to avoid acoustic disturbance exhibiting surface behaviours (McCauley *et al*., 2000). During this study it was found that the use of soft-starts effectively decreased the startle response, and as included within **Table 66**, SLB will be operating in accordance with the EPBC Act and undertaking soft stats when commencing a survey line if the source is not already active.

A subsequent study corroborated these findings and further demonstrated that a source level of 147 dB re 1 µPa was necessary to induce an avoidance reaction in squid. Throughout this experiment, other reactions were also observed including alarm responses (inking and jetting away from the source), increased swimming speed and aggressive behaviour. It was noted that the reaction of the animals decreased with repeated exposure to the sound suggesting either habituation or impaired hearing (Fewtrell & McCauley, 2012). McCauley *et al*. (2000) suggested that thresholds affecting squid behaviour occur at 161 – 166 dB re 1 µPa rms.

Fewtrell (2003) looked at the response of southern calamari squid (*Sepioteuthis australis*) to seismic survey noise, finding avoidance behaviours once noise levels exceeded 158 dB re 1 µPa, and significant increases in alarm responses with noise exceeding 158–163 dB re 1 µPa. However, there was a decrease in the frequency of alarm response for repeated exposures, perhaps suggesting that they became habituated. In a similar study, Fewtrell & McCauley (2012) found that there was a significant increase in alarm response from squid as acoustic release noise levels increased beyond 147–151 dB re 1 µPa SEL, and that there were fewer alarm responses with continued exposure to acoustic source noise. Samson *et al*. (2014) found that cuttlefish became habituated to repeated 200 Hz pips at 150 dB and 165 dB, and Mooney *et al*. (2016) found that squid became habituated during sound exposure trials using 140 – 165 dB.

Fewtrell (2003) found that feeding squid ate immediately after noise exposure, suggesting rapid recovery, where it was noted that food appears to be a powerful stimulus to these animals - "*…. the presence of food in an area could override the stimulus to leave an area affected by seismic survey noise*". This is supported by McCauley *et al*. (2000a), who found that captive squid strongly associated the service dinghy with feeding, to the point where squid approached the dinghy to be fed immediately after the cessation of acoustic noise operations (from the same location). McCauley *et al*. (2000a) also found that cephalopods moved to the water surface during seismic survey simulation, and given sound exposure is lower at the surface due to the 'Lloyd Mirror Effect' this could indicate avoidance behaviour to the sound.

Carroll *et al*. (2017) undertook a literature review on the behavioural (and other) effects of acoustic noise from marine seismic surveys on fish and invertebrates, including cephalopods (**Table 55**). The authors categorised relevant studies into the presence or absence of a response from cephalopods depending on the level of exposure. The level of exposure was determined to be either "*realistic*" for seismic surveys (i.e. few short bursts of low frequency sound at >1 – 2 m), or "*unrealistic / unknown*" (i.e. continuous sound exposure, >100 bursts of nearfield sound exposure, in aquaria).

Carroll *et al*. (2017) found four studies where cephalopods exhibited a startle response to realistic seismic survey noise. These included Fewtrell & McCauley (2012), McCauley *et al*. (2000a), Samson *et al*. (2014), and Mooney *et al*. (2016), all described in the preceding text. Carroll *et al*. (2017) included a fifth study in this list, Komak *et al*. 2005, where juvenile cuttlefish were exposed to local sinusoidal water movements of different frequencies (0.01–1,000 Hz) produced by a vibrating sphere placed 5 mm above their heads. This resulted in a startle response with no evidence of habituation, but the methods are not realistic or comparable to a seismic survey under the Carroll *et al*. (2017) definition.

Given their pelagic lifestyle, there is the potential for squid and cuttlefish to come near the acoustic source during the Otway Basin 2DMC MSS. However, squid are generally short-lived, fast growing species with high fecundity rates. These life history traits mean they are well adapted to disturbance, and it follows that there is no anticipated long-term risk to squid populations given the 5 km line spacing the actual footprint the acoustic source will cover will be small compared to the actual Operational Area.

The STLM predictions for the Otway Basin 2DMC MSS used a threshed criteria of RMS SPL of 156 dB re 1 µPa which suggested that a behavioural response will occur at 3.2 km from the acoustic source in water depths of 50 m and up to 5.8 km from the source in water depths of 4,800 m (**Table 61**).

This is only a behavioural response, and is not acoustic trauma, mortality, or hearing loss, just behaviour and these thresholds are lower than what it would take to result in mortality or permanent damage to a lot of receptors. A typical behavioural response is likely to include being startled (McCauley *et al*., 2000); however, studies have shown that squid quickly become habituated (Fewtrell & McCauley, 2012), and this behavioural disturbance does not appear to influence feeding (McCauley *et al*., 2000a). As a result, any behavioural disturbance or if squid become habituated, based on the available literature should not influence the catch rates.

Table 60 Behavioural Disruption Threshold Level Squid – Impulsive Noise Events

Animal	Zones of impact – maximum horizontal distance from source to impact threshold levels	
	Criteria - RMS SPL (dB re 1µPa)	Maximum threshold distance (m)
Squid	156	3,200 – 5,800

The life history traits of cephalopods (see previous section) mean they are well adapted to disturbance, and combined with the above findings that they appear to become habituated to acoustic release and display other behaviour that indicates rapid recovery, suggests that there is no anticipated long-term risk to squid populations presented by the Otway Basin 2DMC MSS. Consequently, the residual risk of behavioural impacts to cephalopod species from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Unlikely*).

7.2.2.2.4 Marine Reptiles

As described in **Section 5.2.5**, five species of turtle have been reported in southern Australian waters (i.e. South Australia, Victoria, Tasmania) and two of these species; the leatherback turtle (*Dermochelys coriacea*) and the loggerhead turtle (*Caretta caretta*) have distributions which may include the Operational Area (DoE, 2018g; DoE, 2018h). Both species are migratory and have an EPBC Act listing status of endangered.

Nelms *et al*. (2016) conducted a thorough literature review of studies carried out world-wide to investigate the behavioural and physical impacts of seismic surveys on turtles. There were very few turtle studies relative to cetaceans and fish.

Lenhardt (1994) found that loggerhead turtles managed to minimise exposure to seismic simulations in a confined environment by swimming to and remaining at the water surface. Also, in a confined environment, McCauley *et al*. (2000a) observed an alarm response (rapid swimming) in caged loggerhead and green turtles when acoustic source levels exceeded 166 dB re 1 µPa rms. Swimming behaviour was described as more erratic once acoustic source levels reached 175 dB re 1 µPa rms.

As Nelms *et al*. (2016) points out, studies carried out within the confines of a cage or tank are biased by the acoustic properties of the immediate environment, and results may differ in an open ocean environment where behaviour may change because turtles are able to swim away from the acoustic source. Observations of turtle behaviour at sea are difficult because they require calm sea conditions, and it is often difficult to distinguish behavioural response to variables other than the acoustic source sounds, such as the presence of the survey vessel, the towed equipment, and the observation vessel. Nelms *et al*. (2016) also raises the issue of interpretation of turtle behaviour by various observers, giving the example of one study reporting "no signs of panic of distress" during a seismic survey, where "behaviour consisted of either 'steady swimming' or 'diving' to avoid the vessel" (Pendoley, 1997). Similar studies, according to Nelms *et al*. (2016), categorised diving as a startle response or avoidance behaviour.

See **Section 7.2.2.1.7** for information relating to the 'Recovery Plan for Marine Turtles in Australia 2017-2027' (Commonwealth of Australia, 2017a).

The STLM predictions for the Otway Basin 2DMC MSS indicate that using a threshold of RMS SPL of 166 dB re 1 µPa, behavioural disturbance would occur at a maximum distance of 1.7 km from the acoustic source in water depths of 50 m and up to 3 km from the source in water depths of 4,800 m (**Table 61**). However, as turtles primarily swim on the sea surface, they may not experience the levels of acoustic noise the model predicted due to the surface shadow.

Table 61 Behavioural Disturbance Threshold Level for Individual Turtles – Impulsive Noise Events

Animal	Zones of impact – maximum horizontal distance from source to impact threshold levels	
	Criteria - RMS SPL (dB re 1µPa)	Maximum threshold distance (m)
Turtles	166	1,700 – 3,000

As discussed above, turtles are migratory in the South-east Marine Area and there are no known BIAs or critical habitat (National Conservation Values Atlas). Alarm responses (rapid swimming) have been observed in caged turtles during acoustic releases within the SEL range overlap for turtles and seismic surveys, although the response in an open ocean environment is unclear. Consequently, the residual risk of behavioural impacts to marine turtle species from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Low** (*Moderate* x *Rare*).

7.2.2.2.5 Cetaceans

Noise produced by the survey vessels has the potential to disrupt typical behaviours (e.g. foraging, resting) or cause displacement away from the noise source. Difficulties arise in separating the effects of shipping noise from those of the physical presence of the vessel in eliciting a response, and the majority of studies generally involve smaller vessels (Aguilar Soto *et al*., 2006). While behavioural responses to vessels has been observed in a number of species, for example humpback whales in response to whale-watching vessels (Corkeron, 1995) and resident killer whales (Lusseau *et al.,* 2009); these studies were unable to determine the cause of the disturbance (i.e. presence of the vessel versus disturbance from the generated noise).

Blair *et al.* (2016) found evidence of behavioural responses in humpback whales to increasing vessel noise. Significant effects on foraging such as a reduction in the number of bottom-feeding events per dive, slower descent rate and fewer side-roll feeding events (evidence of a cessation of feeding or a switch to another feeding method) per dive corresponded with increasing ship noise. Such behavioural changes and interruptions to foraging events may impact on foraging rate and efficiency. Explanations presented to explain these behavioural effects include the whales perceiving the vessel as a threat, alterations to prey behaviour, or masking effects reducing foraging efficiency (Blair *et al*., 2016). Blair *et al*. (2016) suggests that although humpback whales show habituation towards vessel noise, they are unable to completely adjust to the disturbance.

The behavioural response of Atlantic right whales was experimentally tested to controlled sound exposures; recordings of ship noise, the social sounds of conspecifics, and a signal designed to get some form of response from the whales (Nowacek *et al*., 2007). Although the whales reacted strongly to the alert signal, and mildly to the conspecific sounds, no behavioural response was observed when subject to play-back of vessel noise. A lack of measurable response was also found when whales were approached by a vessel (Nowacek *et al*., 2007).

Dyndo *et al*. (2015) experimentally exposed penned harbour porpoises to play-back of noise from vessel passages. The penned animals reacted to vessel noise recordings by porpoising, suggesting a high level of disturbance to low levels of vessel noise (Dyno *et al*., 2015).

Behavioural effects from MSSs on marine mammals include avoidance or displacement and changes in swimming behaviour (Gordon *et al*., 2003; Miller *et al*., 2009). While behavioural responses may not have direct lethal effects on marine mammals, concern has been raised on the potential for sub-lethal effects such as increases in energy expenditure and demand, decreased foraging efficiency, disruption of group dynamics (e.g. group cohesiveness), and lowered reproductive rates leading to population-wide effects (Weilgart, 2007; 2013). Effects may also be harmless (Weilgart, 2007). Studying the behavioural effects of a MSS on marine mammals can be difficult as reactions vary depending on factors such as the species, individual, age, sex, prior experience with noise, and behavioural state (Weilgart, 2007), with studies typically focusing on opportunistic observations of surface behaviours (Verfuss *et al*., 2018). In addition, behavioural responses may be subtle and barely detectable, with the potential to incorrectly suggest an apparent tolerance of the study animal/s (Weilgart, 2007). In open seas it is unlikely that temporary displacement would have significant energetic consequences for migrating whales, but displacement could have more significant consequences in confined waterways. An RMS SPL of 160 dB re 1 µPa has been identified for the level at which adverse behavioural disturbance could occur. During the Otway Basin 2DMC MSS, an RMS SPL of 160 dB re 1 µPa will occur 2.5 km from the acoustic source in water depths of 50 m and up to 4.5 km from the source in water depths of 4,800 m (**Table 64**). The 3+ km observation zone will ensure that an obvious behavioural change occurring as a result of the survey particularly in the shallower water along the continental shelf will be detected and documented.

An increase in surface behaviour (e.g. breaching or increased time spent at the surface) has been interpreted as a way of reducing exposure to the higher sound's levels from the acoustic source on account of the 'Lloyd mirror effect' (Carey, 2009) which significantly reduces sound intensity in the upper-most part of the water column. Other stress-related behaviours have also been documented for some species in the vicinity of seismic surveys (or under simulated conditions) including changes in respiration rates (Richardson *et al*., 1995), swim speed (Stone & Tasker, 2006), and diving behaviour (Richardson *et al*., 1995). Such changes were observed in bowhead whales up to 54 – 73 km from an active MSS at received levels as low as 125 dB re 1 µPa (Richardson *et al*., 1995).

McCauley *et al*. (2000) made aerial observations on the response of southern migrating humpback whales off Australia's east coast before, during, and after a 3D MSS. A change in sighting rate from the seismic vessel was observed, with sighting rate considerably higher near the vessel with no active source compared to operational periods, suggesting a localised avoidance during operations. Observations suggest that humpback whales spent extended periods of time in surface waters reducing the received sound loading (McCauley *et al*., 2000). During periods where the acoustic sources were alternated between on and off compared to continuously on or off periods, sighting rates increased suggesting either a startle or investigative response of the whales that brought them to the surface. Active whales consistently undertook avoidance manoeuvres (altered course and speed) at >4 km to pass no closer than 3 km behind an operating seismic vessel, while those engaged in sedentary behaviour avoided the operating vessel at a range of 7 – 12 km (McCauley *et al*., 2000). Approach trials were also carried out using a single operating acoustic source; mean SELs for avoidance behaviours to occur was 140 dB re 1 µ Pa mean squared pressure and startle responses were observed at 112 dB re 1 µ Pa mean squared pressure (McCauley *et al*., 2000).

Avoidance responses of humpbacks such as increased distance from a seismic source and reduced travel speed have also been observed in recent studies such as Dunlop *et al.* (2016), supporting the findings of McCauley *et al*. (2000). Dunlop *et al*. (2015) also surveyed southward migrating humpback whales off Australia's east coast and suggested that the whales show little or no behavioural response to acoustic source emissions; however, as the received levels were low (close to background levels up to 156 dB re 1 µPa^{2}s), they may not have been high enough to elicit an observable and consistent behavioural response (Dunlop *et al*., 2015). McCauley *et al*. (2000) hypothesised that actively migrating whales are less sensitive to seismic emissions and were at a low risk to seismic activities, while whales engaging in resting behaviours at key habitats (e.g. resting grounds), and cow-calf pairs were particularly sensitive (McCauley *et al*., 2000).

Following the Dunlop *et al*. (2015) study, Dunlop *et al.* (2017) aimed to further quantify responses of migrating humpback whales and looked at the recovery of whales following the cessation of acoustic emissions. This was then compared to normal behaviours (e.g. dive time, respiration rate, various surface behaviours, and group movement) to assess the biological significance of any response. No abnormal behaviours such as separation of cow-calf pairs or sustained bouts of high energy surface behaviours were observed, and 'typical' behaviours such as singing, surface slapping, conspecific socialising and continuation of general southward migratory travel continued. This led the authors to conclude that the addition of the seismic vessel and acoustic emissions had little impact on typical behaviours and there was no evidence the whales were under significant additional stress. Small and temporary changes in typical behaviours were observed; however, these were within the normal behavioural repertoire of migrating groups. Speed of southward movement was slower in trials with active acoustic sources, although this was a reflection of a deviance from 'normal' course instead of a reduction in travel speed. While Dunlop *et al*. (2017) did not determine whether or not this deviation in migration path would have long-term effects, they did note that migrating whales are only likely to be exposed to a seismic survey for a short period of time before moving away as part of their migration. Dunlop *et al*. (2017) observed that changes in movement behaviour are likely to occur within 4 km from the seismic vessel at received levels over 135 dB re 1 µPa^{2}s. Clear course changes of migrating humpback whales were observed by Dunlop *et al*. (2017) at received levels of 144 – 151 dB re 1 µPa^{2}s, lower than that of Dunlop *et al*. (2015).

Blue whales are suggested to be more sensitive to emissions from MSSs than other baleen whales such as humpback whales (McDonald *et al*., 1995). Tracking data from a blue whale located in an area where an active seismic vessel was operating recorded a long-range avoidance response beginning 10 km from the vessel. The whale's track diverged from that of the vessel by approximately 80° and from its original course by approximately 120°. Estimated received levels at the whale's location were 143 dB re 1 µPa peak-to-peak (McDonald *et al*., 1995). It is worth noting that this study tracked a single blue whale, therefore any conclusions must be treated with caution. However, given the proximity of the Otway Basin 2DMC MSS Operational Area to the Bonney Upwelling and the associated aggregations of blue whales, this information is highly relevant.

Avoidance behaviours of minke (likely Antarctic minke, *Balaenoptera acutorostrata*), sei and fin whales have also been reported. In an analysis of reports from seismic vessels operating in UK waters from 1998 – 2003, Stone (2003) concluded that ranges of minke, sei and fin whales to seismic vessels were higher for sightings made during surveys than at other times, suggesting avoidance of the operating vessel. Avoidance of MSSs by fin whales is supported by the findings of Castellote *et al*. (2012) who observed extended displacement which lasted well beyond the duration of the survey.

Studies into behavioural responses of sperm whales to MSSs have revealed variable results. Mate *et al*. (1994) observed a significant decrease in sperm whale abundance in the Gulf of Mexico, with the closest whales observed at least 50 km away from an active seismic survey. However, results of Jochens *et al.* (2016), Weir (2008), Stone and Tasker (2006) and Madsen *et al*. (2002a) contradict those of Mate *et al.* (1994). In Weir (2008), encounter rates did not differ with operational status of the acoustic source array, and although the mean distance to initial sighting was greater during full-operations, this effect was not statistically significant. In Madsen *et al*. (2002a), sperm whales receiving sound pressures of 124 dB re 1 $\mu Pa^2 s$ did not change behaviours or elicit an observable avoidance of the area, and whales instead remained in the area for at least 13 days of exposure.

In a review of over 200 seismic surveys in UK waters, Stone & Tasker (2006) also found no statistically significant behavioural effects of seismic activity on sperm whales. Jochens *et al.* (2016) report on a multi-year (2000 – 2003) sperm whale tagging study in the Gulf of Mexico. Eight sperm whales were tagged and tracked before, during, and after playback of seismic noise. All whales continued on their course of travel and did not avoid the seismic vessel throughout the playback; however, two whales showed dive changes indicative of avoidance by deep-diving during full-array exposure, and all whales responded in a fashion expected to result in reduced energetic expenditure (i.e. lowered number of pitching movements); evidence of an effect on foraging behaviour (Jochens *et al*., 2016). Observations of distance response was conclusive with that of Madsen *et al.* (2002a) whereby there was no obvious response to pulses at a range of 20 km (Jochens *et al*., 2016). Jochens *et al*. (2016) suggests that conflicting results may be a reflection of a broad spread in sensitivity of sperm whales to sound based on age and sex or history of sound exposure.

During a 3D MSS off Nova Scotia, Moulton and Miller (2005) observed the behaviours of a number of dolphin species: long-finned pilot whales, common dolphins, Risso's dolphins, striped dolphins, and Atlantic spotted dolphins. With the exception of the striped and Atlantic spotted dolphins, all these species have been identified within the South-east Marine Region (**Section 5.2.6.2**). Dolphins were consistently observed during periods when acoustic sources were active; however, some dolphins exhibited localised avoidance behaviours on account of distance to initial sighting being significantly less during non-operational periods. Some dolphins were observed riding the bow of the seismic vessel (a distance of 350 m from the active source) and exhibiting feeding behaviours during active operations. Within 700 m of the active source, dolphins would be exposed to sound levels exceeding 180 dB re 1 µPa (rms) (Moulton & Miller, 2005). Goold (1996) also suggests a localised avoidance of common dolphins to a 2D MSS, with dolphins tolerating seismic emissions outside a 1 km radius.

Harbour porpoises were displaced from an active 470 in^3 acoustic source array over ranges of 5 – 10 km during a 2D MSS over a range of 5–10 km at received peak-to-peak sound pressure levels of 165 – 175 dB re 1 µPa and sound exposure levels of 145 – 151 dB re 1 µPas-1 and were temporarily displaced (Thompson *et al*., 2013). However, these animals were detected again at the affected sites within a few hours after exposure (Thompson *et al*., 2013). Thompson *et al*. (2013) concluded that prolonged seismic surveys did not lead to broad-scale displacement of marine mammals and that impact assessments should focus on sub-lethal effects. However, it is noted that the acoustic source used for this study was far smaller than the source proposed by SLB for the Otway Basin 2DMC MSS; hence, the zone of influence around the larger source is expected to be larger.

The results of Moulton and Miller (2005), Goold (1996) and Thompson *et al.* (2013) studies are inconsistent with the Stone and Tasker (2006) analysis which suggested small odontocetes (i.e. dolphins) exhibit the strongest lateral spatial avoidance of airguns compared to mysticetes, killer whales, and long-finned pilot whales (Stone & Tasker, 2006). As discussed in the EPBC Act Policy Statement 2.1, smaller dolphins and porpoises are less likely to be disturbed by an MSS (and are less vulnerable to acoustic trauma) than baleen and larger toothed whales. This is on account of the frequency produced in an MSS being lower than the high frequency peak sensitivities of the smaller dolphins.

Killer whales remain further from a seismic source when active indicating some level of spatial avoidance, although no reduction in sighting rate in response to an active acoustic source has been observed (Stone & Tasker, 2006). Long-finned pilot whales also show little response to an active acoustic source; the only observed effect is a change in orientation with more moving away from, and fewer towards a vessel during seismic activity (Stone & Tasker, 2006).

The behavioural impacts of seismic surveys on beaked whales are largely unknown as beaked whales are very difficult to observe whilst at sea but based on their observed responses to mid-frequency active sonar (i.e. increased swim speed, unusual dive behaviours and multiple unusual mass stranding events that have ultimately caused the death of individuals) this group is believed to be particularly sensitive to anthropogenic noise (Stimpert *et al*., 2014). Although sonar represents a vastly different sound source to what is used in an MSS, in the absence of any data on the effects of seismic surveys on beaked whales, their responses to sonar provide a useful indication of what might be expected with regard to other underwater noise sources.

In addition to avoidance responses, there is also anecdotal evidence of marine mammals being attracted to seismic operations. For example, common dolphins have been observed repeatedly approaching an operating seismic vessel to bow ride as it entered shallow coastal waters. New Zealand fur seals are also known to approach operating seismic vessels from time to time (Lalas & McConnell, 2016). McCauley *et al*. (2000) observed what were believed to be male humpback whales approaching an operating acoustic source and hypothesised that this was due to the similarity to sounds produced by humpback whale breaching.

Typically, the distribution of marine mammals is closely linked to that of their prey (see Fielder *et al*., 1998), therefore avoidance of the seismic vessel could lead to abandonment of valuable feeding grounds (e.g. large aggregations of krill or fish) or reduced foraging effort. Baleen whales that rely on the Bonney Upwelling as a foraging ground are of particular note here due to the spatial overlap between this ecologically significant area and the acoustic footprint of the Otway Basin 2DMC MSS.

However, to put the overlap of Otway Basin 2DMC MSS and the Bonney Upwelling into context, as discussed previously, there are only six tie lines that encroach into the Bonney Upwelling with a total line length across all six lines of 33.6 km. This is broken down for the six tie lines from west to east by 4.5 km, 5.2 km, 9.1 km, 3.9 km, 8.9 km, and 2 km. Using a conservative vessel speed of 4 knots, the survey vessel will be in the Bonney Upwelling area for approximately 75 minutes on the tie line that has the biggest encroachment into the Bonney Upwelling zone.

In addition, changes in abundance and distribution of prey species are also well recognised as potential indirect effects of seismic surveys (Simmonds *et al*., 2004) whereby the availability of prey species can change as a result of acoustic disturbance (e.g. fish; Pearson *et al*., 1992; McCauley *et al*., 2000; Colman *et al*., 2008; Handegard *et al*., 2013, and zooplankton; McCauley *et al*., 2017). Such indirect effects could lead to decreased foraging efficiency, higher energetic demands, lower group cohesion, higher predation rates and decreased reproduction rates in marine mammals (Weilgart, 2007). Such indirect effects are much more difficult to detect and measure than direct effects; however, as with direct effects, they are likely to vary with species, individuals, age, sex, past exposure and behavioural state (IWC, 2007). As discussed in **Section 7.2.2.1.1** acoustic disturbance has been linked to changes in abundance and distribution of zooplankton. Distributional changes in zooplankton (particularly krill) could have flow on effects to foraging baleen whales. Potential consequences of such flow-on effects are discussed in greater length in **Section 7.2.2.4.2**.

In the event that behavioural impacts do occur during the Otway Basin 2DMC MSS, the significance of such impacts would be greatest for threatened species that are reliant on biologically important habitat in the proximity of the Operational Area. The species listed below are of particular note:

- Southern right whales (endangered) – migrating & calving in coastal waters near the Operational Area from May to October;
- Pygmy blue whales (vulnerable) – feeding along the Bonney Upwelling from November to May, with peak numbers occurring in February;
- Sei whales (vulnerable) – feeding along the Bonney Upwelling from November to May;
- Fin whales (vulnerable) – feeding along the Bonney Upwelling from November to May; and
- Humpback whales (vulnerable) – migrating southwards from November to December.

The following suite of survey design features, mitigations and management procedures are being proposed to minimise potential behavioural impacts to an **Acceptable Level** (see **Table 66** for further detail):

- 'Standard Management Procedures' in accordance with the EPBC Act Policy Statement 2.1. These will be adhered to throughout the Operational Area (Observation Zone, Pre-Start-up Visual Observations, Soft Start procedures, Delayed Start-up procedures, continuous daylight observations, Stop Work procedures, Night Time and Low Visibility procedures), 24-hour operations where possible;
- 'Additional Management Procedures' in accordance with the EPBC Act Policy Statement 2.1. These will be adhered to throughout the Operational Area (Extended Shut-down Zone, Extended Low-Power Zone for all operations that overlap with the BIA for blue whales, presence of experienced MMOs, use of PAM). These additional measures have been implemented on account of the Otway Basin 2DMC MSS having a 'moderate to high likelihood' of encountering whales. These additional procedures are particularly important given the presence of biologically important habitat in the proximity of the Operational Area, in particular the Bonney Upwelling; and
- 'Additional Tie Line Management Procedures' over and above the requirements of the EPBC Act Policy Statement 2.1. SLB recognises that the potential to encounter whales increases as the Operational Area approaches the coastline. In particular the Operational Area overlaps with parts of the Bonney Upwelling System (a recognised BIA for pygmy blue whales) and the BIA for southern right whales along its inshore boundary where the 13 survey tie lines are located (see **Section 7.2.2.4.4**). A suite of additional mitigations has been developed for these tie lines as discussed in **Section 7.2.2.1.8**.

The survey design also confers a degree of mitigation against disturbance to marine mammal in the following ways:

- The Operational Area is located in open ocean; hence will not affect any confined water body or migratory corridor; and
- The 5 km line spacing will ensure that the survey vessel will not focus in any specific area for a long period of time.

The underwater noise level at which behavioural disturbance is likely to occur for most marine mammal species is generally accepted to be RMS SPL 160 dB re 1 µPa (NMFS, 2013) (**Table 62**). However, (and as discussed earlier in this section), behavioural effects resulting from seismic operations have been documented in some species at levels lower than this (see McCauley *et al*., 2000; Dunlop *et al*., 2017; 2017a; McDonald *et al*., 1995) indicating substantial variance in behavioural response between species and sound levels.

Table 62 Behavioural Disruption Threshold for Marine Mammals – Impulsive Noise Events (NMFS, 2013)

Marine mammal hearing group	Zones of impact – maximum horizontal distance from source to impact threshold levels		
	Criteria - RMS SPL (dB re 1µPa)	Water Depth (m)	Maximum threshold distance (m)
All hearing groups	160	50	2,500
All hearing groups	160	100	2,600
All hearing groups	160	200	2,800
All hearing groups	160	400	3,000
All hearing groups	160	800	3,500
All hearing groups	160	1,600	4,000
All hearing groups	160	3,200	4,500
All hearing groups	160	4,800	4,500

The STLM predictions for the Otway Basin 2DMC MSS indicate that an RMS SPL of 160 dB re 1 µPa will occur 2.5 km from the acoustic source in water depths of 50 m and up to 4.5 km from the source in water depths of 4,800 m. In keeping with this, the 3+ km Observation Zone will ensure that any obvious behavioural changes occurring as a result of the survey will be detected and documented particularly in shallower areas and the 3 km Low-Power Zone for operations that overlap with the BIA for blue whales will protect foraging individuals from any behavioural disturbance (i.e. displacement). Exceedance of this threshold level does not trigger any operational response for marine mammals (i.e. shut-down etc.); hence, marine mammal behavioural changes during the Otway Basin 2DMC MSS are expected and are considered to be at an **Acceptable Level**. As responsible operators, SLB are proposing that the acquisition of the tie lines will occur either at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey (i.e. 1 March-30 April 2020) in accordance with a suite of additional mitigation measures specific to tie line acquisition (see **Section 7.2.2.1.8**) to contribute towards minimising behavioural impacts on marine mammals in the most sensitive habitat of the Operational Area.

The residual risk of behavioural impacts to cetacean species from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Moderate** (*Moderate* x *Likel*y).

7.2.2.2.6 Pinnipeds

Studies on the responses of seals to seismic surveys are lacking; however, Harris *et al*. (2001) reported on the response of three species of phocid seals (ringed, bearded, and spotted) to a MSS in the Beaufort Sea. When acoustic sources were operating at full power the average distance at which seals were first observed was greater than when the acoustic source was not active.

Partial avoidance of active seismic vessels was observed within 150 m, although seals remained in the general area and did not move far beyond 250 m. Seals also did not appear to reduce diving behaviours, despite being exposed to receive sound levels above 180 dB re 1 µ Pa (RMS) (Harris *et al*., 2001). It is worth noting that these observations of partial avoidance were made during operations of a full-array (multiple acoustic sources operating). When using a single acoustic source, there were no changes in seal numbers, distribution, or behaviour compared to no active operations (Harris *et al*., 2001). It is also important to note that only one species of phocid seal may be present in the Operational Area; and the relevance of these findings to otariids (fur seals and sea lions) is questionable. Lalas & McConnell (2016) found inconclusive evidence on the effects of full-power active seismic surveys on New Zealand fur seals, suggesting that instead of reacting to noise stimulus, it is the presence of the vessel and towed seismic gear that the seals respond to (see **Section 7.1.2.3**).

Table 62 shows the behavioural disruption threshold level for marine mammals, including pinnipeds for impulsive noise events based on NMFS (2013). During the Otway Basin 2DMC MSS, an RMS SPL of 160 dB re 1 µPa will occur 2.5 km from the acoustic source in water depths of 50 m and up to 4.5 km from the source in water depths of 4,800 m (**Table 64**). Exceedance of this threshold level does not trigger any operational response for marine mammals (i.e. shut-down etc.); hence behavioural changes to pinnipeds during the Otway Basin 2DMC MSS are expected and are considered to be at an **Acceptable Level**.

The residual risk of behavioural impacts to pinniped species from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.2.2.2.7 Elasmobranchs

Sharks are part of an important commercial fishery within Australian waters (**Section 5.5.2.5.3**) and the Gippsland Marine Environmental Monitoring Project (Przeslawski *et al*., 2018; 2018a) found that seismic operations resulted in no evidence of consistent adverse effects on commercial catch rates of sharks, with some species (i.e. elephant fish, broadnose and school sharks) having increased catch rates following the seismic survey, while others (i.e. gummy shark and saw shark) showed decreased catch rates.

Elasmobranchs detect sound via particle motion and some of the highest sound sensitivity to low frequency sound (~20 Hz to ~1,500 Hz) (Myrberg, 2001; Casper, 2011; Casper *et al*., 2012), which is the largest proportion of sound frequency that is generated during a seismic survey (Carroll *et al*., 2017). However, given what has been stated above, elasmobranchs will still show a response to noise; where Klimley and Myrberg (1979) found that sharks would withdraw from high intensity sound source that was more than 20 dB re 1 µPa above broadband ambient SPL once within 10 m of the source location.

Many species of shark are predatory and use their 'hearing' to locate prey. Therefore, any interruptions to their ability to find/detect food through excessive noise in the environment could impact on the sharks feeding ability (Popper, 2003). Free-swimming elasmobranchs (such as pelagic shark species) have been found to have more sensitive hearing apparatus (specifically the macula neglecta) than bottom-dwelling species (Corwin, 1978), possibly placing the pelagic species at greater chance of hearing damage if subjected to high intensity noise sources.

Based on the available information presented in this section and the likely physiological effects to elasmobranchs (**Section 7.2.2.1.9**), significant impacts on elasmobranchs, including white sharks which are a protected species under the EPBC Act, and predicted to be foraging through the Marine Parks in the area, from the Otway Basin 2DMC MSS are predicted to be unlikely.

As a result, the residual risk of behavioural impacts to elasmobranchs from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Unlikely*).

7.2.2.2.8 Seabirds

Although there is little information about the behavioural effects of seismic surveys on seabirds, a number of authors have raised the possibility of disruption to feeding activities. For instance, Goudie & Ankney (1986) suggested that seabird feeding behaviours could possibly be interrupted by acoustic disturbance from the seismic vessel passing through feeding grounds; and MacDuff-Duncan & Davies (1995) postulated that birds in the area could be alarmed as the seismic operations pass close-by, causing them to temporarily stop diving. In addition to the potential direct displacement of seabirds, the displacement of bait fish could lead to a reduction in the diving activities and foraging potential for seabirds in the immediate vicinity of the seismic operations.

Lacroix *et al*. (2003) assessed the effect of seismic operations on the foraging behaviour of moulting male long-tailed ducks in the Beaufort Sea. Long-tailed ducks are incapable of flying during the moult and, in order to compensate for this nutritionally costly moult process, increase their foraging time during this period. The findings of Lacroix *et al*. (2003) indicated that the abundance and distribution of ducks in both seismic and control areas changed similarly following the start of seismic operations suggesting that other influencing factors (e.g. wind) were more important for duck distribution than seismic activities, and that seismic activity did not significantly change the diving intensity of ducks. Overall, Lacroix *et al*. (2003) concluded that there was no evidence to suggest any displacement away from active seismic operations.

Pichegru *et al*. (2017) assessed the foraging behaviour of African penguins before, during and after an MSS that occurred within 100 km of breeding colonies. Penguins foraging within 100 km of the active seismic source showed a change in foraging direction, increasing the distance between feeding area and seismic vessel (Pichegru *et al.,* 2017). Displaced penguins reverted back to normal foraging behaviours following the cessation of seismic activities, suggesting effects are relatively short-lived (Pichegru *et al.,* 2017). It is worth noting that although the Pichegru *et al*. (2017) study was unable to differentiate between penguins shifting foraging activities in direct response to the survey (i.e. behavioural effect) or indirectly due to a change in prey distribution, a behavioural response was determined as the most likely cause. While the penguins were able to locate alternative feeding grounds, the displacement from traditional grounds resulted in an increase in energy expenditure (Pichegru *et al.,* 2017).

Although the Lacroix *et al.* (2003) and Pichegru *et al*. (2017) studies were not carried out on species potentially present within the Otway Basin 2DMC MSS Operational Area, and found differing results, their results suggest that at most seabirds will be temporarily displaced from areas of active seismic operations, and displacement effects will be short-lived, with animals able to return to traditional feeding grounds after the seismic vessel has moved away. The 5 km line spacing's will assist in minimising the disturbance to seabird's behaviour during the Otway Basin 2DMC MSS.

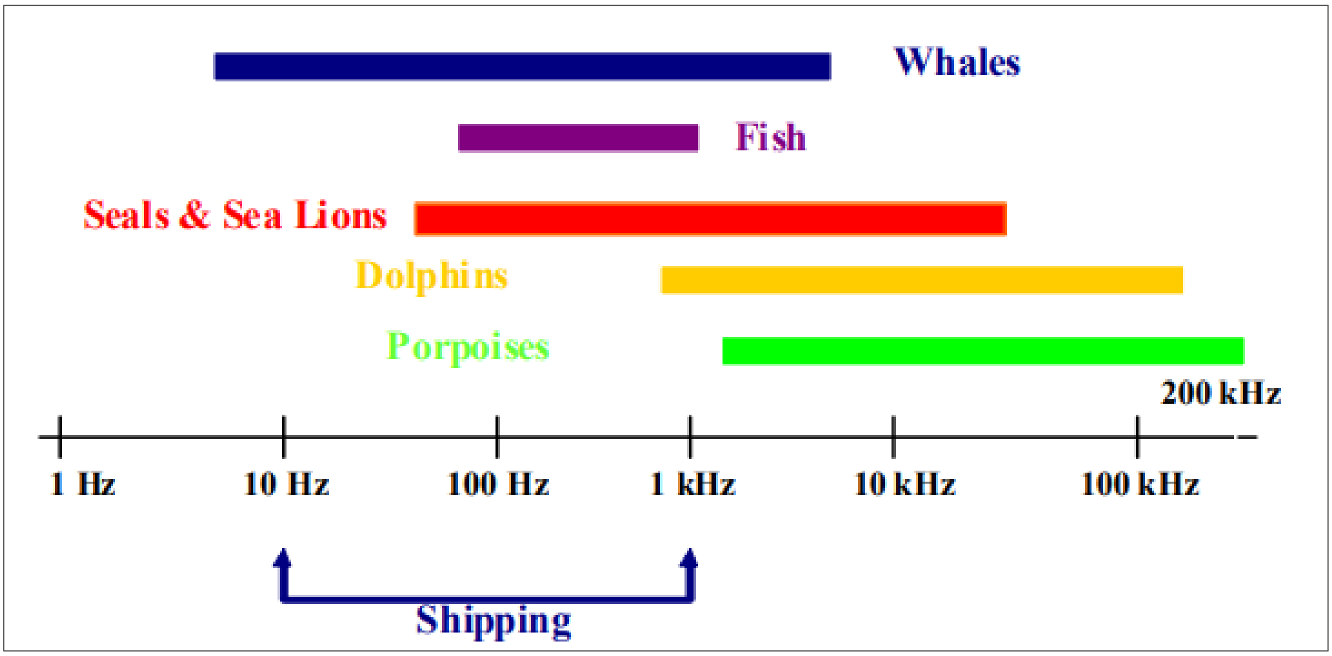
Consequently, the residual risk of behavioural impacts to seabird species from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Possible*).

7.2.2.3 Potential Perceptual Impacts

Marine animals produce sound for a variety of functions (e.g. navigation, communication, predator and prey detection), and even those that do not produce sound utilise sounds around them to learn about and gain an overall awareness of their environment (Fay & Popper, 2000). The ability to perceive biologically important sounds is therefore crucial to these animals. The addition of anthropogenic noise into the marine environment can disrupt an animal's ability to communicate and/or detect biologically important signals (Dunlop *et al.,* 2010). 'Masking' is an increase in the threshold for detection of discrimination of one sound as a consequence of another (Brumm & Slabbekoorn, 2005) and can be either complete, whereby the signal is not detected at all, or partial, whereby the signal is detected but unable to be properly understood (Clark *et al*., 2009). The effects of masking on an animal's fitness and survival include: blocking/alteration of signals alerting to the presence of predators (Lowry *et al*., 2012), incorrect assessment of the quality of rivals or potential mates lowering reproductive success (Halfwerk *et al.,* 2011), and disruption in group cohesion through a breakdown in communication particularly between parents and offspring (Leonard & Horn, 2012).

The general low frequency band of shipping noise overlaps with the frequencies generated by marine fauna, particularly fish, whales, and pinnipeds (**Figure 68**) (Southall & Hatch, 2008). Masking of biologically significant sounds has been suggested to be the primary effect of vessel noise on marine fauna (Southall, 2005).

Figure 68 Typical Frequency Bands of Sound Produced by Marine Fauna compared to Sounds associated with Commercial Shipping



Source: Southall & Hatch, 2008.

The following provides a discussion on the effects of masking on auditory communication of fish and marine mammals (particularly cetaceans).

7.2.2.3.1 Fish

Vessel noise overlaps with frequencies within the hearing and sound production ranges of many fish, which may mask important biological sounds. For example, vessel noise has been experimentally confirmed to increase detection thresholds for biological sounds in two species of reef fish (brown meagre drums and Mediterranean damselfish), with passing boats reducing detection distances under field conditions by up to 100 times (Codarin *et al*., 2009).

Some fish species produce sounds for communication purposes, with vocalisations typically within a frequency band of 100 Hz to 1 kHz (Ladich *et al*., 2006; Bass & Ladich, 2008). There have been no studies into the effects of MSSs on sound masking in fish, although other anthropogenic sounds (e.g. boat noise) have reportedly caused masking (see Picciulin *et al*., 2012). It is therefore reasonable to assume that sound emissions from a MSS could also result in masking of fish calls. For fish species with good hearing, Popper *et al*. (2014) suggested there is a greater likelihood of masking further from the acoustic source than close to it as masking is more likely for these fish when the animals are far enough away from the source for the sounds to merge and become more or less continuous.

Radford *et al*. (2014) suggest five ways in which fish might adapt to masking:

- Avoidance of noise: This can occur either spatially or temporally. Temporal avoidance involves taking advantage of gaps or fluctuations in competing noise, e.g. silver perch vocalise less frequently when recordings of a predator (bottlenose dolphin) were played (Luczkovich *et al*., 2000);
- Temporal adjustments: Signal detection enhances as signal duration increases as a consequence of an increase in the probability that some of the signal is detected during a quieter period, e.g. male toadfish increase their call rate to compete acoustically in the presence of rival males (Fine & Thorsen, 2008);
- Amplitude shifts: In noisy environments, an increase in amplitude increases signal detection (the Lombard Effect). Although this effect has been demonstrated in a number of vertebrates, it is yet to be demonstrated in fish in response to anthropogenic noise;
- Frequency shifts: Broadband sounds are more difficult to detect in a noisy environment than pure tones, e.g. freshwater gobies in waterfall habitats produce vocalisations in a frequency that differs from that of the waterfall noise; they utilise available ‘windows’ in the background frequency range (Lugli *et al*., 2003); and
- Change in signalling modality**:** The repertoire of a species usually consists of more than one signal component; hence when one signal type is ineffective, the caller may swap to another signal type to increase the chance of detection, e.g. a change from vocalisations to visual signals.

Little is known about fish vocalisations for marine fishes in the Operational Area; however, in line with the precautionary principle it is reasonable to assume that the Otway Basin 2DMC MSS may lead to some masking for some fish species.

As masking of fish communication by anthropogenic sound has been demonstrated; therefore, the residual risk of noise perception by fish species from seismic sound exposure during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.2.2.3.2 Cetaceans

Marine mammals produce sounds that are used to inform a range of behaviours: foraging, navigation, communication, reproduction, parental care, avoidance of predators, and to gain overall awareness of the environment (Thomas *et al*., 1992; Johnson *et al*., 2009). The ability to perceive biologically important sounds is therefore crucial to these animals. Anthropogenic sounds in the same frequency as biological signals can interfere with biologically important sounds and potentially lead to significant individual effects (Gausland, 2000). This interference is referred to as 'auditory masking' and is a common effect of acoustic releases on marine mammals (Erbe *et al*., 2016).

The level of masking that will occur depends on a number of factors other than the noise doing the masking, such as the location of the sender and receiver, source level and spectral characteristics of the signal, and the receiver's auditory capabilities (Erbe *et al*., 2016).

Cetaceans are broadly separated into three categories based on hearing capability (Southall *et al*., 2007) (**Table 57**):

- Low frequency cetaceans: have an auditory bandwidth between 0.007 kHz and 22 kHz. Species from this group that could occur in the Operational Area include southern right whale, minke whale, sei whale, humpback whale, blue whale, and fin whale;
- Mid-frequency cetaceans: with an auditory bandwidth between 0.15 kHz and 160 kHz. Species from this group that could occur in the Operational Area include bottlenose dolphin, common dolphin, dusky dolphin, Risso's dolphin, false killer whale, killer whale, pilot whales, sperm whale, and beaked whales; and
- High frequency cetaceans: which an auditory bandwidth between 0.2 kHz and 180 kHz. Pygmy sperm whales are the only species from this group that could occur in the Operational Area.

Aguilar Soto *et al*. (2006) reported on preliminary data showing that elevated received noise levels from a passing large ship (with a closest point of approach of 700 m) coincided with an unusual foraging dive in Cuvier's beaked whales, suggesting that elevated noise from shipping may interrupt foraging behaviours by masking echolocation and communication. Blue whales (McDonald, 2006), killer whales (Holt *et al,* 2008), and North Atlantic right whales (Parks *et al*., 2007) appear to be adjusting the frequency and loudness of calls in order to compensative for masking by vessel noise, while fin whales alter bandwidth and duration of calls in response to increasing background noise from shipping (Castellote *et al.,* 2012). Communication in two delphinid species (bottlenose dolphin and pilot whales) was also demonstrated to be reduced in the presence of vessel traffic, with communication range reduced by 26% within 50 m of a vessel travelling at 5 knots (Jensen *et al.,* 2009).

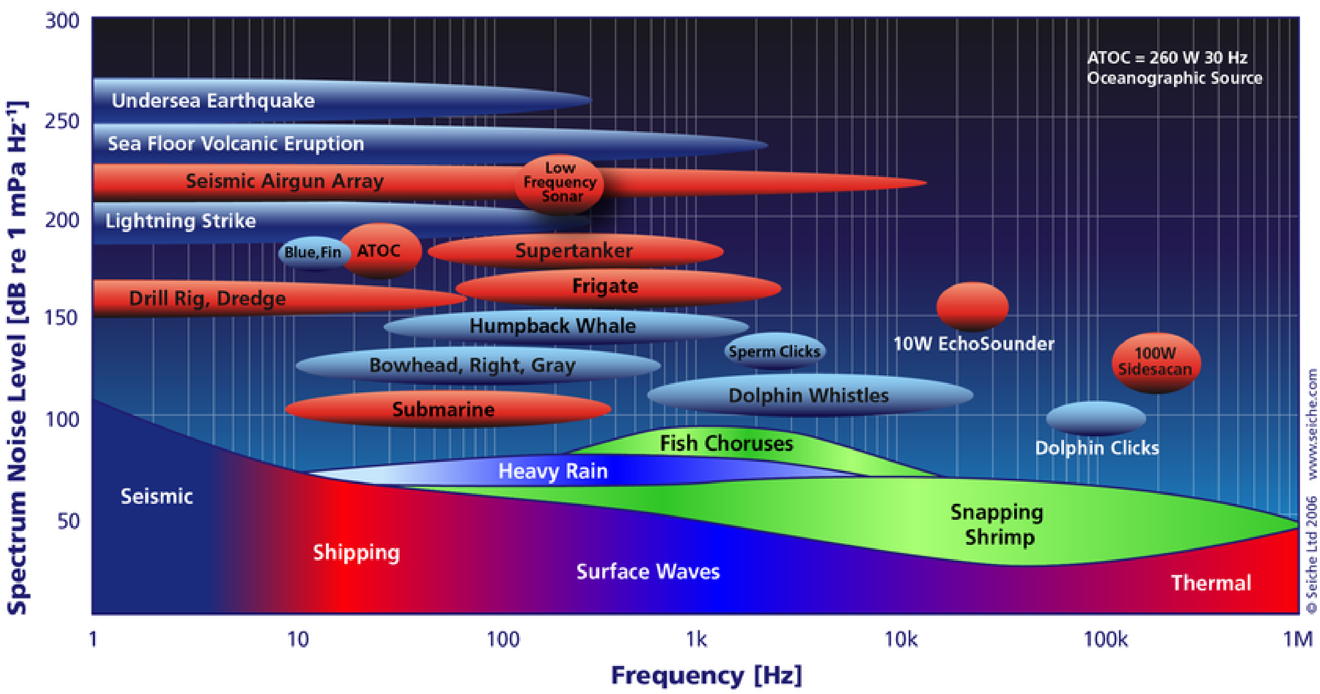
The sound frequencies that are emitted by seismic acoustic sources are broadband, but with most of the energy concentrated between 0.1 kHz and 0.25 kHz. The greatest potential for interference with cetacean vocalisations is at the highest end of the seismic spectrum and the lowest end of the cetacean vocalisation spectrum (**Table 63**); i.e. the lowest frequency cetaceans are particularly affected since they have the most overlap with the frequencies of the seismic survey acoustic sources (**Figure 69**). Auditory masking of mid and high frequency cetacean vocalisations is less likely as these species generally operate at higher frequencies than those generated by a seismic survey.

Table 63 Cetacean Communication and Echolocation Frequencies

Species	Communication Frequency (kHz)	Echolocation Frequency (kHz)
Southern right whale	0.03 – 2.2	N/A
Minke whale	0.06 – 6	N/A
Sei whale	1.5 – 3.5	N/A
Blue whale	0.0124 – 0.4	N/A
Fin whale	0.01 – 28	N/A
Humpback whale	0.025 – 10	N/A
Sperm whale	<9	0.1 – 30
Pygmy sperm whale	No data available	60 – 200
Beaked whales*	3 – 16	2 – 26
Common dolphin	0.5 – 18	0.2 – 150
Pilot whale	1 – 18	1 – 18
Killer whale	0.1 – 35	12 – 25
Bottlenose dolphin	0.2 – 24	0.5 – 130
* = using the bottlenose whale as an example		

Source: summarised from Simmonds *et al.*, 2004

Figure 69 Ambient and Localised Noise Sources in the Ocean



Source: Professor Rodney Coates, The Advanced *SONAR* Course, Seiche (2002)*; from* www.seiche.com

A number of studies have documented adaptive responses (anti-masking strategies) to anthropogenic underwater noise (Erbe *et al*., 2016). Anti-masking strategies include changes in vocalisation strength, frequency, and timing. For example, blue whales increased their calls (emitted during social encounters and feeding) when a seismic survey is operational in the area (Di lorio & Clark, 2010). Such adaptations have been documented in species such as humpback whales (McCauley *et al*., 1998; 2003a), beluga whales (Lesage *et al*., 1999), right whales (Parks *et al*., 2007, 2011), killer whales (Holt *et al.*, 2008), and bottlenose dolphins (van Ginkel *et al*., 2017) where it is thought that increased calling increases the probability that communication signals will be successfully received by conspecifics by reducing the effects of auditory masking.

Marine mammals may also cease vocalising in response to anthropogenic noise, as has been demonstrated in humpback whales at breeding grounds off Angola in response to a MSS whereby singing activity declined with the presence of the MSS and increasing received levels of the seismic pulses (Cerchio *et al*., 2014). Cessation in singing at a breeding ground was implied to have the potential to affect mating behaviour and success (Cerchio *et al*., 2014). This response is not novel to seismic surveys, with humpbacks also halting vocalisations in response to emissions from acoustic fisheries tools (Risch *et al.,* 2012). Cessation in clicking was also observed in sperm whales by Bowles *et al.* (1994) in response to weak seismic survey pulses (received level of 115 dB re 1 µPa); however, contradictory to the findings of Bowles *et al.* (1994), Madsen *et al*. (2002a) did not document any changes in male sperm whale clicks in response to an MSS off Norway. Sperm whales did not cease clicking and did not seem to alter their normal acoustic behaviour during feeding (Madsen *et al*., 2002a).

The calling rates of bowhead whales near an MSS were found to vary with changes in received SELs (Blackwell *et al*., 2015). In this study, at very low SELs (only just detectable) calling rates increased. As SELs continued to increase, calling rates levelled off (as SELs reached 94 dB re 1 μPa^2-s), then began decreasing (at SELs greater than 127 dB re 1 μPa^2-s), with whales falling virtually silent once SELs exceeded 160 dB re 1 μPa^2-s. Hence adaptations to masking for some species may be limited to circumstances when whales are subject to only low to moderate SELs.

Although the two periods for acquisition of the tie lines have been selected for having the least number of blue whale's present, there is the potential that blue whales may be in or around the Operational Area during the Otway Basin 2DMC MSS. Blue whales vocalise at a low frequency (average of 0.01 – 0.110 kHz) (McDonald *et al*., 2001; Miller *et al*., 2014), meaning that their calls can travel hundreds of kilometres underwater. The amplitude of their calls can reach levels of up to 188 dB re 1ɥPa m-1 (Aroyan *et al*., 2000; Cummings & Thompson, 1971). The PAM system that SLB will utilise continuously during the Otway Basin 2DMC MSS (**Appendix N**) whilst the acoustic source is active by experienced PAM Operators (**Section 10.3.2**) will be programmed to ensure sensitivity within a frequency range of 10 Hz to 200 kHz to detect the low frequency vocalisations of the baleen whales.

While our understanding of the sound pressure component of whale vocalisations is reasonable, Mooney *et al*. (2016) demonstrated that acoustic fields generated by singing humpback whales include significant particle velocity components as well and these are also detectable over long distances. Further research is warranted with regard to the role that particle motion plays in whale communication and how anthropogenic noise might affect this.

It is likely that cetaceans in the vicinity of the Operational Area during the Otway Basin 2DMC MSS may be subject to some masking effects. Blue whales and southern right whales have low frequency calls and may be subject to masking from the low frequency seismic operations. However, these whales are also likely exposed to some form of masking in the area already due to the high level of commercial shipping activity between west and east Australian ports. SLBs survey design of the Otway Basin 2DMC MSS will assist in reducing the perceptual impact to cetaceans throughout the Operational Area, as the long survey lines and 5 km line spacing requires that the vessel is continuously moving through the Operational Area and as a result is not focused in any particular area for any length of time. A number of control measures will be implemented during the Otway Basin 2DMC MSS to reduce and minimise potential impacts to cetaceans that may arise from the effects of acoustic disturbance (**Table 66**).

Masking levels are difficult to predict, and no auditory thresholds exist for masking effects on marine mammals (Erbe *et al*., 2016); however, as outlined above masking responses (e.g. changes in calling rates) have been documented to occur at relatively low exposure levels (i.e. lower than would elicit any behavioural response). The STLM results for the Otway Basin 2DMC MSS clearly indicate that cumulative SELs greater than this will be generated during the proposed survey (**Table 57**); hence it is reasonable to assume that received sound levels sufficient to elicit masking will occur not only throughout the Operational Area, but also in surrounding waters. Any masking effects will however cease at the completion of the survey and are highly unlikely to have detectable population level effects on any marine mammal species. On this basis the residual risk of impacts to noise perception by cetacean species from seismic sound exposure and vessel noise during the Otway Basin 2DMC MSS has been assessed as **Moderate** (*Minor* x *Certain*).

Table 64 Summary of Horizontal Distances from 5,265 in^3 Acoustic Array at which Potential Impacts to Marine Receptors may occur

Receptor	Behavioural		Impairment						Mortality/ Potential Mortal Injury	
			TTS		PTS		Recoverable Injury			
	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)
Zooplankton (general)									Pk-Pk SPL: 178	2,700 – 4,500
Fish eggs & larvae									SEL_{24hr} :>210 Pk SPL:>207	30(~40 with an infill line) 130 – 250
Benthic Invertebrates	Per-pulse SEL: 186 SEL_{24hr}: 192 Pk-Pk SPL: 209	240 – 360 120 – 220 350 – 1,250 (490 – 1,750 with infill line)								
Fish (no swim bladder)			SEL_{24hr}: >>186 dB	1,000 – 3,500 (1,400 – 4,900 with infill line)			SEL_{24hr}: >216 Pk SPL: >213	10 75 – 130	SEL_{24hr}: >219 Pk SPL: >213	10 75 – 130
Fish (swim bladder) not involved with hearing			SEL_{24hr}: >>186	1,000 – 3,500 (1,400 – 4,900 with infill line)			SEL_{24hr}: 203 Pk SPL: >207	150 130 – 250	SEL_{24hr}: 210 Pk SPL: >207	30 130 – 250
Fish (swim bladder) that is involved with hearing			SEL_{24hr}: 186	1,000 – 3,500 (1,400 – 4,900 with infill line)			SEL_{24hr}: 203 Pk SPL: >207	150 130 – 250	SEL_{24hr}: 207 Pk SPL: >207	50
Sea Turtles	RMS SPL: 166	1,700 – 3,000							SEL_{24hr}: 210 Pk SPL: >207	30 130 – 250

Receptor	Behavioural		Impairment						Mortality/ Potential Mortal Injury	
			TTS		PTS		Recoverable Injury			
	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)	Threshold Criteria	Distance (m)
HF Cetaceans	RMS SPL: 160	2,500 – 4,500	SEL_{24hr}: 140 Pk SPL: 196	380 – 1,000 500 – 1,000 (700 – 1,400 with infill line)	SEL_{24hr}: 155 Pk SPL: 202	20 275 – 400				
MF Cetaceans	RMS SPL: 160	2,500 – 4,500	SEL_{24hr}: 170 Pk SPL: 224	10 12 – 27	SEL_{24hr}: 185 Pk SPL: 230	- 8 – 16				
LF Cetaceans	RMS SPL: 160	2,500 – 4,500	SEL_{24hr}: 168 Pk SPL: 213	80 – 130 >5,000 (>7,000 with infill line)	SEL_{24hr}: 183 Pk SPL: 219	45 – 50 450 – 1,200 (630 – 1,680 with infill line)				
Phocid Pinnipeds (Underwater)	RMS SPL: 160	2,500 – 4,500	SEL_{24hr}: 188 Pk SPL: 212	80 – 140 200 – 500 (280 – 700 with infill line)	SEL_{24hr}: 185 Pk SPL: 218	10 12 – 55				
Otariid Pinnipeds (Underwater)	RMS SPL: 160	2,500 – 4,500	SEL_{24hr}: 170 Pk SPL: 226	10 10 – 22	SEL_{24hr}: 203 Pk SPL: 232	- 8 – 12				

Note: Peak sound pressure levels (Pk SPL): dB re 1 µPa;
Cumulative sound exposure level (SEL24hr): dB re 1 µPa2 ·s;
Per-pulse SEL: dB re 1 µPa2 ·s
RMS SPL: dB re 1 µPa

7.2.2.4 Potential Impacts on Protected and Sensitive Areas in the Marine Coastal Environment

A number of protected and sensitive environments, species and habitats have been identified in the marine coastal environment in close proximity to the Otway Basin 2DMC MSS Operational Area (**Section 5.3**). These include Protected Areas: Onshore Protected Areas, Marine Parks, State Marine Parks, Marine Sanctuaries, Ramsar sites, and the Australian Whale Sanctuary, and recognised sensitive and/or important areas: Nationally Important Wetlands, TECs, KEFs and BIAs.

These areas are important to the South-east Marine Region at a State, Commonwealth and in some cases international context due to either the habitats, species diversity, productivity or general biodiversity present there.

7.2.2.4.1 Australian Marine Parks

The Otway Basin 2DMC MSS Operational Area overlaps two Australian Marine Parks containing features that could be affected by acoustic disturbances; the Nelson Marine Park and Zeehan Marine Park (**Figure 33**). The conservation and management of these Marine Parks falls under the '*South-east Commonwealth Marine Reserves Network Management Plan 2013*-23', which sets out the zoning within each Marine Park and determines the activities allowed within each zone.

The Nelson Marine Park is zoned as a Special Purpose Zone, while the Zeehan Marine Park is mainly classified as a Special Purpose Zone, with a small section of the Marine Park zoned as a Multiple Purpose Zone. The purpose of these zones is as follows:

- Special Purpose Zone – provides for a wide range of activities provided they will not have an unacceptable impact on the values of the area; and
- Multiple Purpose Zone – provides for a wide range of sustainable activities by allowing those that do not significantly impact on benthic (seafloor) habitats or have an unacceptable impact on the values of the area.

The *South-east Commonwealth Marine Reserves Network Management Plan 2013-23* allows for seismic surveys to continue within these zones; however, effects from such activities need to allow the objectives of the Management Plan to be met. These objectives are:

- Provide for the protection and conservation of biodiversity and other natural and cultural values of the South-east Marine Reserves Network; and
- Provide for ecological sustainable use of the natural resources within the South-east Marine Reserves Network where this is consistent with the above objective.

As described in **Section 5.3.3.2.1**, the Nelson Marine Park lies on the migratory pathway of humpback whales, with blue, fin and sei whales also likely to migrate through the area, all of which have been assessed as having a moderate to high likelihood of occurring within the Operational Area during the Otway Basin 2DMC MSS.

The potential effects of acoustic disturbances on cetaceans, including the species identified as important within the Nelson Marine Park have been thoroughly discussed in **Sections 7.2.2.1.8** and **7.2.2.2.5**. Although impacts on these species may occur, implementation of the control measures described throughout **Section 7.2.5** and summarised in **Table 67** will ensure that the objectives provided in the Management Plan are met within the Nelson Marine Park and that there will be no serious or irreversible ecosystem disturbance by acoustic disturbances**.**

Values within the Zeehan Marine Park have been fully described in **Section 5.3.3.2.2**, but in summary the Marine Park is considered a nursery ground for blue warehou and ocean perch, with concentrations of both these species found within the Marine Park. Giant crabs are also of importance to the Zeehan Marine Park and white sharks forage within its boundaries. The West Tasmania Canyons KEF overlaps with the Zeehan Marine Park in the west, with potential impacts on this KEF considered in **Section 7.2.2.4.6** below.

The potential physiological and behavioural effects on fish from acoustic disturbances have been extensively discussed in **Sections 7.2.2.1.5** and **7.2.2.2.2**, with potential injury and mortality (depending on the presence of a swim bladder in fish) at distances out to 250 m from the acoustic source, and potential for TTS out to distances of 3.5 km from the acoustic source (see **Table 53**, **Section 7.2.2.1.5**). Fish eggs and larvae may experience mortality or injuries out to a maximum distance of 250 m from the acoustic source (see **Table 50**, **Section 7.2.2.1.1**). Despite the potential for disturbance to fish, it was considered that the risk associated with the Otway Basin 2DMC MSS was Low. The proposed timing of the Otway Basin 2DMC MSS overlaps slightly with the end of the spawning season for blue warehou (i.e. winter and spring) and ocean perch (i.e. winter – early summer), reducing the potential for disruption of spawning behaviours.

As discussed in **Section 7.2.2.1.4** and **7.2.2.2.1**, various studies have investigated the effects of acoustic disturbances on decapods, with no mortality effects reported for rock lobster, and highly localised behavioural effects in snow crabs. Although giant crabs have been identified as a value within the Zeehan Marine Park, based on these discussions, the effects from the Otway Basin 2DMC MSS on giant crabs are unlikely to be significant. There has been no recent commercial fishing effort for giant crab within the Operational Area, and therefore no fishing effort within the Zeehan Marine Park.

As detailed in **Section 5.2.3.2.1**, white sharks return to southern Australian waters in later spring to early summer. Although this presence overlaps with the proposed timing of the Otway Basin 2DMC MSS, acoustic impacts have not been identified within the Issues Paper for the *Recovery Plan for the White Shark* as a threat to white shark populations. Furthermore, as discussed in **Section 7.2.2.1.9** and **Section 7.2.2.2.7**, sharks are not considered to be sensitive to acoustic disturbances from MSSs.

Based on the above discussions, the objectives provided within the Management Plan will be met within the Zeehan Marine Park, and there will be no serious or irreversible ecosystem disturbance by acoustic releases associated with the Otway Basin 2DMC MSS.

There are an additional four Australian Marine Parks in the wider environment surrounding the Operational Area; Murray Marine Park, Apollo Marine Park, Boags Marine Park and Franklin Marine Park. With the exception of the Murray Marine Park, these Marine Parks have been classified as Multiple Use Zones. The Murray Marine Park has been divided into three zones; Marine National Park, Special Purpose, and Multiple Use Zones. Seismic surveys are prohibited within Marine National Park Zones; however, as this park lies outside the Operational Area, MSS activities may continue. At 17.5 km away, the Murray Marine Park is the closest of these wider Marine Parks to the Operational Area.

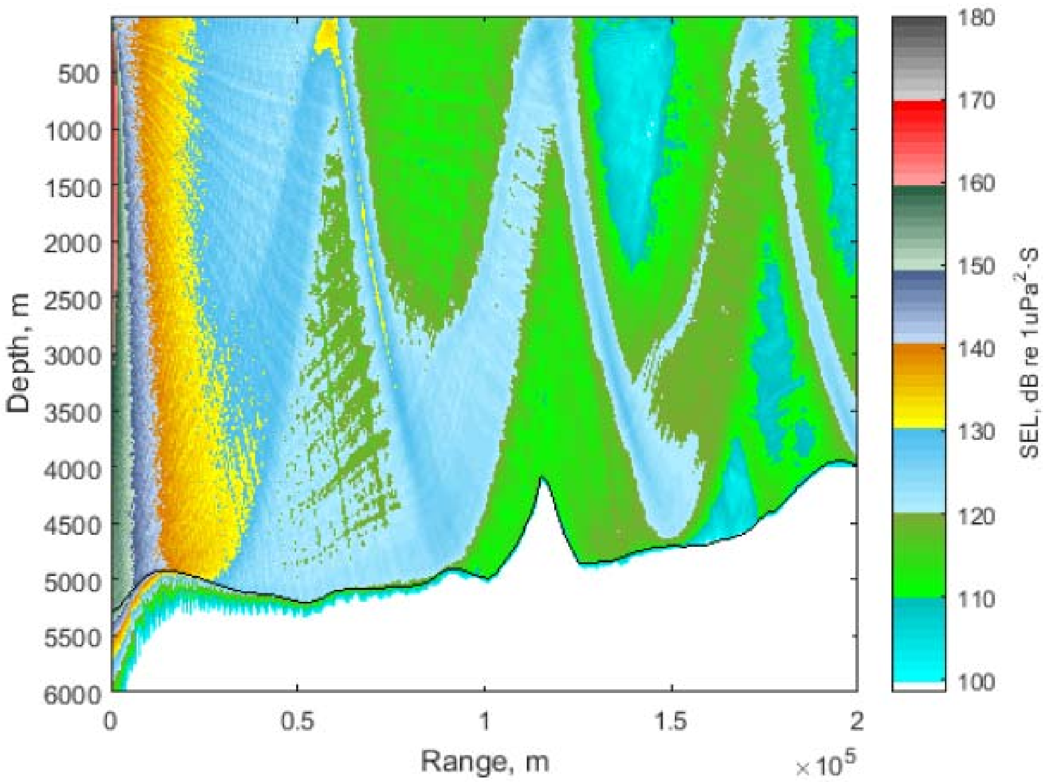
Values within the Murray Marine Park have been fully described in **Section 5.3.3.3.1**. These values include feeding blue whales, fin whales, sei whales, Australian sea lions, and various species of seabirds, inshore nursery grounds for Southern Right Whales, and migrating humpback whales.

The minimum offset distance from active noise sources in the Operational Area to the boundary of the Murray Marine National Park is 50 km. Noise propagation from the Operational Area into the Marine National Park Zone of the Murray Marine Park is expected to be similar to the noise propagation from the deep-water long-range noise modelling location (L4 in **Appendix A** and **Figure 65**). Within this Zone, SEL (and RMS SPL) noise levels are expected to range from approximately 100 – 130 dB, with considerable variation in noise levels at different depths in the water column.

Within the Murray Marine National Park, SEL (and RMS SPL) noise levels generated by the acoustic source are expected to range from around 100 dB up to a maximum of 130 dB, with considerable variation in noise levels at different depths in the water column. **Figure 70** shows an example of long-range noise propagation with range and depth from a deep-water location that is comparable to the propagation that would be expected from the closest approach of the active noise source to the Murray Marine National Park. At offset distances of 50 km and beyond the noise levels are typically below 130 dB. The long-range propagation characteristics of noise mean that further increasing the offset distance from the Murray Marine National Park would not completely eliminate the potential for noise from the survey to be above ambient levels and detectable by marine mammals in the Murray Marine National Park.

While noise levels of 100 to 130 dB RMS SPL are likely to be detectable above ambient noise levels, they are comfortably below the commonly applied 160 dB RMS SPL marine mammal behavioural disturbance threshold. In other words, noise levels of 100 to 130 dB RMS SPL are comfortably below the commonly applied marine mammal, fish, turtle, and benthic invertebrate behavioural disturbance thresholds, and significantly below the mortality/injury threshold for zooplankton and fish eggs/larvae.

Figure 70 Modelled SELs vs Range and Depth along a Propagation Path in Deep Water from Source Location L4 in the Otway Basin 2DMC Operational Area



Note: Black line shows the seabed depth

Although southern right whales at nursery grounds would be considered to be particularly vulnerable to acoustic disturbance, the proposed timing for the Otway Basin 2DMC MSS does not overlap with the calving period for this species (i.e. May – October), with the exception of the very end of the calving season.

Based on the above discussion, physiological effects on marine fauna will not occur, and noise levels within the Murray Marine Park will be below commonly applied behavioural disturbance thresholds, with no behavioural impacts expected. Due to their further distance from the Operational Area than the Murray Marine Park, noise levels within the Apollo, Boags, and Franklin Marine Parks are also not expected to elicit behavioural or physiological changes to marine fauna.

A number of control measures will be implemented during the Otway Basin 2DMC MSS to reduce the impacts of acoustic disturbance on marine fauna. These measures will also serve to reduce the potential for impacts within the Australian Marine Parks. Control measures of relevance include a reduction in the Operational Area to exclude shallower waters and move survey lines further offshore, extending Shut-down Zones for marine mammals, larger line spacing, and the use of MMOs and PAM for the duration of the survey.

Based on the discussion above, the residual risk to Australian Marine Parks within and surrounding the Operational Area arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

While noise levels of 100 to 130 dB RMS SPL are likely to be detectable above ambient noise levels, they are comfortably below the commonly applied 160 dB RMS SPL marine mammal behavioural disturbance threshold. The potential behavioural disturbance impacts to marine mammals at these noise levels have been considered in **Section 7.2.2.2.5**. Specifically, in relation to the Murray Marine National Park, the acoustic impacts are expected to be **Low** (*Minor* x *Likely*). The potential behavioural disturbance impacts to seabirds at these noise levels have been considered in Section **7.2.2.2.8** with the residual risk determined to be **Low** (*Minor* x *Possible*).

7.2.2.4.2 State Marine Parks, State Marine National Parks, State Marine Sanctuaries, State Marine Reserves, and Fisheries Research Areas

While there are no State Marine Parks, Marine National Parks, Marine Sanctuaries, Marine Reserves, or Fisheries Research Areas within the Operational Area, 22 have been identified in the wider vicinity (**Section 5.3.4**).

As determined in the long-range STLM (**Section 7.2.1.3.3**), sound travelling from the acoustic source into shallower waters attenuates at a higher rate than sound travelling into deeper waters. Noise propagating towards the shore drops to below 100 dB 1 μPa^2 s at all depths over a distance of about 60 km from the active acoustic source. Background noise levels of 90 dB re 1 µPa are common in an ocean basin with distant shipping.

Essentially this means that the noise effects from the Otway Basin 2DMC MSS are likely to be negligible at near-shore protected areas that are located more than 60 km from the Operational Area. This includes 15 of the 22 Protected Areas listed in **Table 27**. These 15 areas should therefore receive noise from the Otway Basin 2DMC MSS at levels that are no higher than ambient.

The long-range STLM results also shows that in shallow waters (i.e. <20 m) located ~23 km from the acoustic source, SELs are predicted to be no higher than 100 - 110 dB 1 µPa^{2}s. With the addition of nearshore noise such as wind and waves, seabed sediment movements and the sound-based communication of marine fauna (e.g. crustaceans, fish and marine mammals) the typical background noise can be expected to be higher than 90 dB re 1 µPa in areas close to the coast. Four of the Protected Areas listed in **Table 27** are located between 23 and 60 km from the Operational Area and may receive a small increase in noise above ambient levels, depending on the added influence of natural nearshore noise. Although noise may be elevated within these areas, the elevated noise will be well below levels required to elicit a physiological or behavioural response in the marine fauna present.

The Discovery Bay Marine National Park and two park areas making up the Lower South East Marine Park are located 8 km, 3 km and 4 km respectively from the Operational Area. Based on their close proximity to the Operational Area, these parks may experience noise levels higher than 110 dB 1 µPa^{2}s. Both parks overlap with the Bonney Coast Upwelling KEF. Values associated with this KEF have been assessed in **Section 7.2.2.4.6**.

Marine fauna identified within the Lower South East Marine Park include southern rock lobster, migrating southern right whales, and bluefin tuna, while commercial fisheries for southern rock lobster and marine scalefish also operate within the park. Potential effects on these receptors are discussed in **Sections 7.2.2.2.1** (rock lobster/benthic invertebrates), **7.2.2.2.5** (southern right whales), and **7.2.2.2.2** (tuna/fish). Note that these Sections describe potential behavioural effects as noise levels within the Marine Parks are unlikely to be high enough to elicit physiological injuries. **Section 7.2.3** provides a discussion on potential impacts on commercial fisheries.

Marine fauna values identified within the Discovery Bay Marine National Park include various invertebrates (e.g. southern rock lobster, black-lip abalone and gorgonians), blue whales, sponges, and white sharks. Potential effects on these receptors are discussed in **Sections 7.2.2.2.1** (benthic invertebrates), **7.2.2.2.5** (blue whales/marine mammals), and **7.2.2.2.7** (elasmobranchs).

Diving is also popular at the Lower South East Marine Park, but not Discovery Bay Marine Park on account of the rough conditions. Potential effects of acoustic disturbances on divers are discussed in **Section 7.2.4**.

Based on the information provided in various sections throughout this EP as provided above, the residual risk to State Marine Parks arising from the Otway Basin 2DMC MSS is assessed as **Low** (*Minor x Rare*). However, it is worth noting that this residual ranking of **Low** is based on potential effects within the Discovery Bay and Lower South East Marine Parks which are the located closest to the Operational Area. All other State Protected Areas will not experience noise levels high enough to elicit any impacts on account of their distance away from the Operational Area.

7.2.2.4.3 Onshore Protected Areas, Wetlands of National Importance, and Wetlands of International Importance (RAMSAR)

As discussed in **Section 7.2.2.4.2** above, Protected Areas more than 60 km from the acoustic source are not likely to receive noise at levels greater than the estimated ambient level for open ocean environments. Shallow waters (<20 m) more than approximately 23 km from an active acoustic source are predicted to experience SELs no greater than 100 - 110 dB 1 $\mu Pa^2 s$. This level is within the bounds of ambient noise conditions of a coastal marine environment where maritime shipping is present.

A total of 84 Onshore Protected Areas, five Internationally Important RAMSAR Wetlands, and 15 Nationally Important Wetlands are present in the vicinity of the Operational Area (See **Sections 0**, **5.3.5**, and **5.3.6**). All but one wetland and five Onshore Protected Areas are located more than 23 km from the Operational Area. While those areas beyond 23 km are not likely to receive noise levels above ambient levels, this depends on the added background noise from natural nearshore sources or maritime traffic in the area at the time.

Sound waves attenuate very quickly as they go up into shallower bathymetry. As the wetlands and Onshore Protected Areas are all largely intertidal, these areas would not be influenced by any acoustic effects; the sound would have attenuated by the time it has reached these areas (the closest is 8 km). As a result, the residual risk to these areas from the Otway Basin 2DMC MSS, has been assessed as **Negligible** (*Negligible* x *Remote*).

7.2.2.4.4 Biologically Important Areas

BIAs are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviours. These areas have no legal status; however, a number of Conservation Management Plans outline recommendations for MSSs operating within a defined BIA. There are 19 BIA's within, or in the vicinity of, the Otway Basin 2DMC MSS Operational Area.

There are 14 seabird BIAs of relevance to the Operational Area, although two of these do not overlap with the Operational Area (i.e. black-faced cormorant and little penguin). As discussed in **Sections 7.2.2.1.10** and **7.2.2.2.8**, the consequence of potential impacts from the Otway Basin 2DMC MSS on seabirds is **Minor**. There are no requirements for MSSs operating within seabird BIAs within any of the Recovery Plans or Conservation Advices, with MSSs not identified as a threat to the viability of seabird populations.

A BIA for pygmy blue whale overlaps with the Operational Area towards the coast, with this area identified as important for foraging pygmy blue whales. The potential impacts of acoustic disturbances on pygmy blue whales have been discussed in **Sections 7.2.2.1.8** (physiological impacts), **7.2.2.2.5** (behavioural impacts), and **7.2.2.3.2** (perceptual impacts). With regard to pygmy blue whale BIA's the *Conservation Management Plan for the Blue Whale* states that anthropogenic noise in BIAs is to be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area. Although the EPBC Act Policy Statement 2.1 recommends that MSSs are undertaken outside of BIA's biologically important times, additional control measures will be implemented while the seismic vessel operates within the BIA. The proposed additional control measures have been thoroughly described throughout **Sections 7.2.2.1.8** and **7.2.2.2.5** and are provided in **Table 66**. With the application of the EPBC Act Policy Statement 2.1 required control measures and the proposed additional control measures, impacts from acoustic disturbances in the pygmy blue whale BIA will be appropriately managed as per the blue whale Conservation Management Plan.

A BIA for southern right whales overlaps with the Operational Area within the shallower waters towards the mainland and Tasmanian coasts. This BIA has been identified as it represents known southern right whale core range, aggregations, connecting habitat, migration and resting areas. The potential impacts of acoustic disturbances on southern right whales have been discussed in **Sections 7.2.2.1.8** (physiological impacts), **7.2.2.2.5** (behavioural impacts), and **7.2.2.3.2** (perceptual impacts). Noise interference has been identified within the 2011 – 2021 *Conservation Management Plan for the Southern Right Whales* as a threat to this species, particularly within or close to aggregation areas where calves are present. It is recommended that MSSs should be undertaken outside of BIAs at biologically important times. Southern right whales calve in May – October, therefore the proposed timing of the Otway Basin 2DMC MSS does not spatially overlap with southern right whale calving, and the MSS is proposed to commence at the end of the calving season. As described in **Section 5.2.6.1.1**, southern right whales preferentially utilise water depths ≤10 m while at aggregation and calving sites. The behavioural RMS SPL of 160 dB re 1 µPa will be reached 2.5 km from the acoustic source in water depths of 50 m. As the southern right whales preferentially occupy water depths ≤10 m, noise levels within the BIA and associated aggregation and nursery/calving grounds will be considerably less than that required to elicit a behavioural response in marine mammals (**Table 62**). Despite no behavioural effects expected to occur within the southern right whale BIA, given the potential sensitivity in the area, SLB have proposed additional control measures (see **Table 66**) when acquiring the shallower tie-lines which will further reduce the potential for noise impacts within the southern right whale BIA. Of particular relevance to southern right whales is the implementation of an extended Shut-down Zone when operating within the BIA, whereby the power of the acoustic source will be turned off upon detection of a cetacean 4 km from the acoustic source. This will further reduce sound levels within the southern right whale BIA in the presence of whales.

A foraging BIA for sperm whales has been identified south of Kangaroo Island, 82 km to the northeast of the Operational Area. This BIA does not directly overlap with the Operational Area and there is no sperm whale Recovery Plan or Conservation Advice outlining requirements for MSSs operating in BIAs. Due to the distance from the Operational Area, the Otway Basin 2DMC MSS is unlikely to have any impacts on the sperm whale BIA.

The Operational Area overlaps with the eastern-most boundary of the male Australian sea lion BIA. This slight overlap occurs in the northwest of the Operational Area in the more coastal waters. There are no specific requirements for MSSs operating in the BIA listed within the *Recovery Plan for the Australian Sea Lion*.

A large foraging and distribution BIA for white sharks has been identified which includes all waters covered by the Operational Area. Acoustic impacts have not been identified within the Issues Paper for the *Recovery Plan for the White Shark* as a threat to white shark populations. Furthermore, as discussed in **Section 7.2.2.1.9** and **Section 7.2.2.2.7**, sharks are not considered to be sensitive to acoustic disturbances from MSSs and the Otway Basin 2DMC MSS will not impact the white shark BIA.

Based on the discussion above, the residual risk to BIAs within and surrounding the Operational Area arising from acoustic disturbance during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Likely*).

7.2.2.4.5 Threatened Ecological Communities

There are four TECs located within the wider vicinity of the Otway Basin 2DMC MSS Operational Area:

- Giant Kelp Forests of South East Australia;
- Subtropical and Temperate Coastal Saltmarsh;
- River Murray and associated wetlands including the floodplains and groundwater systems from the junction of Darling River to the sea; and

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

These TECs are fully described in **Section 5.3.7**

Values within the Coastal Saltmarsh, salt-wedge estuaries, and River Murray wetland communities will not be affected by acoustic disturbances due to their largely intertidal nature and large distance away from the Operational Area.

There is no evidence to suggest adverse effects on kelp from MSS; however, while no adverse effects are anticipated for giant kelp, there is potential that organisms living within the kelp forests may be affected by a MSS. Marine species inhabiting kelp forests include fish and invertebrates. Potential effects of acoustic disturbances from MSSs have been thoroughly discussed on these faunal groups throughout **Section 7.2.2.1.5** (for physiological effects) and **Section 7.2.2.2.2** (for behavioural effects). It is worth noting that the effects described in **Section 7.2.2.1.5** and **Section 7.2.2.2.2** have been observed in relatively close proximity to active acoustic sources. Taking this into account, and the relatively coastal distribution of kelp forests, the residual risk from the Otway Basin 2DMC MSS on kelp forests is assessed as being **Low** (*Minor x Rare*), with effects limited to the behavioural effects on the fauna within the kelp forest.

7.2.2.4.6 Key Ecological Features

Three KEFs overlap with the Operational Area: the Bonney Coast Upwelling Zone, West Tasmania Canyons, and shelf rocky reefs and hard substrates. These areas have been gazetted due to their significant regional importance for biodiversity, ecosystem function and integrity. See **Section 5.3.8** for a full description of each KEF.

The Bonney Coast Upwelling lies in the inshore northwest section of the Operational Area and supports high productivity and high species diversity. This area is very important for foraging blue whales and is listed as one of the 11 unique marine areas in Commonwealth waters.

Potential displacement of foraging blue whales from krill aggregations and mortality of krill in the Bonney Coast Upwelling during the Otway Basin 2DMC MSS are key concerns.

A recent study by McCauley *et al.* (2017) suggests that MSSs may cause mortality of larval krill. While there is no information available with regard to how adult krill are affected by MSS, some evidence suggests that zooplankton populations may recover relatively quickly following exposure to acoustic disturbances (Richardson *et al*., 2017) (See **Section 7.2.2.1.1** for a full discussion on the potential effects of MSSs on zooplankton). The indirect effects associated with changes to the distribution and abundance of prey can leave to decreased foraging efficiency and higher energetic demands (Simmonds *et al*., 2004). It is, however, important to note that indirect effects are likely to vary with species, individuals, age, sex, past exposure and behavioural state (IWC, 2007); therefore, such affects may or may not be detrimental depending on the specific circumstances of exposure.

Pygmy blue whales are present in New Zealand's South Taranaki Bight, where similarities to the Bonney Coast Upwelling can be drawn. Due to the presence of the Kahurangi Upwelling, this area is highly productive and attracts large numbers of blue whales, with the fine scale distribution of whales closely linked to that of the krill (Torres *et al*., 2017). Aggregations of blue whales are known to occur in areas of high prey concentrations that coincide with upwelling zones (Fiedler *et al*., 1998; Burtenshaw *et al*., 2004; Croll *et al*., 2005; Gill *et al*., 2011). An extensive number of MSSs have been conducted in the South Taranaki Bight given this area is located in the Taranaki Basin which is the only commercially producing oil and gas basin in New Zealand. From these MSSs that have been conducted over recent years, there has been an aggregation of blue whales confirmed as a result of MMO sightings. SLB has recent experience operating an MSS around blue whale feeding aggregations and mitigated the potential impacts on these feeding aggregations through the implementation of soft start procedures, mitigation zones, shut-down procedures, the use of MMOs and PAM, and survey-specific STLM for the verification of appropriate mitigation zones. During the New Zealand MSSs, SLBs MMOs were able to detect blue whales well ahead of the seismic vessel, with mitigation turns typically made well before the whales approached the Shut-down Zone.

SLB conducted the Taranaki Basin 3D MSS between November 2017 and February 2018 which overlapped both spatially and temporally with the summer foraging of pygmy blue whales in the Taranaki Bight. A 5,085 in^3 acoustic source was used, with a pk-pk amplitude of 262 dB re 1µPa at 1m and a discharge interval of 25 m. Sighting conditions during times of visual observations throughout the survey were often poor (60% of the survey was in poor sighting conditions) and 71% of visual observations were affected to some extent by either partial or strong glare, rain, fog or haze. Despite this, the available visual range of observation for the MMOs was still good, with ~80% of visual observations taking place with an observable range of more than 5 km; with detections out to a maximum of 6.2 km recorded.

A total of 188 marine mammal (cetacean and pinniped) detections were made during the Taranaki 3D MSS, 102 of which were while the acoustic source was at full power, with 37 of the detections requiring mitigation actions to be implemented such as delays to the start-up procedures or shut-down of the acoustic source (RPS, 2018).

Over the last five years, research expeditions consider that there is a population of resident or semi-resident pygmy blue whales (as evident from acoustic data) present in the South Taranaki Bight throughout most of the year (Torres *et al*., 2017). Data collected since 2012 has identified the South Taranaki Bight as a foraging ground for this subspecies, with data suggesting the krill *Nyctiphanes australis* is targeted here (Torres *et al*., 2015), which are predominately present when environmental conditions are favourable for upwelling. There is currently no gazetted protection of the South Taranaki Basin that prevents MSSs from taking place.

However, the distribution of blue whales in the South Taranaki Bight varies with oceanographic patterns that drive the distribution of their prey. In El Niño conditions whales tend to be located west of the Bight, but inside the Bight during more typical weather patterns (Torres & Klinck 2016). As a result, due to the high energy requirements of the blue whales, they need a significant amount of krill each day, so they will follow the food source, as opposed to residing in an area.

NIWA conducted a visual survey in the South Taranaki Bight in January/February 2018 with the intention to deploy satellite tags to blue whales to learn more about the movement patterns. Despite there being large numbers of blue whales in the South Taranaki Bight at end of 2017, at the start of 2018 there were no surface feeding whales present which was considered to be due to La Nina anomalous conditions, resulting in warmer temperatures (4-6 °C higher than average climatology), reduced west wind flows, and consequent reduction in upwelling, which significantly impacted the productivity characteristics of the South Taranaki Bight region. As a result, there were no blue whales observed in the South Taranaki Bight (*Expert 3 – Sensitive Information*). The tagged whales did not do what was expected, as they did not spend any time in Taranaki waters, one whale circumnavigated the South Island, while the other whale headed due north towards the top of the North Island.

Following information provided by fishermen, the blue whales were found down the west coast of the South Island off Westport and two had had satellite tags fixed to them.

During SLBs Taranaki 3D MSS, approximately 93% (n = 56) of blue whale sightings were made within a 21-day period (between 28 November 2017 and 16 December 2017), with all whales being spatially confined within a similar area (RPS, 2018). However, the whales do not stay in the area for long, as soon as the food source is not present, the whales move on looking for food, as they require a large amount of food each day to sustain their metabolic requirements.

The West Tasmania Canyons are located in the southeast of the Operational Area, primarily in deep water beyond the shelf break. Under certain oceanic conditions, upwelling can occur within this area, and it is known that there is a concentration of sponges concentrated near the canyon heads. This creates an ecosystem within which an abundance of marine life aggregates around. The effects of MSS acoustic disturbances on fish have been discussed in **Sections 7.2.2.1.5** and **7.2.2.2.2**.

Sponges are primitive, multicellular filter-feeding organisms that lack a definitive nervous system and musculature, and which use flagellated cells to drive water movement through their bodies (Encyclopaedia Britannica, 2018). Although sexual reproduction occurs in sponges, larval exchanges tend to be minimal, with larvae tending to settle close to the parent population (Mariani *et al*., 2003; 2006). Sponges also have the ability to regenerate by restoration of damaged or lost parts, as well as complete regeneration of adults from fragments or single cells. In unfavourable conditions, sponges may be reduced to small fragments, with a complete sponge forming from the fragments upon the return of favourable conditions (Encyclopaedia Britannica, 2018).

Studies on the effects of seismic activities on sponges are lacking, with effort usually targeted towards the effects on corals, and other reef inhabitants such as fish and invertebrates. Due to a lack of evidence, the potential for effects on sponges cannot be ruled out; however, due to the restorative and regenerative abilities of sponges, any effects are likely to be temporary in nature. Sponge larvae do not remain viable in the water column for very long (Malonado & Bergquist, 2002; Queensland Museum, 2018), therefore the presence of any sponge larvae will be restricted to close proximity to parent populations and in the lower body of the water column, reducing the potential for adverse effects to occur.

Although shelf rocky reefs and hard substrates have not been spatially defined, they are known to occur around the continental shelf edge, but above the shelf break in water depths of 50 – 220 m (Hosack & Dambacher, 2012). The known and potential impacts from acoustic disturbances associated with the Otway Basin 2DMC MSS on marine fauna supported by this KEF have been discussed throughout **Sections 7.2.2.1** (potential physiological effects) and **7.2.2.2** (potential behavioural effects).

During the planning and development stages of the Otway Basin 2DMC MSS, two revisions have been made to the spatial extent of the Operational Area resulting in a combined reduction of approximately 100,000 km^2 off the original Operational Area. In relation to the KEFs, the reduction to the Operational Area has resulted in a considerable reduction in the amount of overlap with the Bonney Coast Upwelling and West Tasmania Canyons.

Revisions to the Operational Area have resulted in the following:

- Removal of 6,162 km^2 from the defined Bonney Coast Upwelling, leaving an overlap of 1,357 km^2, or 9% of the Bonney Coast Upwelling;
- Survey lines have been moved further offshore, with the exception of the tie lines that extend inshore to the previously drilled wells. The tie lines are the only survey lines that will encroach into the defined Bonney Coastal Upwelling Zone. The six tie lines have respective lengths from west to east of 4.5 km, 5.2 km, 9.1 km, 3.9 km, 8.9 km, and 2 km that enter into the Bonney Upwelling Zone. This equates to a total line length of 33.6 km, which when associated to time to acquire, is in the order of approximately four hours based on a travel speed of 4.5 knots and assuming there are no shut-downs due to marine mammals entering the Low-Power Zone or the Shut-down Zone; and
- Removal of 5,904 km^2 from the defined area of the West Tasmania Canyons, leaving an overlap of 2,627 km^2, or 20% of the West Tasmania Canyons.

There are 13 tie lines located in the shallowest section of SLB's Operational Area. SLB are aware that the coastal region inshore of the Operational Area is considered to have regional significance, and to reflect this, SLB has proposed additional control measures to compensate. The additional tie line procedures have been discussed in **Section 7.2.2.1.8** and will act to further mitigate against the potential for displacement or disruption of marine mammals feeding within the Bonney Upwelling.

Based on the above discussions and the change to the original Operational Area reducing significant overlap with the KEFs, the residual risk to KEFs arising from the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor x Unlikely*).

7.2.2.4.7 World and National Heritage Properties

There are three UNESCO World Heritage Sites across South Australia, Victoria and Tasmania regions identified in **Section 5.4.2** as relevant to Otway Basin 2DMC MSS Operational Area: Naracoorte Caves National Park Australian Fossil Mammal Site (South Australia), Royal Exhibition Building and Carlton Gardens (Victoria) and Tasmanian Wilderness (Tasmania) (**Figure 42**). These three world heritage sites are located in the terrestrial environment and will not be impacted in any way by the Otway Basin 2DMC MSS.

There are eight National Heritage sites within the wider vicinity surrounding the Operational Area. The heritage values of these sites have been fully described in **Section 5.4.2.1**. Two sites are terrestrial and will not be affected in any way by the MSS activities. Four are land-based coastal margins located approximately 200 km from the Operational Area and given the values that these sites are recognised for they will not be impacted by the Otway Basin 2DMC MSS.

There are two National Heritage sites located closer to the boundary of the Operational Area that extend a few hundred meters into the Coastal Marine Area; the Great Ocean Road and Scenic Environs (36 km from Operational Area) and Western Tasmanian Aboriginal Cultural Landscape (114 km from Operational Area). The values within these areas are largely scenic values and terrestrial historical artefacts and history. These values will not be impacted in any way by acoustic disturbances associated with the Otway Basin 2DMC MSS.

Due to the significant distance of National Heritage and UNESCO World Heritage sites from the Operational Area, and their largely terrestrial values, the residual risk to these sites arising from acoustic disturbances during the Otway Basin 2DMC MSS has been assessed as **Negligible** (*Negligible x Remote*).

7.2.3 Known and Potential Impacts on Commercial Fisheries

Changes in the behaviour and physiology of fish and invertebrate species (see **Sections 7.2.2.1.2**, **7.2.2.1.5**, **7.2.2.2.1** and **7.2.2.2.2**) as a result of seismic surveys can potentially affect commercial fishing operations (McCauley *et al*., 2000). Although the analysis of catch data does not reveal the underlying mechanisms that may cause changes in catch rates, such data are, understandably, the response type most directly of interest to the fishing industry.

There have been 18 different fisheries identified in or around the Otway Basin 2DMC MSS Operational Area (see **Section 5.5.2** for details), of which the rock lobster fishery, scallop fishery, giant crab fishery, southern bluefin tuna fishery, southern and eastern scalefish and shark fishery, small pelagic fishery, southern squid jig fishery, and abalone fishery are the largest (SETFIA, 2019). Of these identified fisheries, studies examining the effects of seismic activities on catch rates in Australia are specifically available for rock lobsters and scallops and these studies are discussed below. Other Australian and international studies focussing on the effects of seismic operations on the catch rates of other marine fish and invertebrates are also presented. These provide important insights into the potential impacts the Otway Basin 2DMC MSS may have on the other commercial fisheries occurring in the region.

7.2.3.1 Catch Rates – Crustaceans

The following crustacean fisheries have management areas which overlap the Otway Basin 2DMC MSS Operational area:

- Victorian Managed Fisheries:
  - Rock Lobster; and
  - Giant Crab.
- South Australia Managed Fisheries:
  - Rock Lobster (Southern Zone).
- Tasmania Managed Fisheries:
  - Rock Lobster; and
  - Giant Crab.

Further details of these fisheries are provided in **Section 5.5.2**.

As covered in **Section 7.2.2.1.2**, some studies report evidence of physiological effects occurring in crustaceans as a result of seismic exposure (e.g. Day *et al*. 2016a; Fitzgibbon *et al*. 2017). However, these studies do not investigate the impacts of the results at an ecological level. As such, it is not known whether physiological effects identified at the individual level will affect the catch rates of commercially fished benthic invertebrate species. The studies discussed below have specifically examined the effects of seismic surveys on catch rates of crustacean species. It is also important to note that rock lobsters, scallops and other marine invertebrates have limited potential to suffer any increase in mortality from sound exposure as they are not influenced by the pressure component of a sound source, only by the vibration component. As a result, scallop and lobster have to be very close to the source to be impacted, with no increase in mortality at the noise levels expected within 350 m of the active noise source (or up to 500 m of the source if an infill line results in a "double dose" exposure at a particular location) during the Otway Basin 2DMC MSS (see **Section 7.2.2.1.2** for more details). At these exposures (i.e. beyond 350 – 500 m from the source) impacts to rock lobster or scallop larvae are also expected to be *negligible*.

Parry & Gason (2006) examined catch rate data for the southern rock lobster (*J. edwardsii*) and found no significant effects of seismic surveys on commercial catch rates in western Victoria, Australia, between 1978 and 2004, during which time multiple seismic surveys occurred (a total of 28, 2D and five 3D MSSs). In this study, the number of seismic pulses was correlated to catch per unit effort data over 12 depth stratified regions. Catch per unit effort data detected no significant change in catch rates during the weeks and years following seismic surveys, leading the authors to conclude there was a lack of apparent impact on rock lobster fisheries from seismic surveys in that region.

Also, in Australia, Steffe & Murphy (1992) analysed historical catch data for king prawns before, during and after seismic survey operations off Newcastle, New South Wales. They concluded that there were no significant differences in pre-, during and post-survey catch rates and could not detect any impact on offshore prawn catches that were attributable to the seismic survey. However, these authors did not statistically analyse the catch data and details of the seismic survey (source type, source level, exposure level, exposure duration) were not provided.

Internationally, Andriguetto-Filho *et al*. (2005) found that the catch rates of the southern white shrimp (*Litopenaeus schmitti*), southern brown shrimp (*Farfantepenaeus subtilis)* and Atlantic seabob (*Xyphopenaeus kroyeri)* were unchanged during a seismic survey (peak source level 196 dB re 1 µPa at 1 m). These authors concluded that the results suggest that shrimp stocks are resilient to disturbance by seismic acoustic sources under experimental conditions.

Christian *et al*. (2003) found that catch rates of snow crabs (*Chionoecetes opilio*) in Newfoundland were higher following exposure to a seismic source, but noted that this was probably due to physical, biological or behavioural factors unrelated to the acoustic source.

Concerns from snow crab harvesters in Atlantic Canada that seismic noise from widespread hydrocarbon exploration was having negative effects on catch rates led Morris *et al*. (2018) to undertake a Before-After-Control-Impact study to examine the effects of industry-scale seismic exposure on catch rates. The study area and methodology were developed following consultation with industry-based snow crab harvesters and seismic surveying industries to ensure that the study design aligned with industry standards and was realistic. Results showed no evidence of negative effects of seismic activity on catch rates over both short (within days) and longer (over weeks) time frames. Significant differences in catch rates did occur across study areas and between years; however, it was concluded that, if seismic effects on snow crab harvests did exist, the magnitude of these effects was smaller (and less important) than changes related to natural spatial and temporal influences.

Due to the absence of sound pressure-detecting structures in benthic invertebrates and the large separation distances between the seismic source and the seabed across most of the Otway Basin 2DMC MSS (89% of the Operational Area is in water depths greater than 1,000 m), the residual risk of physiological and behavioural impacts to benthic species from seismic sound exposure have both been assessed as **Low** (*Minor* x *Possible*) (**Sections 7.2.2.1.4** and **7.2.2.2.1**).

Based on these **Low** risk ratings, the literature discussed in this section, and that any significant impacts on benthic invertebrates from discharge of the acoustic array are likely to be confined to close ranges to the source and be short to medium term (hours to days) in duration, it is considered that population level effects are unlikely to occur as a result of impacts to benthic invertebrates within the Otway Basin 2DMC MSS.

With the control measures implemented as listed in **Table 66**, it is considered that the risk of any discernible impacts on catch rates of commercial fisheries targeting rock lobsters and crabs during the Otway Basin 2DMC MSS will be **Low** (*Minor* x *Possible*).

7.2.3.2 Catch Rates – Molluscs

The following mollusc fisheries have management areas which either overlap the Otway Basin 2DMC MSS Operational Area or are located nearby:

- Commonwealth Managed Fisheries:
  - Bass Strait Central Scallop (no fishing effort in Operational Area); and
  - Southern Squid Jig Fishery.
- Victorian Managed Fisheries:
  - Abalone (daylight hours only) (no fishing effort in Operational Area).
- South Australia Managed Fisheries:
  - Abalone (Southern Zone).
- Tasmania Managed Fisheries:
  - Abalone Greenlip – North-west (no catch or effort data recorded from this fishery in the Operational Area);
  - Abalone Blacklip – North-west and West;
  - Scallops (unlikely to be any fishing effort in Operational Area); and
  - Squid (not mentioned as a fishery within or near Operational Area in the SETFIA Report.

Fishermen targeting mollusc species, in both Australia and globally, have been concerned about the potential impacts of MSSs on catch rates. These concerns relate to the effects of MSSs causing mortality of adults and/or larvae, and/or sub-lethal effects such as weakened adductor muscles in scallops. As covered in **Section 7.2.2.1.2**, some studies report evidence of physiological effects occurring in mollusc species as a result of seismic exposure (e.g. Day *et al.,* 2016a). However, these studies do not investigate the impacts of the results at an ecological level. As such, it is not known whether physiological effects identified at the individual level will affect the catch rates of commercially fished benthic invertebrate species.

Parry *et al*. (2002) investigated the effects of seismic airgun noise on commercial scallop abundance in the Bass Strait Central Zone Scallop Fishery by comparing the mortality (and adductor muscle strength) of scallops deployed in an area exposed to passes of a survey vessel towing an operating 24-airgun array, with those in a control area 20 km away from the test area. The study found no significant differences in the abundance of scallops (or abductor muscle strength) in the two months following seismic surveying. Similarly, Harrington *et al*. (2010) found no negative impacts on adult commercial scallops in Bass Strait during seismic surveys and in the two months following survey completion.

Internationally, Brand & Wilson (1996) assessed the effect of seismic surveys in the field off the Isle-of-Man by comparing long-term catch-per-unit-effort (**CPUE**) of commercial scallops with CPUE following a seismic survey. The results showed no evidence of seismic surveys affecting scallop CPUE; a decline, coincident with the 3D seismic survey, was attributed to two years of poor recruitment prior to the seismic survey.

La Bella *et al*. (1996) studied the effects of seismic surveys on the main fisheries resources of the Adriatic Sea and found no evidence of catch reductions in mantis shrimp (*Squilla mantis*), golden carpet shell (*Paphia aurea*) or inaequivalve ark shells (*Anadara inaequivalvis*). There was a significant change in catch rate for purple die murex (*Bolinus brandaris*) but this was attributed to a behavioural change rather than immediate mortality.

However, in 2010, mass mortality of scallops and other benthic invertebrates occurred in the months following a seismic survey in Bass Strait. The western and eastern scallop beds within the survey area suffered high mortality rates whereas the southern scallop bed which lay approximately 50 km away remained healthy (J. Semmens, as cited in Przeslawski *et al*., 2018; 2018a). As such, fishing groups were concerned that the seismic survey had caused the mass mortality event. To investigate their concerns, Przeslawski *et al*. (2018; 2018a) carried out a study to investigate the potential impact of marine seismic surveys on scallops in the Bass Strait region. One component of the study specifically addressed the 2010 mass mortality event by using satellite data to examine patterns of sea surface temperatures over a ten-year period from 2006 – 2016. The data showed that there was a pronounced thermal spike in eastern Bass Strait between February and May 2010, and that the thermally impacted area overlapped the scallop beds where mass mortality occurred with respect to both space and time. As such, it is not clear whether the mass mortality event resulted from the thermal spike, which occurred in the same region on almost exactly the same dates as the seismic survey operation, or from the seismic survey.

An additional component of the study involved deploying an Autonomous Underwater Vehicle (**AUV**) to examine the potential response of two scallop species before a 2015 marine seismic survey, and again at two- and 10-months post-survey (Przeslawski *et al*., 2018; 2018a). Dredged samples were also taken. Results showed that there was no evidence of mortality that could be attributed to the survey, although the authors note that sub-lethal effects cannot be excluded. The satellite data showed that thermal fluctuations were within normal ranges during the survey. The authors concluded that due to the acquisition of *in situ* data, consideration of commercial seismic arrays, and pairing of dredging and AUV imagery for the field-based components, the results were ecologically realistic and will have value informing future applications for marine seismic surveys and as well as their assessment by regulatory authorities.

Due to the absence of sound pressure-detecting structures in benthic invertebrates and the large separation distances between the seismic source and the seabed across most of the Otway Basin 2DMC MSS (89% of the Operational Area is in water depths greater than 1,000 m), the residual risk of physiological and behavioural impacts to benthic species from seismic sound exposure have both been assessed as **Low** (*Minor* x *Unlikely*) (**Sections 7.2.2.1.4** and **7.2.2.2.1**).

Based on these Low risk ratings, the literature discussed in this section, and that any significant impacts on benthic invertebrates from discharge of the acoustic array are likely to be confined to close ranges to the source and be short to medium term (i.e. hours to a day) in duration while the vessel passes through the area, it is considered that population level effects are unlikely to occur as a result of impacts to molluscs within the Otway Basin 2DMC MSS.

With the control measures implemented as listed in **Table 66**, it is considered that the risk of any discernible impacts on catch rates of commercial fisheries targeting scallops and abalone during the Otway Basin 2DMC MSS will be **Low** (*Minor* x *Possible*).

7.2.3.3 Catch Rates – Fish

The following fisheries have management areas which overlap or are in the surrounding waters of the Otway Basin 2DMC MSS Operational area:

- Commonwealth Managed Fisheries:
  - Small Pelagic;
  - Southern/Eastern Scalefish & Shark;
  - Eastern and Western Tuna and Billfish; and
  - Southern Bluefin Tuna.
- South Australia managed fisheries:
  - Marine Scalefish.
- Victorian managed fisheries:
  - Ocean (General); and
  - Wrasse (Ocean).
- Tasmanian managed fisheries:
  - Scalefish.

As discussed in **Section 7.2.2.2.2**, acoustic disturbance associated with MSSs may modify fish behaviour, and this is often observed as fish moving away from a loud acoustic source to reduce or minimise their exposure. As a result of modified fish behaviour, local abundances, distributions and, consequently, catch rates may be impacted during MSSs. This has the potential to manifest as short-term effects on catch rates within and around a survey area. However, fish behavioural responses are often observed to be temporary and short-term, with fish returning to their original area after a short period of time. For example, studies by Engås *et al.* (1996) and Slotte *et al*. (2004) have observed fish species (cod/haddock and blue whiting/herring respectively) moving back to their original areas within five days following the completion of seismic activity.

A number of studies have examined the effects of seismic activities on catch rates of fish species. A recent critical review by Carroll *et al*. (2017) concluded that such studies have found positive, inconsistent, or no effects of seismic surveys on catch rates or abundance of fish. Relevant key studies are discussed in the following paragraphs.

Bruce *et al*. (2018) examined the impacts of a 2D MSS in Australia's Gippsland Basin using a combination of field studies and analysis of commercial catch rates before and after the MSS, with this study representing one of the few studies on the direct effects of seismic discharges on unrestrained fish in the field. The displacement and movement of tiger flathead, gummy sharks, and swell sharks (i.e. species that are caught in the Southern and Eastern Scalefish and Shark Fishery) was monitored using acoustically tagged wild caught and released fish. Tags were detected by receivers placed on the seabed, allowing the movement of fish to be tracked. Catch rates were compared within each gear type (i.e. Danish seine and gill-net) before and after the survey (January 2012 – October 2015); three years prior to the survey was taken into account to examine any seasonal and inter-annual variation, and six months post-survey to examine potential impacts. The survey utilised a single 2,530 in^3 acoustic source array, with a highest measured SEL of 146 dB re 1 µPa recorded at 51 m water depth when the acoustic source was operating 1.4 km away. The response of the study species to the MSS was found to be species-specific, showing the following results:

- Movement of gummy sharks and swell sharks out of the monitored area largely occurred prior to the commencement of the MSS, although both species moved in and out of the monitored area throughout the study period, with two gummy sharks returning to the experimental zone during seismic operations;
- Of the tiger flathead located within the experimental zone during seismic operations, 50% remained in the area for the entire survey, and 50% departed. None of those that departed returned; however, a degree of residency was suggested for those detected for extended periods, and a possible seasonal movement out of the area was suggested due to all but one individual of this species departing the monitored area by mid-June. The percentage of recorded movements was greater after the survey, with movements during this period more consistently spread throughout a diel cycle;
- An increase in tiger flathead swimming speed was observed during the survey period, suggesting a potential short-term startle response to the MSS activities;
- Catch rate analysis indicated changes in the six-month period following the MSS in nine out of the 15 analysed species; catch rates increased in six species, while three showed reductions in predicted catch rates. The authors note; however, that sawshark catch in the Danish seine sector increased sharply prior to the MSS which is likely to have inflated the predicted catch rate, leading to a greater perceived decrease in catch following the survey than might otherwise have occurred; and
- Changes in catch rate was found to be species and gear specific, with no single species showing a consistent pattern in variation in catch between gear types.

Overall, Bruce *et al*. (2018) concluded that little evidence of consistent behavioural responses (excluding flathead movement) or catch rate changes induced by the MSS were found.

Also, in Australia, Thomson *et al*. (2014) undertook a desktop study of four fish species (gummy shark, tiger flathead, silver warehou, school whiting) in the Gippsland Basin, Bass Strait and found no consistent relationships between catch rates and effects from 183 MSSs undertaken in the area. These authors do however acknowledge that the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded. A further desktop study in 2015 targeted a single seismic survey and found that catch rates in the six months post-survey, six of the 15 species examined showed higher catch rates, three species showed reduced catch rates, and five species showed no change (Przeslawski *et al.* 2016a).

International studies that report no significant effects of seismic activities on catch rates include Pickett *et al*. (1994), who documented the distribution of bass in Lyme Bay (UK) during a seismic survey (peak source of 202 dB re 1 µPa@1 m) over three and a half months and found no long-term changes in bass distribution or large-scale emigrations from the survey area. In another study, Jakupsstovu *et al*. (2001) undertook a large-scale study on catch rates around the Faroe Islands and found that although the majority of fishers perceived a decrease in catch during seismic operations, analysis of logbook records during periods with and without seismic operations showed no significant effect of seismic activity on catch rates in the area. Furthermore, La Bella *et al*. (1996) found no changes in trawl catches of short-finned squid (*Illex coindetti*) or Norway lobster (*Nephrops norvegicus*) one day after a seismic survey using an acoustic source at a SPL of 210 dB re 1µPa @ 1 m (corresponding to levels of 149 dB re 1µPa at the animals' location) in the Central Adriatic Sea.

Løkkeborg *et al.* (2012) found that during seismic activities on a Norwegian fishing ground, catch rates changed for all species studied, except for saithe. Gillnet catches for redfish and Greenland halibut increased by 86% and 132% respectively, compared to pre-activity levels. In contrast, longline catch rates fell (16% for Greenland halibut, 25% for haddock). These varied results were explained by greater swimming activity versus lowered food search behaviour in fish exposed to air-gun sound emissions. Acoustic mapping of fish abundance did not suggest displacement from fishing grounds, suggesting strong habitat preference in some species.

Some studies clearly demonstrate a reduction in catch per unit effort in close proximity to seismic operations. Such effects are usually temporary and localised, generally lasting from one to five days following the cessation of seismic activity. For example, Bendell (2011) analysed long-line catches off the coast of Norway during the acquisition of a two-week seismic survey with a peak source level of 238 dB re 1 µPa@1 m. Catch rates reduced by 55 – 80% within the survey area for distances up to 5 km from the active source; however, these reductions were temporary with catch rates returning to normal within 24 hours of the seismic operations ceasing. There are no studies reporting evidence of long-term displacement in commercially fished species.

In studies where reductions in catch rates occur in conjunction with seismic activities, it can often be difficult to conclusively attribute a change in catch rate to the impacts of such exposure. For example, Engas *et al*., (1996) investigated the abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) in the central Barents Sea seven days before, five days during, and five days after seismic acquisition using acoustic sources. They found that trawl catches of cod and haddock and longline catches of haddock declined, on average, by 50% after acquisition started and longline catches of cod reduced by 21%. Catch rates did not return to pre-survey levels during the five-day period after seismic acquisition ended. These authors hypothesised that the reduction in Atlantic cod and haddock catch rates reported from commercial longlines and trawls was most likely due to fish moving away from the seismic area; however, Skalski *et al*. (1992) argued that it may have been due to decreased responsiveness to baited hooks associated with an alarm behavioural response, or impacts related to fishing the same area for over two weeks. Some authors (e.g. Gausland, 2003) also argue that reductions in catch may represent natural fluctuations in fish stocks or long-term negative trends.

Sometimes, apparent increases in catch rates are observed in response to seismic surveys. For example, significant changes to catch rates (both increases and decreases) were reported in response to seismic surveys in Prudhoe Bay, Alaska (Streever *et al*., 2016). These changes were attributed to fish displacement with increased and decreased catch rates occurring depending on the location and timing of fishing efforts in relation to the seismic survey.

Catch rates could also conceivably change in response to flow-on effects associated with changes in the abundance or distribution of zooplankton prey. As discussed in **Section 7.2.2.1.1**, a recent study by McCauley *et al*. (2017) links seismic surveys to zooplankton mortality, which could presumably have a negative effect on the prey availability for some pelagic fish species. However, any potential flow-on effects to marine food webs are expected to be spatially restricted to within a few kilometres of the survey vessel with baseline conditions resuming relatively quickly after survey completion (see Richardson *et al*., 2017).

Behavioural changes which may result from seismic activities also have the potential to affect fish spawning activities. This may occur as a result of fish temporarily diverting efforts away from spawning aggregations, egg production and recruitment success. Masking of fish vocalisations may also reduce the amount of spawning activity (Hawkins & Popper 2017).

Due to a lack of data it is not possible to determine spawning periods and/or locations within the Otway Basin 2DMC MSS Operational Area for a number of fish species. There is likely to be limited benefit (if any) from trying to implement a survey design based around these restrictions in place as the Operational Area has a large spatial extent; with 89% being in water depths greater than 1,000 m and is considered that the Operational Area is located offshore from most of the spawning habitats and distribution of most of the commercially fished species in the region.

Based on this, and the fact that any behavioural effects on fish from seismic surveys are likely to be short term and temporary, with literature finding that fish return to normal behaviour and distributions within days of acoustic exposure, it is assessed that the Otway Basin 2DMC MSS will have limited impact on fish fecundity, spawning or reproductive potential (assessed in relation to fish behavioural effects).

Section 7.2.2.1.1 provides a discussion and assessment of the potential effects of seismic acoustic disturbance on fish eggs and larvae, where it is also discussed that seismic operations may have some negative effects on zooplankton populations based on recent studies. Consequently, there is the potential for fisheries yield and spawning stock to be adversely affected in subsequent years. The oil and gas industry is concerned by this and is supporting further research is to assess potential impacts of seismic surveys. These studies are on the effects of plankton communities which is a continuation of the CSIRO project, as well as a three-year study by the Australian Institute of Marine Science who are investigating the long and short-term impacts of marine noise from the petroleum industry on pearl oysters and fish. These studies are all investigating and measuring the quality and amount of noise pollution produced by seismic surveys and vessel activity to produce real-world information about the potential impacts from these anthropogenic disturbances which can then be used in risk assessment processes such as this EP.

From the literature discussed in this section, it can be summarised that for fish species, studies suggest that in some circumstances behavioural displacement reduces catch rates while in other circumstances catch rates increase. A number of studies also show no change in catch rates. This summary agrees with the conclusion reached by Przeslawski *et al*. (2016a) who concluded that "...[their] *results support previous work in which the effects of seismic surveys on catch seem transitory and vary among studies, species, and gear types*". Although some studies have linked reductions in catch rates to the effects of seismic activities, the body of peer reviewed literature on this topic does not support any long-term abandonment of fishing grounds by commercial fish species. There are a number of studies indicating that post-survey catch levels return to pre-survey levels following the cessation of seismic activities (e.g. Carroll *et al.* 2017). Also, important to note is that although some fish may be temporarily displaced during seismic activities, the total number of fish within the fishery stock will remain unchanged (Przeslawski *et al.,* 2016a).

As discussed in **Section 7.2.2.1.5**, the potential for fish mortality due to peak noise exposure has been identified within 250 m of the active source at full power. However, it is important to note that there are currently no documented cases of fish mortality upon exposure to seismic sound under field operating conditions. Studies show that exposure to seismic sound is considered unlikely to result in direct fish mortality; this may be because the moving character of the source and requirement for soft starts allow time for fish to avoid the highest theoretically possible exposures.

To further reduce the potential for any impacts on fish at the population level, SLB have also taken steps to ensure that the Otway 2DMC MSS takes place in the shortest time possible (i.e. 24 hour operations); and through stakeholder engagement has identified sensitive areas for fisheries, and has made a commitment through the ongoing stakeholder engagement plan to continually engage with the fishers so that any impacts on the fishers and fisheries can be considered as part of the survey design during the acquisition phase if required.

Given the evidence of fish returning to survey areas following the cessation of seismic/acoustic activities, it is highly likely that any effects on fish will be temporary and fish will return to normal behaviour and distributions within days of any acoustic exposure. There are unlikely to be any population level effects for fish and subsequently, effects on catch rates are considered to be minimal.

With the control measures implemented as listed in **Table 66**, it is considered that the risk of any discernible impacts on catch rates of commercial fisheries targeting fish during the Otway Basin 2DMC MSS will be **Low** (*Minor* x *Possible)*.

7.2.3.4 Catch Rates Summary

Carroll *et al*. (2017) recently published a critical review of the potential impacts of marine seismic surveys on fish and invertebrates. This review concluded that studies investigating the potential effects of seismic signals on catch rates or abundances on cephalopods, bivalves, gastropods, decapods, stomatopods, and ophiuroids have all detected no significant differences between sites exposed to seismic operations and those not exposed.

Based on this, and the literature presented in this section, it is possible that there may be some short-term localised effects on the catch rates of commercially important species in the Otway Basin 2DMC MSS Operational Area due to temporary distributional or quantitative changes in fisheries stocks. Most of the Operational Area is located in very deep waters, with 89% in waters deeper than 1,000 m (**Figure 61**).

The SETFIA (2019) report states that a large part of the Operational Area is too deep for commercial fishing; however, commercial fishing activity still takes place within the Operational Area as summarised within SETFIA, (2019). There have been a number of concerns raised by commercial fishers during the stakeholder engagement process, with a number of submissions received (**Appendix F**) about the potential impact of the Otway Basin 2DMC MSS on their fishing activities, and questions asked through the SIV and TSIC reports (**Appendix H** & **Appendix J**).

Stakeholder concerns have been addressed during survey planning and design, and each submission has been assessed and considered and a response has been provided to every stakeholder who provided submission. Where submissions were considered relevant and justified, changes to the survey design were made by SLB, such as moving the survey lines further offshore and significantly reducing the Operational Area, primarily to move seismic operations away from the shallower inshore waters where most of the rock lobster fishing takes place. There have been two reductions to the Operational Area during the planning stages, totalling ~100,000 km^2 (**Figure 59** and **Figure 60**). These measures have resulted in reductions in the overlap with fishing grounds and key ecological features such as the Bonney Upwelling Zone and the West Tasmanian Canyons.

In South Australia the rock lobster fishery is closed from June to September to allow for the spawning period to finish. The Victorian rock lobster season opens on 16 November until 14 September where the highest catch rates are reported in December and January (SETFIA, 2019). The Otway Basin 2DMC MSS is scheduled to commence in October 2019 and engagement is taking place with the rock lobster fishers on how any potential conflict for the Otway Basin 2DMC MSS can be best managed, which is largely going to occur when the tie lines are acquired. However, being a 2D MSS, it is only a relatively narrow swath of the ocean that needs to remain clear to avoid pots, so this will be raised with the industry bodies and licence holders during the next round of engagement, and they will be provided with survey line coordinates and charts showing exactly where the survey lines are placed, and this engagement will continue until the Otway Basin 2DMC MSS commences and for the duration of the MSS.

A large number of stakeholders have been notified of the Otway Basin 2DMC MSS (**Section 4** and **Appendix B**) and there have been multiple updates provided to the stakeholders throughout the planning and preparation stage of this EP. Significant emphasis has been placed on communications with commercial fishers given their reliance on the marine environment for their livelihood. This engagement has also involved SLB entering into a formal agreement with SIV and TSIC to engage with all of their members that the Otway Basin 2DMC MSS is relevant to in terms of potential conflict to their activities as discussed further below. This communication will continue throughout the acquisition of the survey through the 48-hour look-ahead, SMS to fishers mobile phones and direct contact with associations and SLB.

SIV and TSIC have developed a policy for consultation between the oil and gas sector with the professional seafood industry, of which SIV and TSIC are the signatories of the policy document. The policy document was developed due to an increasing demand from other resource sectors seeking to engage with the seafood industry which was creating a burden on their resources. The engagement policy puts a structure in place with policies and timeframes for how effective engagement can take place for proponents wanting to engage with licence holders, of which an administration fee is charged for the subsequent time.

SLB have been in contact with SIV and TSIC from the commencement of the stakeholder engagement process and have been working through the process of stakeholder engagement in accordance with the policy to specifically provide licence holders that those peak bodies represent accurate information of the proposed Otway Basin 2DMC MSS.

SLB are fully committed to effectively engage with the commercial fishing industry and have done so throughout the Otway Basin 2DMC MSS programme and will continue to do so through the implementation of the ongoing stakeholder engagement plan. SLB will keep the fishers fully informed of the MSS schedule and vessel movements (i.e. 48-hour look-ahead plans) and will remain as flexible as possible during the planning stages while developing the operational schedule to minimise temporal conflict with fishers, particularly in the more inshore waters of the Operational Area.

Likewise, SLB engaged SETFIA to undertake an assessment of the fishing activity that occurs within the Otway Basin 2DMC MSS Operational Area as a way to identify the licence holders that are actively fishing in this area and to get an understanding of the catch that comes out of the Operational Area, in terms of species and volume. This information allowed SLB to more effectively focus the engagement on those fishers with the greatest potential for overlap between the Operational Area and fishing locations. As part of this agreement, SETFIA will be providing daily SMS's to those fishers identified as fishing in and around the Operational Area, with an update of where the seismic vessel will be and where the vessel is heading.

The report provided by SETFIA (SETFIA, 2019) details 18 fishing sectors relevant to the Otway Basin 2DMC MSS, their overlap with the Operational Area and the potential impact of the proposed activity on each sector. This analysis was based on data provided by AFMA (Commonwealth fisheries); the VFA (Victorian Fisheries); DPIPWE (Tasmanian Fisheries); and SARDI (South Australia Fisheries) which was specifically focused on the Operational Are. Where available, fisheries catch and effort figures, and information on catch values from published reports, were also used.

Following the analysis of the potential effects on each of the 18 fisheries in relation to the proposed activity, SETFIA (2019) summarised the fisheries into three groups: those expected to experience 'significant', 'some' and 'no or negligible' impact (**Table 65**). These groupings were based on calculations of the overlap of the Operational Area with the landed commercial catch (and revenue) taken within that same area. Potential impacts beyond the Operational Area or on other life history stages of commercially fished species were not considered.

Table 65 shows the fisheries that are, to some extent, affected by the proposed survey, with at least eight of these fisheries being considered to be significantly affected. The fishery which SETFIA (2019) considered to have the greatest potential to be affected by the Otway Basin 2DMC MSS was the South Australia Rock Lobster (southern zone) fishery. This fishery has an annual average catch value from the Operational Area of almost $8.2M and represents 7.2% of the total annual catch from this southern zone rock lobster fishery.

SETFIA (2019) considers that, within the Operational Area, the overall impact on the commercial fisheries is lessened by a number of reasons including:

- The presence of marine parks (which exclude most commercial fishing);
- The very large (Commonwealth) "deepwater" fishing closure (which limits the impact on Commonwealth fisheries);
- Half of the proposed survey occurs in water depths that are too deep for fishing; and
- The fishing industry is generally less concerned about 2D than 3D surveys, given their larger line spacing, reduced intensity and decreased survey duration.

Table 65 Summary of SETFIA Fisheries Assessment

Fishery (by impact)	Data	Juris-diction	10 yr av. catch in area	Fishery TAC 2016/17	Fishery catch most recent year	% of catch potentially impacted	Annual average catch value potentially impacted
			A	B	C	D=A/C	E=A*price
			tonnes	tonnes	tonnes	%	tonnes
Rock Lobster (S)	Table 17	SA	90.1	1,245.7	1,237.7	7.2%[i]	$8,171,000[ii] (based on depth analysis)
Rock lobster (W)	Table 8	Vic	85.3	230[iii]	209[iii]	41%	$5,328,000
CTS otterboard trawl	Table 4	Cth	1241	≈21,077[iv]	8413[v]	15%	$4,455,000
GHaT scalefish hook	Table 6	Cth	24.6	410[vi]			$132,000
Giant crab	Table 9	Vic	11.7	10.5[vii]	9[vii]	100%	$223,000
MSF Fishery	Table 18	SA	30	Not applicable	~2000	1.5%	$167,000
Rock lobster	Table 12	Tas	3.2[viii]	1050.7[ix]	1026.7[ix]	0.3%	$169,000
GHaT shark hook	Table 5	Cth	20.8	2,522[x]	2,734[xi]	0.8%	$132,000
GHaT shark gillnet							
Southern squid jig	Table 7	Cth	73	See note [xii]	213 [xiii]	3.4%	$14,000 Variable
Giant Crab (S)	Confidential	SA	Confidential	22.1	16.8	Confidential	Confidential
Charterboat	Confidential	SA	At least 599 fish	Not applicable	94,891 fish[xiv]	0.6%	Confidential
Ocean general	Table 10	Vic	4.1[xv]	Not applicable	2,775[xv]	Not applicable	Confidential
WTBF		Cth	Negligible	10,125[xvi]	322[xvi]	Negligible	Negligible
SZ Abalone	Table 19	SA	Negligible	129.6[xvii]	124	0%	Negligible (based on depth analysis)
Ocean wrasse	Confidential	Vic	Confidential	Not applicable	19[xv]	Confidential	Confidential
Scalefish	Table 13	Tas	0.4	Not applicable	313[xviii]	Confidential	$2,572
Small pelagic		Cth	Negligible	48,900	5,713[xix]	Negligible	Negligible
ETBF		Cth	Negligible	7,592[xx]	4,615[xx]	Negligible	Negligible
SBTF	Confidential	Cth	Negligible	5,697[xxi]	5,334[xxi]	Negligible	Negligible
TOTALS			**1,584**		**18,947**	**8.4%**	**$18,793,572**

Source: SETFIA, 2019

The continual engagement and provision of information throughout the Otway Basin 2DMC MSS will enable fishers to schedule their activities around the seismic operations with the aim of reducing potential conflict through the displacement of fishing activities. As mentioned previously, and above, the 48-hour look-ahead reports that SLB will provide, which will be updated every 24 hours, will detail the vessel's planned survey lines within the Operational Area with GPS coordinates of line start and end points. These will also be supplemented with SMS by SETFIA with similar information for those fishers who don't have email access at sea.

7.2.3.5 Southern Squid Jig Fishery

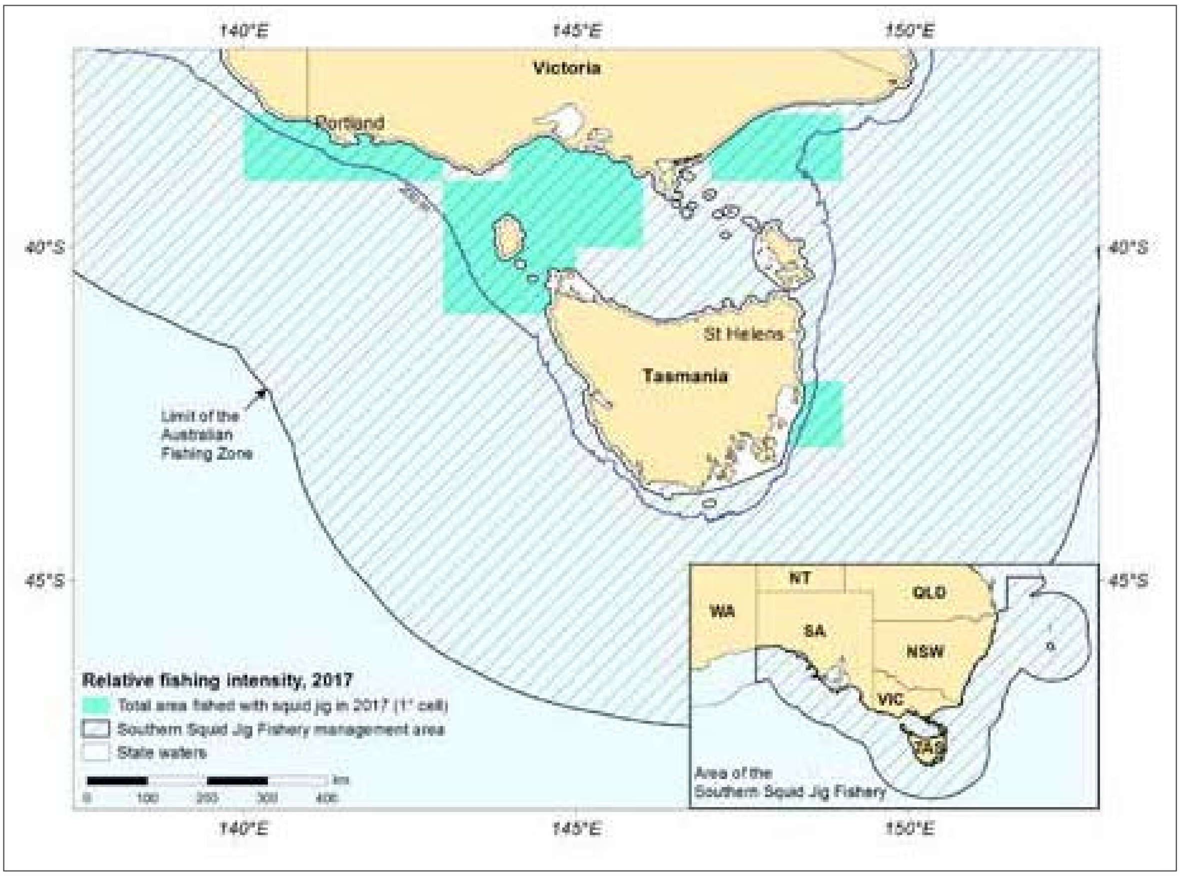
As described in **Section 5.5.2** the Southern Squid Jig Fishery overlaps with the Otway Basin 2DMC MSS Operational Area. Fishing effort for the Southern Squid Jig Fishery is concentrated on the edge of the continental shelf near Portland, Victoria, in water depths between 60 and 120 m (**Figure 71**), with squid jig vessels typically operating at night (ABARES, 2018a).

Squid are also caught in the Commonwealth Trawl Sector (**Figure 72**) and the Great Australian Bight Trawl Sector, where in recent years more squid has been landed collectively than from the Southern Squid Jig Fishery (Patterson *et al*., 2017). The Southern Squid Jig Fishery is a sustainable fishery that is not subject to overfishing, but low catch-and-effort levels in recent years indicates low net economic returns.

Annual fishing effort has been below the long-term average since 2006, held back by high costs relative to revenue and a variable annual biomass. In 2017, catch rates and effort within the Southern Squid Jig Fishery declined relative to 2016, with catch rates remaining stable in the Commonwealth Trawl Sector (ABARES, 2018a).

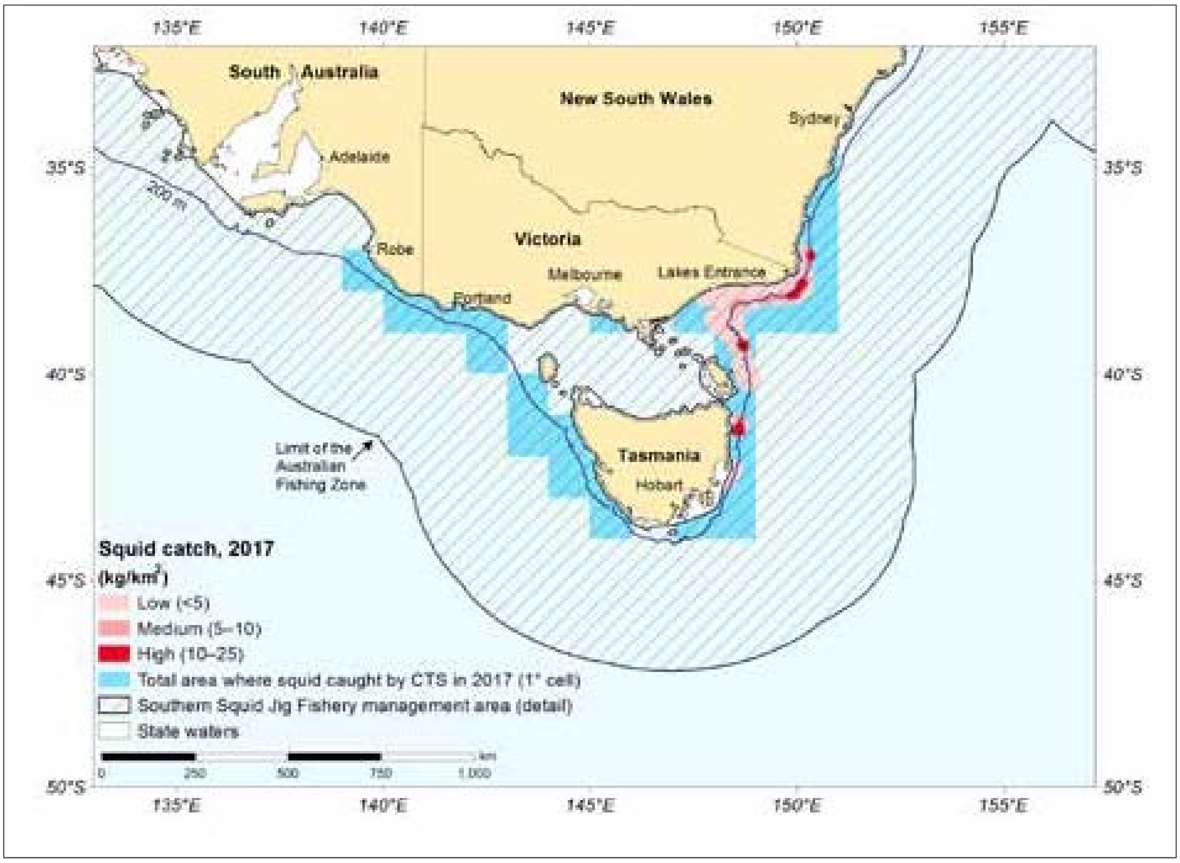
Since 2006, effort within the Southern Squid Jig Fishery has been below the long-term average, with low effort attributed to high costs relative to revenue in combination with a highly variable biomass or stock availability (ABARES, 2018a). While effort increased in 2015 and 2016, the decline in 2017 relative to 2016 was due to difficulty in locating squid aggregations and reduced catches, with fish processors unable to source enough squid (AFMA, 2017).

Figure 71 2017 Relative Fishing Intensity in the Southern Squid Jig Fishery



Source: ABARES, 2018a.

Figure 72 2017 Commonwealth Trawl Sector Squid Catch



Source: ABARES, 2018a.

As described in **Section 7.2.2**, while squid respond to seismic survey noise with avoidance behaviours and alarm responses, they generally appear to be resilient. STLM predicts that the Otway Basin 2DMC MSS will elicit some form of behavioural response out to 3.2 km in waters 50 m deep and 5.8 km in waters 4,800 m deep. A typical behavioural response could involve exposed individuals being startled, but studies have shown that squid quickly become habituated, and acoustic disturbance does not appear to influence feeding (McCauley *et al*., 2000); hence catch rates should not be significantly influenced by behavioural changes. There is no mortality threshold for squid, but various studies found evidence of acoustic trauma in cephalopods following exposure to seismic survey noise; however, methods for all studies were categorised by Carroll *et al*. (2017) as being "*unrealistic / unknown*" in relation to comparisons with seismic surveys. Fewtrell (2003) found that seismic survey noise of up to 192.4 dB re 1µPa (0.2 km from a 2,678 in^3 acoustic source) is not lethal for the southern calamari squid, *Sepioteuthis australis.*

La Bella *et al*. (1996) looked specifically at the effect of seismic surveys on squid fishing catch in the central Adriatic Sea. The study concludes that no apparent changes in trawl catches were found in short-finned squid (*Illex coindetti*) the day after a seismic survey, where the acoustic source had a SPL of 210 dB re 1µPa, deployed at 1 m (corresponding to levels of 149 dB re 1µPa at the animals' location).

The effect of seismic surveys on cephalopod larvae and eggs is not known. However, arrow squid produce eggs year-round (Virtue *et al*., 2011), suggesting that if there was a large-scale loss in recruitment over a three-month period then the squid's life history traits (generally short-lived, fast growing with high fecundity rates) mean they are well adapted to disturbance and the population would not be at risk.

It is proposed that the Otway Basin 2DMC MSS will take place for approximately 100 days from October 2019, where there will be some overlap temporally as the Southern Squid Jig Fishery season opens from January – June. Approximately 96% of the Operational Area is located in waters that are >200 m deep. Therefore, with squid fishing effort concentrated in a relatively small area off Portland at depths of 60 – 120 m (**Figure 71**), there is only the potential for a small spatial overlap between the Otway Basin 2DMC MSS and the Southern Squid Jig Fishery. However, the STLM shows that as sound travels into the shallower water depths it dissipates far quicker than the offshore direction (**Figure 66**) and given the apparent resilience of squid to the effects of underwater noise, with the distance between the Operational Area and the squid fishing grounds, it follows that the risk to squid populations presented by the Otway Basin 2DMC MSS is **Moderate** (*Minor* x *Certain*).

7.2.3.6 Southern Bluefin Tuna Fishery

The influence of seismic activities on fish has been extensively discussed in **Section 7.2.2.1.5**, with effects including startle responses, and changes in distribution (e.g. horizontal and vertical distribution) in relation to MSSs. While there is currently no formal evidence confirming MSSs result in direct mortality of southern bluefin tuna, concerns have been raised during the stakeholder engagement programme for the Otway Basin 2DMC MSS that the survey may have effects on the presence and movements of juvenile southern bluefin tuna in the Great Australian Bight, with flow-on effects for the commercial southern bluefin tuna fishery (see **Section 5.2.3** for further information on the tuna fishery, and **Section 4** and **Appendix F** for details on consultation). Adult southern bluefin tuna may move through the Operational Area from approximately October to December, and therefore may be present during the start of the Otway Basin 2DMC MSS. Juvenile southern bluefin tuna spend summer months within the Great Australian Bight and will be present, particularly in coastal waters during the MSS.

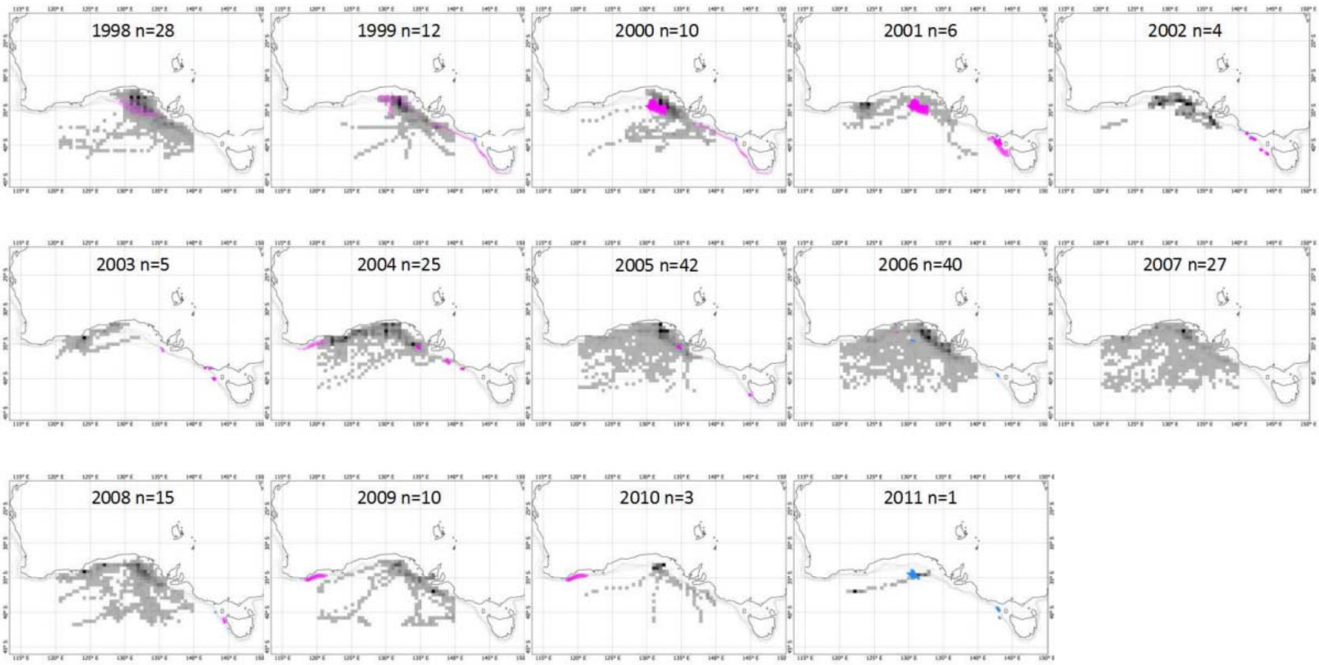
Although the hearing capabilities of southern bluefin tuna have not been studied, measurements of hearing thresholds in a small number of juvenile Atlantic bluefin tuna (*Thunnus thynnus*) have been determined based on behavioural responses to sound (Dale *et al*., 2015). Hearing was found to be most sensitive from 400 – 500 Hz (Dale *et al*., 2015). Hearing capabilities have also been determined in yellowfin tuna (*Thunnus albacares*), with this species responsive to sounds in the range of 50 – 1,100 Hz, with best sensitivity at 500 Hz (Iversen, 1967). Based on the hearing capabilities of other tuna species, it is likely that southern bluefin tuna are capable of detecting sound emissions from MSSs (Evans *et al*., 2017a).

The ocean-ranching tuna industry in South Australia takes advantage of the surface feeding and basking habits of juvenile southern bluefin tuna in the Great Australian Bight, allowing spotter planes and vessels to more easily see and capture tuna schools. Displacement of southern bluefin tuna due to noise, either vertically deeper in the water column, or horizontally away from the active seismic source, could impact commercial fishers in the tuna industry. However, juvenile southern bluefin tuna aggregations are also known to be pushed off the surface when warmer surface waters extend deeper through the water column, so larger scale climatic variations also have significant effects on the presence and catch-ability of this species. Although commercial fishers rely on the schooling behaviour of southern bluefin tuna, Basson *et al.* (2012) and Willis and Hobday (2007) suggest that the interruption of schooling behaviour is not a serious energetic issue for juvenile southern bluefin tuna, with schools being naturally dynamic, i.e. regularly breaking-up and reforming.

Through the Great Australian Bight Research Program (a collaboration between BP, CSIRO, SARDI, the University of Adelaide and Flinders University), Evans *et al.* (2017a) investigated the effects of MSSs on the distribution of southern bluefin tuna in the Great Australian Bight and wider vicinity, including the Otway Basin. The distributions of MSS activities were overlaid with the movements of juvenile southern bluefin tuna, as determined by historic and contemporary tagging studies (**Figure 73**). Overlaying the two data sets revealed that there has been an overlap in the timing of MSSs and the occurrence of juvenile southern bluefin tuna, with overlap having occurred for a substantial number of years (since at least the 1990's). Tag data indicated considerable inter-annual variation in surfacing behaviour and time spent at depth, but no obvious large-scale distributional shifts in years with high levels of exploration activities. This highlights the difficulties in determining behavioural changes over and above natural variability in wild populations that are capable of large-scale movements. Overall, Evans *et al*. (2017a) found that tagged individuals remained within the Great Australian Bight and Otway Basin regions during the period across which MSSs were conducted, with individuals for which data is available across multiple years continuing to return across the summer period despite the presence of active surveys.

While the Evans *et al.* (2017a) analysis does not reveal any obvious effects of seismic operations on the distribution and occurrence of juvenile southern bluefin tuna within the Great Australian Bight, the authors concluded that ascertaining any cause and effects relationship is impossible from observational data alone, due to the complex relationships between environmental parameters and tuna distribution. Furthermore, the precision of the deployed tags does not allow the pin-pointing of an individual at an exact location at an exact time; therefore, fine-scale distribution could not be assessed.

Figure 73 Spatial overlay of 2D (pink) and 3D (blue) MSSs and Time Spent by Juvenile SBT across the Summer Months in Each Year 1998 - 2011



Source: Evans *et al*., 2017a

In contrast to Evans *et al*. (2017a), CSIRO noted lower abundances of one-year old tuna relative to previous years when undertaking aerial surveys for stock assessments while a large-scale MSS was being undertaken in the Great Australian Bight. While it is possible that these low abundances reflect displacement of tuna away from the largest MSS ever conducted in the Great Australian Bight (from November 2011 – May 2012). However, the relationship between the MSS and potential changes in tuna abundance and distribution is still being analysed, with other factors potentially contributing to the low stock levels observed such as the strength of the Leeuwin Current. Furthermore, aerial survey results for one-year old tuna the following season (January – March 2013) indicated that stocks had returned to expected levels (DoEE, 2012).

The Otway Basin 2DMC MSS will be operating outside of the Western Australia migration route used by juvenile southern bluefin tuna moving south from spawning grounds. Although the proposed timing of the MSS will overlap with the main commercial tuna fishery season (i.e. December – March) within the Great Australian Bight, this fishery mainly operates outside of the Operational Area. SETFIA (2019) report that less than five vessels associated with the southern bluefin tuna fishery have fished within the Operational Area between 2008 and 2017.

There is however a concentration of purse seine effort near Kangaroo Island approximately 100 km to the west of the Operational Area. Long range STLM predicts that the maximum SELs that southern bluefin tuna at this fishing location could be exposed to is around 100 dB re 1 µPa^2.s. At this distance from the noise source, the SEL and the RMS SPL parameters are directly comparable (see **Appendix A**). Hildebrand, (2009) indicates that background noise levels of 90 dB re 1 µPa are common in ocean basins with distant shipping. Given the significant amount of commercial maritime traffic in the area (**Figure 54**) and the commercial fishing activity in southern Australia, a 10 dB increase in noise above ambient levels is unlikely to have any behavioural effects that would displace southern bluefin tuna from this area. This conclusion is supported by tagging studies, which have revealed that tagged fish have remained within the Great Australian Bight despite the presence of seismic operations (Evans *et al*., 2017a). Furthermore, tagged fish have been recorded returning to the Great Australian Bight in the years following MSS exploration (DoEE, 2012; Evans *et al*., 2017a), even when it was suggested that a large-scale seismic survey had altered juvenile tuna distribution (DoEE, 2012).

In addition, based on the STLM results, noise propagation is enhanced downslope, in the inline direction to deeper waters. A reduction in sound speed with increasing depth results in downward refraction, where the highest sound levels occur in the lower portion of the water column. This means that noise levels are generally highest in the mid-water column, and considerably lower near the surface (see **Figure 66**), where juvenile tuna aggregate.

Although there is expected to be a small spatial overlap between the presence of adult southern bluefin tuna and the Operational Area, juveniles are typically targeted in the commercial fishery (see **Section 5.5.2.5.7**) and given the large spatial distances between the Otway Basin 2DMC MSS and the main fishing grounds, the potential risk to southern bluefin tuna commercial fisheries from noise emissions during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Possible*).

7.2.4 Known and Potential Impacts on Commercial and Recreational Dive Operations

Commercial dive operations (e.g. commercial dive fisheries and operations related to oil and gas installations) and recreational diving may occur inshore of the Otway Basin 2DMC MSS Operational Area. Noise emissions from the proposed MSS would impact both recreational and commercial divers similarly, and these have therefore been assessed collectively. The following discussion focuses on noise emissions from the acoustic source because noise from the survey vessels is not considered to be an issue with regard to divers.

Seismic operations may be audible to divers inshore of the Otway Basin 2DMC MSS Operational Area. Human ears are most sensitive to waterborne sounds that range in frequencies from 400 Hz to 1 kHz, with a peak sensitivity at 800 Hz (Anthony *et al*., 2009). The sensitivity of the diver to underwater noise is largely influenced by the diving apparatus worn. SCUBA dive masks result in a 'wet' ear where the water floods the external auditory canal. In contrast, enclosed helmets most often used by commercial divers maintain a 'dry' ear. Hearing sensitivity is lower in divers using a 'wet' ear system, and therefore elevated noise levels are more damaging to divers using 'dry' ear systems (Anthony *et al*., 2009). Further hearing protection may be provided by neoprene hoods used by 'wet' ear divers, reducing noise attenuation, particularly in shallower water depths (Anthony *et al*., 2009; Cudahy & Parvin, 2001).

Effects of noise on human divers range from dizziness, disorientation, temporary paralysis of limbs, or TTSs, to PTSs, severe pain, and haemorrhaging of soft tissues (Cudahy & Parvin, 2001). For sounds with frequencies of 500 – 2,500 Hz, Parvin *et al*. (2002) reported temporary dizziness and related symptoms for bareheaded divers exposed to sound levels above 176 dB re 1 µPa, and vibration in forearms and thighs at sound levels above 180 dB re 1 µPa. Sounds were tolerated up to 191 dB re 1 µPa (the maximum used in the trial); however, from these results a threshold exposure level for human divers of 155 dB re 1 µPa was proposed.

The Diving Medical Advisory Committee suggests a threshold level for unprotected (i.e. not wearing an enclosed helmet system) commercial or recreational divers of 201 dB re 1 µPa (as referenced in Ainslie, 2008). It is worth noting that frequency was not specified for this threshold. Thresholds provided by Parvin *et al.* (2002) provide the most conservative thresholds for divers and have been used to assess the effects of noise on commercial and recreational divers from the Otway Basin 2DMC MSS. Based on the STLM results, the threshold of 155 dB re 1 µPa would be at distances between 4 and 5 km from the active acoustic source.

Commercial abalone divers operate in water depths less than 30 m; however, the shallowest depth of the Operational Area is 50 m, with 98% of the Operational Area being in water depths greater than 200 m, beyond the shelf edge.

It is likely that commercial divers working inshore of the seismic vessel while it is acquiring data may be able to hear the seismic pulses. Commercial abalone licence holders have been consulted and provided all the relevant and updated information during the engagement process; however, no concerns have been raised thus far from the Abalone Council of Australia who is the peak industry body that represents the wild-harvest abalone industry from the five producing states, of which Tasmania, Victoria and South Australia are of relevance to the Otway Basin 2DMC MSS. The licence holders will be informed throughout the Otway Basin 2DMC MSS and alerted when the vessel could be operating close to diving grounds.

Offshore oil and gas installations are typically noisy above and below water; therefore, commercial divers working around the offshore facilities are already exposed to high levels of noise (Anthony *et al*., 2009; Kirkland *et al.,* 1989). Dive operations at these installations are routinely carried out for inspection and maintenance works and may occur while the Otway Basin 2DMC MSS is operating. The closest producing fields from the Operational Area are

- Thylacine (Otway Gas Project), operated by Lattice Energy – 18 km; and
- Casino, operated by Cooper Energy (CH) Pty Ltd – 20 km.

Based on STLM, thresholds for divers will not be exceeded at distances greater than about 5 km out from the acoustic source; both of the producing fields listed above are located outside of this range. All installation operators have been informed of the Otway Basin 2DMC MSS and will be kept updated throughout the programme with the 48-hour look-ahead so that they may schedule any dive operations as they deem appropriate to ensure the safety of their divers as they undertake their own risk assessment as part of their diving procedures.

Most recreational diving occurs in water depths less than 30 m, and commonly includes exploration, wreck diving and/or photography, or may include recreational fishing such as collection of abalone, scallops, rock lobster, or spearfishing. The Otway Basin 2DMC MSS will take place during the open seasons for the recreational take of rock lobster and abalone; however, water depths for recreational diving are located well inshore of the Operational Area. The noise thresholds for recreational divers are not expected to be exceeded at distances greater than 5 km from the acoustic source. Popular recreational dive sites surrounding the Operational Area include the reefs and shipwrecks surrounding King (55 km away) and Flinders Islands (300 km away) (Tasmania) and the shipwrecks along the Great Ocean Road (Victoria and South Australia); however, these are located inshore of the Operational Area, and beyond the 5 km SPL threshold distance that has been determined from the STLM results.

Although some of the tie lines come close to shore, these lines remain in water depths greater than those utilised by recreational divers and remain further from dive sites (such as ship wrecks in dive-able depths) than the modelled 5 km threshold distance. The Otway Basin 2DMC MSS is not expected to have any adverse effects on recreational divers at these popular dive locations. The dive clubs, charters, and associations that frequent these areas have been notified of the MSS and will be informed throughout the duration of the MSS of the activities. Thus far, no recreational divers have raised concerns regarding the Otway Basin 2DMC MSS.

In 2011 the Diving Medical Advisory Committee released the '*Safe Diving Distance from Seismic Surveying Operations*' Guidance Note advising actions to be taken when seismic surveys are planned around dive areas. The Guidance Note recommends the following for commercial divers:

- Where seismic activities will occur within 10 km of dive operations, a joint risk assessment should be conducted between the dive operators and seismic contractors in advance of any simultaneous operations;
- Plans should be made to avoid overlapping seismic and diving activities, but where this is unavoidable, the activities should be prioritised, and a simultaneous operations plan developed;
- Parties should perform a communication exercise or test at the start of simultaneous operations to determine the acceptable safe distance for local conditions. This should be carried out by gradually ramping up the seismic source array starting from a distance of 10 km. The minimum safe distance determined by this testing should not be compromised by either party and this distance may be required to be increased in adverse conditions (e.g. shallow water);
- The dive operator and seismic contractor should be in regular (at least daily) contact so that both are aware of each other's work programmes. Communication should be continuous when seismic operations are within 5 km from dive operations;

- Should any diver in the water experience sudden discomfort, the seismic source should be immediately shut-down if requested to do so. Contingency arrangements should be included in the simultaneous operations plan; and
- A diver's exposure should be terminated if the noise level is considered to exceed acceptable levels of noise exposure, interferes with diver communications, induces discomfort or places the diver at risk in any other way.

The closest commercial dive operations are likely to be at the Thylacine gas field 18 km from the Operational Area. Sound threshold levels of 155 dB re 1 µPa will be met within about 5 km from the acoustic source, therefore based on the Thylacine gas field being 18 km from the Operational Area, sound levels exceeding this threshold will not be reached and therefore divers will not be affected. However, SLB will be in regular contact with gas installation operators who will be able to schedule dive operations as they deem appropriate.

An assessment was undertaken on the shipwrecks present in the waters surrounding the Operational Area as an indicator for potential recreational dive sites. Within a 60 km radius of the inshore boundary of the survey lines 150 shipwrecks were identified, of these 130 are in water depths less than 40 m (based on an assessment of bathymetry contours) and when further defined, most are in water depths less than 20 m.

Given the sheer number of shipwrecks, as part of the stakeholder engagement process, all recreational dive clubs, dive charters and associations, commercial diver operations and dive training facilities have been contacted to allow any concerns or further questions to be raised and to ensure that operations can be managed so that the Otway Basin 2DMC MSS does not displace the ability of recreational divers to get in the water (**Appendix B**). To date no concerns have been raised by any relevant person associated with diving and the feedback has only been positive. The information packs were distributed prior to the STLM results being available; consequently, the STLM results have verified that the thresholds for safe recreational diving will not be exceeded. Hence, there will be no effect on divers from the Otway Basin 2DMC MSS at any of the recreational dive sites near the Operational Area. This message will be conveyed as part of ongoing stakeholder engagement to the diving community.

Tie line acquisition will bring the seismic vessel into the shallowest portion of the Operational Area, where the shallowest survey tie line will come into nearly 50 m water depth. However, the threshold distance of 5 km for diver effects will not overlap with any shipwreck locations during tie line acquisition; hence effects on recreational divers are not anticipated

Based on a conservative SPL threshold distance of 5 km from the active acoustic source within which divers could be affected, the potential risk to recreational and commercial divers from noise emissions during the Otway Basin 2DMC MSS has been assessed as **Low** (*Minor* x *Unlikely*).

7.2.5 Control Measures

All potential control measures (to manage potential impacts from seismic noise emissions to **ALARP**) that were considered during the planning of the Otway Basin 2DMC MSS have been included in **Table 66**. These control measures have been assessed to consider the environmental benefits gained through their implementation, relative to their time and effort with a clear delineation made between which control measures will be implemented during the Otway Basin 2DMC MSS and those which won't. Justifications have been provided for each of the decisions against each control measure in **Table 66**.

Table 66 Assessment of Control Measures for Managing the Acoustic Disturbance to the Marine Environment

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
Limitation on maximum capacity of the acoustic source	P = Yes E = Effective	Source capacity is reduced to the minimum level possible whilst still enabling survey objectives to be met within Operational Area. This minimises the produced sound levels entering the marine environment. Both smaller and larger arrays were considered but given the water depth and target depths of the geological structures, SLB have determined that the 5,265 in^3 source is the most efficient source size to complete the requirements of the survey objectives. This source volume will produce an equivalent 0-peak SPL no higher than 258.5 dB re 1 µPa @ 1 m.	Yes	Yes
24/7 MSS operations	P = Yes E = Effective	With the exception of periods where the acoustic source is inactive (e.g. marine mammal presence within Exclusion Zone triggering a shut-down), the MSS will operate 24/7. This reduces the overall duration of the survey to minimise disturbance and displacement.	Yes	Yes
Restrictions on acoustic releases outside of the Operational Area	P = Yes E = Effective	Acoustic release will be limited to within the defined boundaries of the Operational Area, thereby restricting potential effects of acoustic disturbance to within the boundaries of the Operational Area. These effects have been considered within this EP.	Yes	Yes
NOPSEMA website search on activity status and summaries for EP submissions and decisions	P = Yes E = Effective	The NOPSEMA database has been searched for EP submissions and decisions so SLB can identify whether any MSS's may potentially overlap spatially or temporally with the Otway Basin 2DMC MSS. This enables the development and implementation of mitigation measures for cumulative effects.	Yes	Yes
Spatial limitations of operations between multiple MSSs to prevent cumulative effects	P = Yes E = Effective	Multiple MSSs operating simultaneously in close proximity to each other would potentially increase the spatial extent of acoustic energy and the intensity of acoustic energy (if acoustic areas overlap).	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		Ensuring complete spatial separation of each seismic vessel (and therefore each acoustic source), will help limit sound source levels to those associated with a single seismic source, which is easier to manage and assess with respect to risks to marine species. SLB will implement a 40 km spatial separation between SLBs survey vessel and any other operating MSS vessel so that they will not acquire data simultaneously within 40 km of each other.		
Minimum depth limitations for activation of the acoustic source	P = Yes E = Effective	The inshore boundary of the Operational Area is in water depths generally greater than 50 m. This excludes large areas of the inshore coastal waters used to target the high value rock lobster and abalone fisheries. A 25,000 km^2 reduction to the Operational Area to exclude shallower water depths was initially implemented based on feedback during the stakeholder engagement programme to actively reduce impacts to these fisheries as well as sensitive ecological areas such as the Bonney Upwelling and the associated BIAs for whales in the area. A further reduction of 73,000 km^2 has also been implemented in the southeast part of the Operational Area, so all parts of the Operational Area near Tasmania are now in water depths greater than 1,000 m.	Yes	Yes
Inshore spatial restrictions to operation of acoustic source	P = Yes E = Effective	The original Operational Area was revised following stakeholder engagement to move away from the more sensitive nearshore environment which is very important to the commercial fishing industry. A 3 NM buffer from the coastline provides protection of shallow reefs and known seabird and pinniped breeding colonies. Coastal whale and dolphin species such as southern right whales, pygmy right whales, common dolphins, and bottlenose dolphins utilising shallow waters within a few kilometres of the coast will also be protected from the higher SELs that are emitted closer to the seismic source.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		The minimum distance from the inshore boundary of the Operational Area to the Australian coastline is 6.2 km, 11 km to the nearest tie line and 22 km to the nearest non-tie line.		
Compliance with the EPBC Act Policy Statement 2.1	P = Yes E= Effective	The EPBC Act Policy Statement 2.1 outlines procedures that should be followed by all seismic vessels conducting surveys in Australian waters and has a focus on mitigating the effects of MSS on whales. Part A procedures **must** be followed, while Part B procedures are additional measures that **may be required** to further mitigate against any effects. Details of both Part A and Part B procedures that will be implemented are detailed in their respective sections later in this table.	Yes	Yes
Maintenance of vessels	P = Yes E = Effective	Proper maintenance of vessel machinery eliminates excess vibrations which transfer noise into the water column.	Yes	Yes
A 'turtle pause' (or 'shot pause') will be implemented if a marine turtle is seen within 500 m of the active acoustic source. The seismic source will power-up when the turtle is observed to be >500 m from the source, or has not been seen for 15 minutes	P = Yes E = Effective	This will result in a temporary cessation of the acoustic source so that there is no acoustic disturbance when the source array is likely to be closest to the turtle (or the turtle's predicted position).	Yes	Yes
Inform relevant commercial fishers and the public about the timing and duration of MSS	P = Yes E = Effective	This will keep all relevant users of the area informed and reduce impacts on fishers and marine users by allowing them to target locations away from the area of active acoustic data acquisition on any given day. This will also minimise any potential interactions between the seismic vessel and equipment (i.e. streamer) and other commercial and recreational fishing vessels and gear.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		48-hour look-aheads will be provided to those relevant commercial fishers and associations, and relevant fishers will be part of the ongoing stakeholder engagement programme to ensure they have correct and up to date information for the duration of the survey to assist with their planning. They will also have all relevant contact details of who to contact on the water and on the shore should they have any questions or issues about the operations. Public notices will be posted of the commencement of the survey and all local Councils or Government/State departments will be notified of the survey. They will be provided with electronic versions of the Information Pack (including contact details) which can be passed on should they receive any calls or concerns.		
Detailed marine fauna sighting report (cetaceans, turtles) and any interactions will be recorded and submitted as part of the MMO Report and post-survey Environmental Performance Report. A procedure will be in place so that notification will be provided to the relevant local authorities of any cetaceans in distress or dead animal carcasses and their locations as soon as practicably possible.	P = Yes E = Effective	OPGGS Environment Regulation 26(C) requires that “a titleholder undertaking an activity must submit a report to the Regulator in relation to the titleholder’s environmental performance for the activity, at intervals provided for in the environment plan.” Within two months following the completion of the Otway Basin 2DMC MSS, SLB will prepare a Post-survey Environmental Performance Report for submission to NOPSEMA. This report will review the entire programme and have the same scope and objectives as the Annual Report. If possible, these reports maybe combined. The OPGGS Environment Regulation 14(2) requires that “the titleholder report to the Regulator in relation to the titleholder’s environmental performance for the MSS and provide that the interval between reports will not be more than one (1) year”. Accordingly, SLB will submit an annual report to NOPSEMA that reviews the outcomes and achievements for the Otway Basin 2DMC MSS.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		The annual report(s) will be submitted within two months of the anniversary of the acceptance of this EP. Further details of the Annual Report are in **Section 10.6.2**. IAGC mitigation measures for cetaceans during Geophysical Operations recommend documenting all observations and report immediately to local authorities any animals in distress.		
EPBC Act Policy Statement 2.1 – Interaction Between Offshore Seismic Exploration and Whales Part A standard measures to be adhered to:				
EPBC Act Policy Statement 2.1: Precaution Zones	P = Yes E= Effective	Precaution Zones are set based on the likely sound levels surrounding the acoustic source as demonstrated by STLM. The use of Precaution Zones provides the basis for the mitigation measures throughout the EPBC Act Policy Statement 2.1 and defines the zones where certain operational procedures will be implemented (e.g. shut-downs of the acoustic source when a whale enters/is sighted within the Shut-down Zone). Based on the STLM results, SLB will undertake a conservative approach and will implement an extended 2 km Shut-down Zone and a 3+ km Observation Zone for the duration of the survey. These zones will be visually monitored by two MMOs. In addition, SLB will have two PAM Operators that will be monitoring 24 hours per day while the source is active to assist in locating whales in the vicinity but outside the visual Observation Zone, and during the hours of darkness or periods of poor visibility.	Yes	Yes
EPBC Act Policy Statement 2.1: A.1 – Pre-survey Planning	P = Yes E = Effective	Pre-survey planning is a requirement of the EPBC Act Policy Statement 2.1 and requires SLB to identify the key environmental receptors with regard to the Operational Area, including identification of important habitats/areas, seasonality, etc. Mitigation measures have been implemented while taking into consideration the findings of the pre-survey planning phase.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		Extensive pre-survey planning has formed the basis of this EP. Multiple sensitivities in and around the Operational Area have been identified, and control measures have been developed to ensure that a precautionary approach has been adopted for the duration of the survey. In particular, additional mitigations have been implemented to account for the temporal and spatial overlap between the proposed MSS operations and feeding activity of pygmy blue whales during the Bonney Upwelling season and the coastal breeding of southern right whales. These additional mitigations are presented later in this table in relation specifically to the acquisition of tie lines which have the greatest degree of potential overlap with these ecologically significant habitats.		
EPBC Act Policy Statement 2.1: A.2 – Crew training	P = Yes E = Effective	Vessel crew are required to have sufficient training in order to implement the mitigation procedures of the EPBC Act Policy Statement 2.1. SLB will ensure there is sufficiently trained crew to fulfil the basic requirements outlined below. The trained crew members who are nominated must have proven experience in whale observation, distance estimation and reporting. At the start of the survey a briefing will be provided to all crew on board the survey vessel (and support vessel(s)) on environmental matters, including information on the EPBC Act Policy Statement 2.1, whale identification and the environmental legal obligations for companies operating in Australian waters. Reference material will be provided and made available for the duration of the survey onboard the vessel(s), including the EPBC Act Policy Statement 2.1, the Department's Whale and Dolphin sighting report form and the APPEA CD Guide 'Search Australian Whales and Dolphins'.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		Appropriate visual aids such as binoculars will be available on board the vessel to aid in the identification and reporting of any whales sighted. In addition to trained crew (as required under the standard management procedures), SLB are also required to have two dedicated and experienced MMOs onboard as per EPBC Act Policy Statement 2.1as a result of the likelihood of encountering whales during the Otway Basin 2DMC MSS being moderate to high as assessed within this EP. The two MMOs onboard will have primary responsibility for whale observation and compliance of the Precautionary Zones; however, trained crew can act as a support role when required to provide additional observations.		
EPBC Act Policy Statement 2.1: A.3.1 – Pre-start-up visual observations	P = Yes E = Effective	Pre-start up visual observations are required under the EPBC Act Policy Statement 2.1. The Observation Zone (3+ km) will be monitored for the presence of whales for at least 30 minutes before the commencement of a soft-start procedure during daylight hours. SLB will also have two dedicated and experienced MMOs onboard for the Otway Basin 2DMC MSS. MMOs will have direct responsibility for undertaking pre-start-up visual observations and compliance with the Precautionary Zones, with trained crew (see above) support as required.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
EPBC Act Policy Statement 2.1: A.3.2 – Soft start procedures	P = Yes E = Effective	Soft start procedures are a gradual increase of power over a set period of time with the intention of allowing adequate time for whales to leave the area before being exposed to the highest sound levels (Wright & Cosentino, 2015). They will also alert fish and allow them time to move away from the active source, avoiding potential physiological impacts. Soft starts over a period of 30 minutes are a requirement of the EPBC Act Policy Statement 2.1, where their implementation allows the power of an acoustic source to be gradually increased prior to the survey commencing which ensures that any whales that go undetected during pre-start-up observations have an opportunity to leave the vicinity of the seismic array before full operational power is reached. Soft start procedures will be limited to conditions that allow visual inspection of the Observation Zone.	Yes	Yes
EPBC Act Policy Statement 2.1: A.3.3 – Start-up delay procedures	P = Yes E = Effective	During soft start procedures during daylight hours, an MMO will be on the bridge observing for whales. If a whale enters the 3+ km Observation Zone, another MMO or trained crew member will be called to the bridge to assist in monitoring the whale/s to assess whether it leaves the zone or enters the 2 km Shut-down Zone. If the whale enters the Shut-down Zone, the acoustic source will be immediately shut-down. If the acoustic source is shut-down, a soft start procedure will only resume after the whale has been observed to move outside the Shut-down Zone, or when 30 minutes has lapsed since the whale was last sighted. If an infill line is required, a minimum delay of five hours would occur to allow for repositioning of the source and streamer to repeat data acquisition at a particular location.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		The intention of these delays is to allow sufficient time for any whale/s to exit the Precaution Zones and avoid exposure to the highest sound levels. Start-up delays are a requirement of the EPBC Act Policy Statement 2.1.		
EPBC Act Policy Statement 2.1: A.3.4 – Operations procedures	P = Yes E = Effective	Operational procedures are a requirement of the EPBC Act Policy Statement 2.1. Operational procedures to minimise acoustic disturbance include the implementation of soft starts and delay procedures (outlined above), and the requirement for the continuous visual monitoring of whales in relation to the Precaution Zones during daylight hours: which in the case of the Otway Basin 2DMC MSS will be undertaken by dedicated and experienced MMOs. SLB will completely shut-down the acoustic source during line turns. During this time observations for whales will continue and operations will only recommence following a soft start procedure.	Yes	Yes
EPBC Act Policy Statement 2.1: A.3.5 – Stop work procedures	P = Yes E = Effective	Stop work procedures are a requirement of the EPBC Act Policy Statement 2.1. Stop work procedures will be implemented when a whale enters the 2 km Shut-down Zone, reducing exposure of the whale to the highest sound levels. This control measure will be implemented by independent MMOs that will be onboard the seismic vessel at all times. After the whale has been observed to have left the Shut-down Zone for a period of 30 minutes or has not been detected for 30 minutes, the start-up procedures can commence again.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
EPBC Act Policy Statement 2.1: A.3.6 – Night-time and low visibility procedures	P = Yes E = Effective	Specific night-time and low visibility procedures are a requirement of the EPBC Act Policy Statement 2.1. They allow the MSS to continue throughout periods of reduced/low visibility (e.g. night-time, or periods of rough seas or fog). During these periods, operations may proceed provided there have not been three or more whale instigated shut-downs during the preceding 24-hour period. However soft start procedures will be limited to conditions that allow visual inspection of the Observation Zone. SLB has adopted the threshold of three or more whales based on what was recommended within the EPBC Act Policy Statement 2.1 Standard Management Procedures. SLB will have a PAM system running 24 hours per day with dedicated, trained and experienced PAM Operators conducting acoustic monitoring for the presence of cetaceans. The PAM system will be specifically tuned to detect the species likely to be found in the Operational Area as identified in the development of the EP. The full system specifications of the PAM system are provided in **Appendix N**.	Yes	Yes
EPBC Act Policy Statement 2.1: A.4 – Compliance and Sighting Reports	P = Yes E = Effective	A report on the conduct of the survey and any whale interactions will be provided to the DoEE within two months of survey completion following the minimum content recommendations in the EPBC Act Policy Statement 2.1. All cetacean sightings will be recorded in the 'Cetacean Sightings Application' software.	NA	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
EPBC Act Policy Statement 2.1 – Interaction Between Offshore Seismic Exploration and Whales Part B additional measures for whales:				
EPBC Act Policy Statement 2.1: B.1 – Marine Mammal Observers	P = Yes E = Effective	The use of trained, dedicated and experienced MMOs is a recommendation of Part B.1 of the EPBC Act Policy Statement 2.1 when the likelihood of encountering whales is moderate to high. From the assessment undertaken within this EP (**Section 5.2.6**) it has been determined that the likelihood of encountering whales during the Otway Basin 2DMC MSS is moderate-high. Therefore, SLB will have two trained and experienced MMOs onboard the seismic vessel for the duration of the MSS. Their role onboard the vessel is to undertake all visual observations for whales and to ensure that the appropriate mitigation measures occur in response to any whale sightings in the Precaution Zones in compliance with the mitigation measures outlined in this EP. MMOs will also assist the trained crew in any marine mammal observations and be available to provide advice should whales be encountered. The MMOs used during the Otway Basin 2DMC MSS must have logged a minimum of 20 weeks' relevant sea-time engaged in MSS operations in Australian waters as an MMO or MFO and have proven 'at sea' experience in whale identification and behaviour, and distance estimation. In particular the MMOs used must be confident in the identification of those species that the EP predicts will be present in the Operational Area.	Yes	Yes
EPBC Act Policy Statement 2.1: B.2 – Night time/Poor visibility	P = Yes E = Effective	The EPBC Act Policy Statement 2.1 recommends that in areas where whales are expected to be encountered, the proponent should include measures to detect whale presence and apply measures to reduce the likelihood of encounters. In regard to this, PAM will be implemented to assist with whale detection (see below). Despite this, SLB will also limit the initiation of soft start procedures to conditions that allow visual inspection of the Observation Zone.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
EPBC Act Policy Statement 2.1: B.4 – Increased Precaution Zones	P = Yes E = Effective	The EPBC Act Policy Statement 2.1 defines the standard Shut-down Zone as being 500 m from the acoustic source with a Low-power Zone out to 2 km. In keeping with their precautionary approach, SLB have committed to extending the Shut-down Zone out to 2 km from the acoustic source to provide additional protection for whales. On this basis, the Low-power Zone is deemed unnecessary.	Yes	Yes
EPBC Act Policy Statement 2.1: B.5 – Passive Acoustic Monitoring (PAM)	P = Yes E = Effective	Visual methods of scanning for whales are restricted to daylight hours and relatively calm weather conditions. Animal behaviour such as diving further reduces detection probability (Verfuss *et al*., 2018). PAM detects whale vocalisations in real-time and is particularly useful during night-time, low visibility operations and for submerged animals. The use of PAM is a suggestion under Part B.5 (Additional Measures) of the EPBC Act Policy Statement 2.1 when the likelihood of encountering whales is moderate to high. SLB will run and monitor a PAM system around the clock while the acoustic source is active. The system will be programmed to ensure sensitivity within a frequency range of 10 Hz to 200 kHz to detect the low frequency vocalisations of the baleen whales. Two trained, dedicated and experienced PAM Operators will be on the survey vessel for the duration of the survey, with at least one PAM Operator maintaining 'acoustic watch' at all times. PAM Operators must have logged a minimum of 20 weeks' relevant sea-time engaged in MSS operations in Australian waters as a PAM Operator (following the recommendation of the Marine Mammal Observer Association (MMOA, 2019). PAM experience will be a pre-requisite for the recruitment of personnel for these positions. A full replacement PAM system will be kept onboard the seismic vessel and will be used as a back-up in the event that the PAM system malfunctions and is unable to be repaired.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		Frequency sensitivity will be designed into the hardware to remove vessel noise at very low frequencies masking whale vocalisations which may limit the performance of PAM. PAMGuard software will be incorporated into the PAM system to assist with locating and classifying the vocalisations of marine mammals. This sophisticated software allows the trained PAM Operators to make robust decisions during real-time mitigation operations, such as requesting shut-downs based on whales entering the Precaution Zones or based on whales remaining in the vicinity over longer time periods risking TTS. The full PAM specs that will be implemented for the Otway Basin 2DMC MSS are provided in **Appendix N**.		
EPBC Act Policy Statement 2.1: B.6 – Adaptive Management	P = Yes E = Effective	If three or more shut-downs occur within a 24-hour period, the seismic vessel will relocate to another area at least 10 km away (i.e. two survey lines away). The vessel would then commence the start-up and soft-start procedures for a new area in accordance with the EPBC Act Policy Statement 2.1. Once these start-up procedures are complete, seismic acquisition will commence. If three or more shut-downs occur within a 24-hour period, the density of whales within the area will be considered to be 'high' and would require the implementation of Additional Management Procedures as per the EPBC Act Policy Statement 2.1. Pygmy blue whales are a typically solitary species, forming aggregations at breeding and foraging areas; multiple sightings within the same area may indicate foraging blue whales at krill aggregations (and the presence of upwelling systems). If a southern right whale mother and calf pair is observed during the Otway Basin 2DMC MSS, the acoustic source will be immediately shut-down. Start-up and soft-start procedures will not commence until the whales have disappeared from observable distance for at least one hour or approximately 8 km away.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Blue whale and southern right whale Biologically Important Area Control Measures				
Additional blue whale and southern right whale BIA control measures.	P = Yes E= Effective	SLB recognises that the potential to encounter whales increases as the Otway Basin 2DMC MSS Operational Area approaches the coast and whale densities in these areas are likely to be significantly higher than elsewhere in the Operational Area. In particular, the Operational Area overlaps with parts of the Bonney Upwelling System, a BIA for pygmy blue whales, and a BIA for southern right whales along its inshore boundary, where the 13 survey tie lines are located. The following (in addition to the above-mentioned Standard and Additional Control Measures) are proposed in relation to acquisition within the BIAs in order to minimise the potential for behavioural disturbance within these sensitive areas: • A 4 km buffer will be implemented around the boundary of the blue whale BIA and southern right whale BIA; • An Extended Shut-down Zone will be implemented when acquiring within the BIAs and 4 km buffer, with shut-downs occurring out to 4 km horizontal radius from the acoustic source; • Two experienced MMOs will be in the bridge of the survey vessel during daylight hours when the source is active within the BIA and 4 km buffer; • An experienced MMO will be present on the support vessel to provide additional observations from a second platform during daylight hours while the acoustic source is active within the BIAs and 4 km buffer. The presence of the MMO on the support vessel and operation of the support vessel will be undertaken in accordance with the Support Vessel MMO Operational Plan;	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		• Adaptive management measures (i.e. when more than three shut-downs occur in a 24-hour period) will be in place for this area for observations that are unexpected; and • If whale sightings are higher than anticipated, and adaptive management measures are being implemented repeatedly then a discussion will be held with the DoEE for any additional management measures required.		
Bonney Upwelling Zone and Tie Line Control Measures				
Additional control measures for operating within the Bonney Upwelling Zone and along tie lines	P = Yes E = Effective	In addition to the control measures outlined above, the following additional mitigations are proposed in relation to acquisition along the tie lines and in the Bonney Upwelling Zone on account of the increased likelihood of encountering whales within these areas: • Tie line acquisition will only occur during day light hours and in good visibility conditions that allow visual observations well beyond the 3+ km Observation Zone; • An Extended Shut-down Zone will be implemented when acquiring within the Bonney Upwelling Zone and tie lines, with shut-downs occurring out to a 4 km horizontal radius from the acoustic source; and	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		• Within the defined operational window of October to June, two periods have been identified when the biological significance of any potential impacts to whales from the acquisition of the inshore tie lines will be lowest. In particular, tie line acquisition at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey (i.e. 1 March-30 April 2020) will minimise the potential overlap between seismic operations and 1) the end of the southern right whale breeding season in October, 2) the start of the southern right whale breeding season in May/June, and 3) the peak of the pygmy blue whale feeding in the Bonney Upwelling foraging area in January/February. Gill *et al*. (2011) documented that blue whale foraging typically occurs in the west of the upwelling system (in the vicinity of Kangaroo Island and Eyre Peninsula) early in the upwelling season (November-December), before spreading eastward between Cape Jaffa and Cape Otway. While the proposed survey timing does overlap with the southward migration of humpback whales, tagging studies indicate that the majority of humpbacks move south along the east coast of Tasmania (Andrews-Goff *et al.*, 2018) well away from the tie line locations.		
Adaptive Management Measures				
Re-positioning of survey vessel following high numbers of whale detections.	P = Yes E = Effective	If high numbers of whale detections result in three or more shut-downs within a 24-hour period, the seismic vessel will relocate to another survey line at least 10 km away. The threshold of three whales will be utilised to provide an indication of foraging, and therefore the presence of high prey/krill densities and an active upwelling system.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Shut-down of acoustic source in the presence of mother and calf pairs.	P = Yes E = Effective	Certain behaviours and life-stages of marine mammals are more sensitive to disturbances from MSSs. Of particular concern are disruptions to calving and nursing behaviours and potential impacts on juveniles. The presence of mother and calf pairs will provide an indication that sensitive behaviours are taking place (i.e. calving and/or nursing). If a southern right whale mother and calf pair is observed during the Otway Basin 2DMC MSS, the acoustic source will be immediately shut-down. Start-up and soft start procedures will not commence until the whales have disappeared from observable distance for at least one hour, or approximately 8 km away. This will be applied throughout the entire Otway Basin 2DMC MSS Operational Area.	Yes	Yes
Consultation with the DoEE when higher than anticipated sightings occur	P = Yes E = Effective	If whale sightings are higher than anticipated a discussion will be held with the DoEE for any additional management measures required.	Yes	Yes
Control Measures for Stakeholders and Other Marine Users:				
Pre-survey stakeholder engagement	P = Yes E = Effective	Pre-survey stakeholder engagement allows stakeholder objections, claims, or expectations to be heard and understood and incorporated into the development of the EP (NOPSEMA, 2018). Early identification of issues allows mitigation measures to be developed to reduce the risk to **ALARP** and **Acceptable Levels**. Pre-survey engagement with identified stakeholders is a requirement of the OPGGS Act.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		Throughout the development of this EP, an extensive stakeholder engagement programme was undertaken. This was conducted via many different means such as email, phone contact, and face-to-face meetings. Fishing associations were also engaged with as they represent the licence and quota holders and the preference by industry is that the operators deal and engage with the associations rather than directly with the licence holders. This is detailed in **Section 4** and **Appendix F**.		
Ongoing communication with marine users: • provision of a 48 hr 'look-ahead' plan; • Publication of Notice to Mariners; • SMS updates; and • Meetings with fishers and industry associations throughout the survey period.	P = Yes E = Effective	Communication with marine users allows the opportunity for both parties to work together to understand each other's activities and minimise disturbance and interactions (i.e. commercial fishers can avoid deploying gear in the path of the seismic vessel). Provision of a 48 hr 'look-ahead' plan allows marine users to understand the future movements of the seismic vessel over the next 48 hours and plan accordingly to avoid interactions. Daily SMS notifications will be sent out by mobile phone to those fishers who have been identified to fish in and around the Operational Area. Under the Navigation Act 2012, the AHO publish and distribute a Notice to Mariners. This Notice outlines potential hazards and restrictions to marine users.	Yes	Yes
Data acquisition will not occur over recreationally dived waters	P = Yes E = Effective	The Operational Area is in water depths greater than 50 m which is beyond the safe diveable depths of recreational divers (i.e. 30 m).	Yes	Yes
Notification of MSS commencement to diving operators (diving charters, dive schools, dive equipment).	P = Yes E = Effective	The Operational Area is beyond the safe diveable depths of recreational divers (i.e. 30 m). The STLM results show that the SPL thresholds that could have an effect on divers occur within about 5 km from the acoustic source.	Yes	Partially

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
The gas field operators close to the Operational Area will be contacted prior to the survey commencing. If requested, they will be provided with 48-hour look-aheads so they will know where the vessel will be operating, so they can consider as part any commercial diving operations if required	P = Yes E = Effective	The nearest gas fields are 18 km and 20 km from the Operational Area. This distance is located beyond what is considered to have an effect on divers from acoustic noise based on the STLM results. However, SLB acknowledges commercial diving operations need to consider all potential risks into their job hazard analysis and health and safety plans.	Yes	Yes
If three or more shut-downs due to whales entering the Shut-down Zone occur in a 24-hour period and the seismic vessel cannot move away from the current area and continue data acquisition in another area (i.e. end of survey, weather constraints), SLB will increase the pre-start up visual observation time to 45 minutes.	P = Yes E= Effective	Having an increased observation period before soft start procedures can commence will allow any deep diving whales time to surface from any feeding activities below the surface. This increases the certainty that there are no whales within the Precautionary Zones when soft start begins, which is important if there have previously been a number of sightings in the area. This would be implemented if the seismic vessel could not move to another part of the Operational Area for various reasons and the shut-downs triggered this control to be implemented.	Yes	Yes
Alternative Control Measures:				
Elimination of noise emissions from the acoustic source	P = No E = Very Effective	Although the most effective way to halt any potential effects on marine organisms, complete elimination of noise from the acoustic source is not practical. Acoustic release of the acoustic source is required to obtain data from below the seabed and the survey cannot be undertaken without noise emissions. The survey is required to provide robust data for the region. Given the precautionary control measures to be implemented, the costs far outweigh the benefits.	Yes	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
EPBC Act Policy Statement 2.1: B.3 – Spotter aircraft	P = Partly E = Fairly effective	The EPBC Act Policy Statement 2.1 recommends that in areas where the likelihood of encountering whales is high spotter craft could be used to assist in the detection of whales. The EP identifies that the likelihood of encountering whales increases in the proximity of the coast therefore additional mitigations have been proposed for use on the tie lines as described below; however, spotter planes will not be used during the MSS due to the control measures that will be implemented. The use of the second platform with an additional experienced MMO, and the 4 km Shut-down Zone will be able to be visually and acoustically monitored by the MMOs and PAM Operators. In the very inshore part of the Operational Area, daytime only operations will occur in the waters less than 200 m deep which is the area that will overlap with the Bonney Upwelling slightly. However, the actual length of the survey lines that overlap with these areas are not that long and is estimated to take in the order of 2-4 hours to acquire. As a result, the MMOs are not going to be having to look at the extended Shut-down Zone for 12-hour days, they will get some reprieve. Mobilising an aircraft with at least two MMOs in the air for these inshore survey lines is expected to cost in the vicinity of $1,800-$2,000 per day, for whales which may not even be present in the area at the time of survey based on the selection of timings, or if they are, could be observed by the MMOs on the vessels is considered to have a cost that is disproportionate to the benefit or mitigation that may be gained from their inclusion in the survey.	Limited	No
Use of alternative seismic sound sources and alternative geological imaging technology	P = No E = Unknown Effectiveness	Alternative technologies are not yet commercially available or have not been proven to meet geophysical data quality objectives, operational safety, and reliability requirements (IOGP, 2017).	Unknown	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Increase in line spacing	P = No E = Fairly effective	Wider spacing would not allow the objectives of the Otway Basin 2DMC MSS to be achieved due to reduced data coverage. Pre-survey planning has already increased line spacing to 5 km and reduced the number of survey lines as much as possible. Therefore, the cost of this control measure would be disproportionate to the benefit that may be gained.	Limited	No
Implementation of a Low-power Zone, where the acoustic source is operated on the lowest possible setting when a whale enters the Low-power Zone	P = Practical E = Effective	Part A3.2 of the EPCT Act Policy Statement 2.1 recommends the implementation of a Low-power Zone. During the standard acquisition lines (i.e. not tie lines) the Shut-down Zone will be extended to incorporate the Low-power Zone as well. As a result, the Shut-down Zone will be 2 km for the duration of the Otway Basin 2DMC MSS. For the areas within the BIAs and Bonney Upwelling Zone the Shut-down Zone is extended to 4 km. During line turns, SLB will turn the acoustic source off completely. The implementation of the extended Shut-down Zone control measure will provide a more conservative approach, resulting in more protection to whales from noise emissions than would normally be provided by the implementation of a Low-power Zone.	Limited	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Geographical and seasonal restrictions for all fish spawning areas (i.e. no acquisition during peak spawning periods)	P = No E = Fairly effective	Due to a lack of data it is not possible to determine spawning periods and/or locations within the Operational Area for a number of fish species. For many species, including all of the commercially fished species in the Operational Area, spawning periods are known, but spawning locations are often not, nor the distribution of eggs after spawning occurs. There is likely to be limited benefit (if any) from trying to implement a survey design based around these restrictions in place. The Operational Area has a large spatial extent; with 89% being in water depths greater than 1,000 m. Fish are likely to be widely distributed and more abundant in the nearshore coastal region, mostly inshore of the Operational Area. As such, it is considered that it is not reasonable to restrict survey efforts to a (more) limited area when the entire area is likely to contain spawning fish. Furthermore, spawning fish are likely to display a behavioural response and temporarily avoid the Operational Area while remaining in the wider spawning region. As such, effects at the population level are unlikely and costs are considered to be disproportionate to benefits.	Yes	Partially
Seismic activities will be restricted to areas outside key commercial fishing areas/seasons	P = No E = Fairly effective	This would avoid overlap with the commercial fishing operations identified during the stakeholder engagement process. Best efforts have been made to avoid fisheries where possible; however, there will be some overlap, and this will be managed through control measures and ongoing communication for the duration of the survey to minimise conflict and disturbance.	Yes	Partially

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		SLB removed a large part of the Operational Area (25,000 km^2) from the inshore portion to reduce conflict with the inshore fishers and moved the survey further offshore to deeper water. A further 73,000 km^2 was also reduced from the Operational Area in the southernmost part of the Operational Area. This removed all the survey lines near the Tasmanian coastline so that the survey lines are beyond 5 km of the 1,000 m contour, and beyond where most commercial fishing takes place. As a result, 98% of the survey lines are in waters greater than 200 m and 89% of the Operational Area is in water depths greater than 1,000 m.		
Shut-down of the acoustic source following a request from dive operators in response to divers experiencing discomfort	P = No E = Effective	The *'Safe Diving Distance from Seismic Surveying Operations'* Guidance Note recommends shut-down of seismic operations at the request of the dive operator if divers in the water suddenly experience discomfort. Based on results from STLM, and the distance of the Operational Area offshore, SPL thresholds for divers are not expected to be exceeded in water depths where recreational diving would occur, therefore discomfort is not expected. Oil and gas field operators will be notified of the timing of the survey and will be updated throughout the survey so that they can schedule any dive commercial operations as they deem appropriate to minimise exposure.	Yes	No
Alternative methods for detecting marine mammals other than PAM and visual observations (i.e. Active Acoustic Monitoring (**AAM**), Thermal Imaging, and Radio Detection and Ranging (**RADAR**))	P = No E = Limited/ Unknown Effectiveness	Visual sightings methods using MMOs are restricted to daylight hours and relatively good weather conditions and can only detect whales at the sea surface. Therefore, any additional method for detecting marine mammals during poor sighting conditions would be beneficial, especially during night-time operations and detection of submerged animals. Alternative detection methods include PAM, AAM, Thermal Imaging, and RADAR.	Limited / Unknown	No (apart from PAM)

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		SLB will utilise PAM during the Otway Basin 2DMC MSS. PAM will be operational 24 hours per day while the acoustic source is active and will be continuously monitored by an experienced PAM Operator. Classification to species level from the acoustic detections can only be reliably achieved using PAM, as all other detection methods have not yet been commercially proven (including for detection distance) (Verfuss *et al*., 2018). PAM provides the most cost effective and reliable method to complement visual sightings.		
Use of remote sensing for detection of indicators of potential feeding aggregations (i.e. sea surface temperature, chlorophyll-α, fluorescence, salinity).	P = No E = Unknown	Oceanographic data could be used to estimate potential upwelling zones where suitable food sources are present for baleen whales. This would allow the survey vessel to avoid these areas during a survey while those certain oceanographic conditions driving upwellings are present. This could reduce potential disturbance to marine mammals and minimise disruptions to the MSS by reducing the number of shut-downs. Remote data is accessed from satellites, where it is subject to cloud cover and is only available during daylight hours. If cloud cover is present when the images are taken, only patchy data or no data may be able to be captured. Significant processing and interpretation by experts is also required to identify likely upwelling zones at a scale within the survey area that can be identified. In a number of circumstances there can also be time lags on the data received and the conditions present, which makes this control measure not operationally feasible. In addition, the available resolution of the data may be large depending on the availability of a particular satellite, and satellite data of a very large-scale resolution may be difficult to accurately determine the presence and position of particular oceanographic features which the MSS would be aiming to avoid.	Limited / Unknown	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		To operate a control measure with such restrictions does not offset the significant expense to implement such a measure. There is also uncertainty with the results, which could result in areas being excluded despite there being no whales actually present which could add significant financial implications to the project through exclusions of areas for no apparent reason or extending the duration of the project if the data is not correct. Therefore, it is considered that the costs (financial and otherwise) of using remote sensing for detection of indicators of potential feeding aggregations are disproportionate to benefits.		
Noise reduction controls for vessels	P = No E = Fairly effective	Noise reduction controls involve significant engineering intervention. Seismic vessels are already designed to limit noise emissions from the vessel to avoid interference with the acoustic release. As such, it is considered that the costs are disproportionate to any potential benefits gained.	Yes	No
If three or more shut-downs due to whales entering the Shut-down Zone occur in a 24-hour period, then no night time recording will continue until a full days' operation has elapsed without a shut-down due to whale sightings	P = No E= Effective	Modelling indicates that injury (PTS or TTS) to whales from an individual impulse will be limited to the immediate area around the seismic source (80 to 130 m). The potential for PTS in baleen whales due to cumulative exposure has been identified out to 1,200 m, well within the precautionary Shut-down Zone adopted by SLB of 2 km. TTS due to cumulative exposure over long time periods up to 24 hours is theoretically possible over larger distances (5 to 7 km) but is unlikely in practice since behavioural disturbance is expected to occur at shorter distances. SLB has committed to additional precautionary controls by extending the Shut-down Zone out to 2 km and removing the Low-power Zone.	Yes	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		If three or more shut-downs occur, the first response of the seismic vessel would be to move away from the current area. The vessel would then commence the start-up and soft-start procedures for a new area in accordance with the EPBC Act. Once these start-up procedures are complete, seismic acquisition will commence. The control measure of no night time operations is not considered practicable, as it will result in extending the duration of the overall survey. The Operational Area has a large geographical extent, providing flexibility to move well clear of any 'hotspots' or 'aggregations' of whales that may be found during the survey.		
Use of drones or unmanned aerial vehicles (UAV)	P = No E = Limited	The capability of drones in offshore environments is limited by battery life, the distance they can travel and to low wind conditions (~<20 knots). The battery life of UAV's is longer, and they are capable of travelling longer distances, but are still limited to wind conditions of <25 knots. An experienced pilot is needed to operate an AUV and the costs associated with this in an offshore environment are likely to be up to $700/hr, excluding the cost of drone hire. Therefore, the cost of having a pilot on a survey vessel for 100 days would be approximately $70,000. It is considered that there would be limited benefit of using a drone/UAV over visual observation by MMOs as both are best suited to optimal conditions. As such, the costs associated with using drones or UAV's to observe for whales are considered to be disproportionate to the benefits.	Limited	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Compensation to commercial fishers who fish in or in close proximity to the Otway Basin 2DMC Operational Area	P = No E = No	Based on all of the assessments undertaken within this EP, combined with the results from the STLM, relevant literature, and previous seismic surveys that have been undertaken globally, no significant impacts are expected for commercial fisheries within the Operational Area or surrounding environment. There are also no potential impacts expected on the marine life within the Otway Basin that make up the food web of the commercially fished species. Concerns have also been raised over the more sensitive life stages of commercially fished species such as the egg and larval stages which has led fishers to suggest compensation should be paid to the fishers by Schlumberger. However, following extensive literature reviews, STLM results, and the determination of behaviour and impact thresholds have been used to determine likely impacts to marine life based on the specific acoustic source that will be used during the Otway Basin 2DMC MSS. There are many different environmental variables at play within the Otway Basin that can contribute to the success and recruitment or the lack there of, the different commercial fisheries and these variables can all contribute towards lower catch rates. As a result, it is extremely difficult to associate poor catch rates or recruitment success of a certain species in a given year solely due to a seismic survey. An example of this is the Bass Strait Scallops where seismic was originally blamed for the mortality; however, recent studies have found there were large increases in water temperatures at the same time as the seismic survey and it is not clear whether the mass mortality event resulted from the thermal spike, which occurred in the same region on almost exactly the same dates as the seismic survey operation, or from the seismic survey (Przeslawski *et al.*, 2018; 2018a).	No	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
A Before After Control Impact (**BACI**) study is implemented prior to the Otway Basin 2DMC MSS commencing.	P = No E = Yes	A number of commercial fishers requested that SLB undertake a BACI study throughout the Operational Area to assess the impacts of MSSs on commercial fisheries. Tuna fishers suggested that SLB should commit to a BACI on southern bluefin tuna to show no effect to the fishery otherwise commit to compensation to the fishers. Developing and completing a BACI experiment for all of the fisheries within and surrounding the Operational Area is a significant undertaking and would need to occur over a long time period to assure that the methodology was robust. There would also need to be enough replication within the survey design for each of the different species to incorporate variability of results. A BACI project on southern bluefin tuna would require adequate sample sizes and controls to account for a number of compounding factors and it would need to be able to attribute changes in behaviour to the factors that are driving them. BACI experiments are complex, logistically difficult, and very expensive to undertake. This type of experiment is something that needs to be developed industry wide and could be put forward for both the petroleum and seafood industry as a shared research programme covering a sufficient period of time to ensure the findings are scientifically robust. For these reasons and given the short duration of the Otway Basin 2DMC MSS it is considered that the BACI experiment is not an appropriate undertaking for the purposes of the requested outcomes of the commercial fishers. The costs of such an extensive BACI project would be grossly disproportionate to the environmental benefit gained from implementing such a control measure.	No	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		Many studies have been undertaken on the effects of fish and their response to seismic emissions, where most fish will typically move away from a loud acoustic source if they are uncomfortable with the noise, thereby minimising their exposure and the potential for any physiological effects. Most studies that are undertaken on fish are essentially represented as worst case scenarios, as the fish are not able to move away from the seismic source like they can in the wild. The proposed seismic survey will have 5 km line spacing's and each survey line will take 11 hours to acquire. So, there are large line separations, whereby the vessel is not concentrated in any particular area for a period of time.		

7.2.6 Environmental Performance

The environmental performance outcomes for the effective management of environmental impacts from noise emissions during the Otway Basin 2DMC MSS are:

- Reduce potential adverse impacts on marine fauna to **ALARP** whilst still meeting the MSS objectives with regard to data coverage and quality throughout the Operational Area;
- Always utilise soft start procedures to slowly increase source noise and allow fauna to move away minimising potential for noise effects on marine fauna;
- Undertake MSS in manner that prevents injury and TTS to whales;
- Undertake MSS in manner that minimises the potential for behavioural disturbance to marine mammals, particularly when operating in BIAs;
- Undertake MSS in manner that prevents impairment and/or mortality to turtles and is consistent with outcomes of the turtle recovery plan (e.g. reduction of anthropogenic threats to turtles and habitats);
- Undertake MSS in manner that prevents impairment and/or mortality to whales and is not inconsistent with EPBC Policy 2.1 or species-specific conservation management plans; and
- Undertaken MSS in manner that prevents cumulative impacts from impairing or killing marine fauna.

The environmental performance outcome, through the implementation of mitigation and control measures, will enable the ongoing environmental performance of the MSS activity to adhere to, or improve on, risk acceptability described in **Section 6.7**. It is critical to the environmental performance of the project that all relevant legislation is complied with for the duration of the Otway Basin 2DMC MSS to minimise or avoid any health and safety risks or incidents as far as practicable, not only to personnel but to the marine environment as well.

The environmental performance standards within **Table 67** have been defined to manage the impacts from noise emissions to **ALARP** and an **Acceptable Level**. A number of control measures will be implemented to achieve these standards for the duration of the Otway Basin 2DMC MSS and **Table 67** also provides the measurement criteria to show how they will be assessed for compliance to reach the environmental performance outcome.

Table 67 Environmental Performance Standard and Measurement Criteria for Noise Emissions

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Limitation of acoustic source volume	Ensuring no more acoustic noise is discharged to the marine environment than is necessary to achieve the objectives of the MSS. The acoustic source will have a maximum source volume no greater than 5,265 in^3, which will produce an equivalent 0-peak SPL no higher than 258.5 dB re 1 µPa @ 1 m	STLM will verify the power of acoustic source and model output. Marine Mammal Observers will record source volumes as part of their daily observations each swing.	SLB Project Manager
Operational Procedures	Acquisition will occur under 24/7 operations (where possible).	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 show when operations occurred. Bridge logs.	MMO and Vessel Master
Acoustic array designed to direct sound energy downwards and reduce horizontal spreading	The configuration of the acoustic array will be designed to direct sound energy downwards to the seabed.	STLM report will verify the configuration of the array and directionality of sound propagation.	SLB Project Manager
Restrictions on acoustic releases outside of the Operational Area	There will be no activation of the acoustic source outside of the boundaries of the Operational Area	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 show no breach in operations. Bridge logs.	MMO and Vessel Master
Reporting and notification requirements	Reporting of performance against the EP and regulations through the MSS for any non-compliance against the Environment Regulations and Industry Best Practice. Notification of any harmed animals may enable the cause of distress or death to be determined and a necropsy to be performed.	Compliance with OPGGS Environment Regulation 26(c), 14(2) and the IAGC recommended mitigation measures.	SLB Project Manager Vessel Master
NOPSEMA website search	The NOPSEMA database of approvals will be searched to identify the potential for temporal and spatial overlap with other seismic surveys	Search of the NOPSEMA activity status and summaries website, looking in particular for EP submissions or decisions in the surrounding areas to the SLB Operational Area	SLB Project Manager
Spatial limitations of operations between multiple MSSs	In the event that another vessel is acquiring seismic data in the region, the survey vessel will not acquire data simultaneously within 40 km of the other seismic vessel.	Vessel records show no breach of these requirements. Bridge logs.	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Depth limitations to activation of the acoustic source	There will be no acoustic release from the acoustic source in water depths less than 50 m.	Vessel records show no breach of these requirements. Bridge logs and vessel track records.	Vessel Master
Inshore spatial restrictions to operation of acoustic source	The Operational Area will exclude all waters within 3 NM of the coast.	Vessel records show no breach of these requirements or operating outside of the Operational Area. Bridge logs and vessel track records.	Vessel Master
Maintenance of vessel machinery	Vessel machinery will be properly maintained in accordance with vessel Planned Maintenance Systems.	Records demonstrate the latest maintenance has occurred.	Vessel Master
Compliance with the EPBC Act Policy Statement 2.1	Operations will comply with the EPBC Act Policy Statement 2.1. Part A requirements and certain Part B requirements at all times (see below for specifics).	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of these procedures	MMO
EPBC Act Policy Statement 2.1: Precaution Zones	Precaution Zones will be implemented throughout the duration of the Otway Basin 2DMC MSS and will be as follows: Observation Zone – 3+ km Shut-down Zone – 2 km (or 4 km).	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO
	Within the Observation Zone, whales and their movements will be monitored to determine whether they are approaching or entering the Shut-down Zone.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO
	When a whale is sighted within or is about to enter the Shut-down Zone, the acoustic source will immediately be completely shut-down.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO
EPBC Act Policy Statement 2.1: A.1 – Pre-survey Planning	An EP will be prepared and submitted to satisfy the requirements of NOPSEMA, including detailed stakeholder engagement.	Submission of an EP to NOPSEMA for review	SLB Project Manager

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
EPBC Act Policy Statement 2.1: A.2 – Crew training	Sufficiently trained crew will be on-board the seismic vessel with enough proven experience in whale observation, distance estimation and reporting to fulfil the basic requirements of the EPBC Act Policy Statement 2.1. Two experienced MMOs will be on board so trained crew will not have direct responsibility for this requirement but may act in a supporting role.	Induction records outline qualifications/training of each observer/trained crew member	SLB Project Manager
	Observers will be inducted in their responsibilities regarding environmental matters (including the EPBC Act Policy Statement 2.1), whale identification, and the environmental legal obligations for companies operating in Australian waters. Two experienced MMOs will be on board so trained crew will not have direct responsibility for this requirement but may act in a supporting role.	Induction records outline the content of vessel inductions and crew present	Vessel Master
	Reference material will be available on board all vessels, including the EPBC Act Policy Statement 2.1, the Department's whale and dolphin sighting report form, and the APPEA CD Guide Search Australian Whales and Dolphins. Appropriate visual aids will also be supplied on board the vessel	Audit/inspection records verify the presence of reference materials on board the vessel	Vessel Master
	Observer training will be in accordance with details described in **Section 2.2.1.3** of this EP. Observer experience will be in accordance with **Section 10.3.2**.	Training records verify completed training qualifications	SLB Project Manager MMO
EPBC Act Policy Statement 2.1: A.3.1 – Pre-start-up visual observations	During daylight hours, visual observations for the presence of whales will be undertaken by suitably trained crew in the 3+ km Observation Zone for at least 30 minutes before the commencement of soft-start procedures. Two experienced MMOs will be on board so trained crew will not have direct responsibility for this requirement but may act in a supporting role.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
EPBC Act Policy Statement 2.1: A.3.2 – Soft start procedures	Soft-start procedures may commence only if no whales have been sighted within the Shut-down Zone during the pre-start observation period. Soft-starts will be used each time the acoustic sources are initiated and will involve the gradual increase of power over a 30-minute period	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO
EPBC Act Policy Statement 2.1: A.3.3 – Start-up delay procedures	If a whale is sighted within the Observation Zone during soft-start procedures, an additional trained observer will be brought to the bridge to continuously monitor the animal. Two MMOs will be onboard and will be supported by trained crew.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO
	If a whale is sighted within or about to enter the Shut-down Zone, the acoustic source will shut-down completely. A soft-start procedure will resume only after the whale has been observed to move outside the Shut-down Zone, or when 30 minutes has lapsed since the whale was last sighted.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO
EPBC Act Policy Statement 2.1: A.3.4 – Operations procedures	During daylight hours, visual observations by trained observers will be maintained continuously, including during soft-start operations. Two MMOs will be on board so trained crew will not have direct responsibility for this requirement but may act in a supporting role.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs.	MMO
	Observations will continue if the array is completely shut-down and a re-start will only occur following the start-up delay and soft-start procedures.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs. MMO Logs	MMO
EPBC Act Policy Statement 2.1: A.3.5 – Stop work procedures	If a whale is sighted within the Observation Zone, an additional trained observer will be brought to the bridge to continuously monitor the whale while it is in sight.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs and MMO logs.	MMO

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
	If a whale is sighted within/about to enter the Shut-down Zone, the acoustic source will be shut-down completely.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs and MMO logs.	MMO
	Power-up of the acoustic source will only occur after the whale has been observed to more outside the Shut-down Zone, or when 30 minutes has lapsed since the last sighting. Power-up will follow the soft-start procedure.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs and MMO logs.	MMO
EPBC Act Policy Statement 2.1: A.3.6 – Night-time and low visibility procedures	At night or other times of low-visibility (i.e. observations cannot extend to 3+ km from the acoustic source), start-up may commence according to the A3.2 Soft-start procedure: • Provided that there have not been ≥3 whale instigated shut-down situations during the preceding 24-hour period; or • If operations were not previously underway during the preceding 24 hours, the vessel has been in the vicinity (~10 km) of the proposed start-up position for at least 2 hours (with good visibility conditions) within the preceding 24-hour period and no whales were sighted	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs and MMO logs.	MMO
	Operations may proceed provided there have not been ≥3 whale instigated shut-down situations during the preceding 24-hour period.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Bridge logs and MMO logs.	MMO
	During low-visibility, continuous observations to spot whales will be maintained where conditions allow, with a focus on the Shut-down Zone. If whales are detected, the Stop-work procedures will apply.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Bridge logs and MMO logs.	MMO
	If whale sightings are frequent/higher than anticipated during survey planning, appropriate night-time provisions and additional management measures will be discussed with the DoEE.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Bridge logs and MMO logs.	MMO

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
EPBC Act Policy Statement 2.1: A.4 – Compliance and sighting reports	Whale sightings will be reported in accordance with the EPBC Act Policy Statement 2.1 Part A.4 Compliance and Sighting Reports requirements, including submission of a report to the DoEE within two months of the survey completion	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Whale Observation Report.	MMO and SLB Project Manager
EPBC Act Policy Statement 2.1: B.1 – Marine Mammal Observers	Two trained MMOs will be onboard the seismic vessel at all times, with at least one MMO on the bridge of the seismic vessel for the visual detection of marine mammals during daylight hours.	MMO Report	MMO SLB Project Manager
EPBC Act Policy Statement 2.1: B.5 – Passive Acoustic Monitoring	PAM will be implemented on the seismic vessel and will operate continuously while the acoustic source is active.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Bridge logs. PAM Logs	PAM Operator
	A trained and experienced PAM Operator will be engaged for the duration of the survey Two experienced PAM Operators will be onboard the seismic vessel for the duration of the survey. At least one experience PAM Operator will maintain 'acoustic watch' at all times while the acoustic source is in the water.	Induction/vessel records list crew onboard seismic vessel and appropriate training	SLB Project Manager
	The PAM system will have the capability to receive/recognise vocalisations of whales within the frequencies 10 Hz to 200 kHz.	PAM system is suitable for use and will receive the vocalisations of the cetaceans likely to be found within the Operational Area. Checked by PAM Operator that it is working.	PAM Operator
	All PAM detections will be validated and cross-referenced against daylight visual observations and ranges to determine the error (if any) in PAM detections	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Bridge logs, MMO logs, PAM logs.	PAM Operator
	If PAM records prove reliable in estimating distances, PAM will be used to trigger shut-down procedures at night and during periods of poor visibility. If PAM records are shown to be inaccurate in estimating distances, the seismic vessel will power-down in the event of a confirmed detection (comprising ≥3 detection records for an individual whales) and not power-up until 30 minutes has passed without another detection	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 verify the implementation of this procedure. Bridge logs, MMO logs, PAM logs.	PAM Operator

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
	A full replacement PAM system will be onboard the seismic vessel.	PAM system specifications are suitable for use and will receive the vocalisations of the cetaceans found in the Operational Area. Checked by PAM Operator that it is working.	SLB Project Manager
Blue whale and southern right whale BIA control measures	The Standard and Additional Control measures will be implemented within the BIAs and 4 km buffer, as well as the additional BIA controls.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 and MMO/PAM logs verify the implementation of these procedures.	MMO and PAM Operator
	A 4 km buffer will be applied to the offshore extent of the BIAs.	MMO and PAM logs	Vessel Master and Observer/PAM Operator
	A 4 km Extended Shut-down Zone will be implemented when operating within the BIAs (and 4 km buffer).	MMO and PAM logs	Observer/PAM Operator
	Two experienced MMOs will be stationed on the bridge of the survey during daylight hours while the source is active in the BIAs and 4 km buffer.	MMO and bridge logs and vessel records list crew onboard seismic vessel and appropriate training	MMO SLB Project Manager
	An additional experienced MMO will be stationed onboard the support vessel and will provide additional observation effort during daylight hour while operating within the BIAs and 4 km buffer.	MMO and bridge logs and vessel records list crew onboard seismic vessel and appropriate training	MMO, SLB Project Manager
	The addition of the MMO on the support vessel and operations of the support vessel will be undertaken in accordance with the Support Vessel MMO Operational Plan.	Bridge logs	MMO and Vessel Master
	Adaptive management measures will be in place for this area for observations that are unexpected.	MMO and PAM logs	MMO and PAM Operator
	If whale sightings are higher than anticipated, and adaptive management measures are being implemented repeatedly during the survey (i.e. ≥3 shut-downs in a 24-hour period), a discussion will be held with the DoEE for any additional management measures required.	MMO, PAM and Bridge Logs	MMO, PAM Operator and Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Bonney Upwelling and Tie Line control measures	The Standard and Additional control measures as well as BIA control measures, as well as the additional tie line control measures will be implemented along the tie lines.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4 and MMO/PAM logs verify the implementation of these procedures.	MMO and PAM Operator
	Tie line acquisition will only occur during daylight hours.	MMO/PAM and Bridge logs	MMO, PAM Operator and Vessel Master
	A 4 km Extended Shut-down Zone will be implemented when acquiring the tie lines.	MMO and PAM logs	MMO/PAM Operator
	Acquisition of tie lines will be undertaken either at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey (i.e. 1 March-30 April 2020).	MMO/PAM and Bridge logs	MMO, PAM Operator and Vessel Master
EPBC Act Policy Statement 2.1: B.6 – Adaptive Management	If high numbers of whale detections result in three or more shut-downs in a 24-hour period, the seismic vessel will relocate to another survey line at least 10 km away.		
	If a southern right whale mother and calf pair is observed, the acoustic source will immediately be shut-down. Start-up and soft-start procedures will not commence until the whales have disappeared from observable distances for at least one hour, or approximately 8 km away.	MMO logs	MMO
	If whale sightings are higher than anticipated, a discussion will be held with the DoEE for any additional management measures required.	Compliance and sighting reports as per the EPBC Act Policy Statement 2.1 Part A.4. Bridge logs and MMO logs.	MMO, PAM Operator and Vessel Master

7.2.7 Residual Risk of Impact

Following the implementation of the control measures in **Table 66**, the likelihood of noise emissions having any impact on marine fauna is *Moderate* and marine users is *Minor*. The consequence from having noise emissions during the survey is considered *Possible – Likely* based on the discussions within **Section 7.2.2**.

Therefore, using the risk matrix outlined in **Section 6.5**, the residual risk from acoustic disturbance, following the implementation of control measures (**Table 66**) is considered to be **Moderate** (**Table 68**).

Table 68 Residual Risk Summary for Acoustic Disturbance to the Marine Environment

Likelihood	Consequence	Residual Risk
Likely	Moderate	Moderate

7.2.8 Demonstration of ALARP

To demonstrate the potential impacts from noise emissions are managed to **ALARP**, SLB has considered a number of control measures to assess the benefits of their implementation towards risk reduction (**Table 66**), based on a Hierarchy of Controls (**Table 69**). The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental impacts of noise emissions from the acoustic source, and any further efforts towards reducing potential risk of impacts (i.e. additional or modified control measures) are not considered relevant to provide any further environmental benefit or not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained. As a result, the impacts from acoustic emissions have been reduced to **ALARP**, where the residual risk from adoption of these control measures is reduced to **Moderate** (**Table 68**).

Table 69 Hierarchy of Controls for Acoustic Disturbance to the Marine Environment

Eliminate	Noise emissions are a fundamental requirement of any MSS in order to produce the detailed geological images and meet survey objectives. As a result, noise emissions cannot be eliminated.
Substitute	While alternative acquisition options for acquiring geological data have been trialled, they are not yet commercially available or proven.
Reduce	The maximum capacity of the acoustic source has been designed to be as low as possible while still maintaining the ability to meet survey objectives. Survey operations will run 24/7 (where possible) in order to reduce the total duration of the survey. During the survey planning stage, three different source sizes were investigated, and the 5,265 in^3 that was selected was considered to be still achieve survey objectives, even though the larger source would have been more effective at imaging the subsurface.
Mitigate	Control measures have been assessed within **Table 66** in order to mitigate the impacts from noise emissions to **ALARP** levels. Those which are appropriate and are not impracticable or unfeasible (**Table 66**) will be implemented for the duration of the Otway Basin 2DMC MSS.

The proposed control measures in **Table 66** to minimise and mitigate the risk of noise emissions to the marine environment are considered appropriate to the nature and scale of potential environmental impacts during the Otway Basin 2DMC MSS. These proposed control measures are in accordance with industry best practice and regulatory requirements. No further practicable controls have been identified to effectively reduce the impact and risks to the marine environment, marine organisms, and marine users from noise emissions from the acoustic source over and above what is proposed in **Table 66**.

Based on the information presented throughout this section, including: the STLM results, the survey design (in particular the 5 km line spacing and the reduction of the inshore extent of the Operational Area so that 89% of Operational Area occurs in waters deeper than 1,000 m), and the ongoing stakeholder engagement process; it is considered that the potential impacts from acoustic disturbance from the Otway Basin 2DMC MSS are reduced to **ALARP**.

7.2.9 Risk Acceptability

Seismic surveys are required to identify hydrocarbon reserves and there are currently no alternatives to accurately image these potential reserves under the seabed. As part of the survey design phase, SLB considered three source sizes to determine the most appropriate size to minimise impacts while still achieving survey objectives. The preferred source size for illumination of the subsurface was 6,280 in^3 and a smaller size source (3,147 in^3) was found to be insufficient. As a result, SBL selected a 5,265 in^3 acoustic source that is sufficient to meet the survey objectives for the water depths and geological parameters found within the Operational Area, whilst minimising impacts from acoustic disturbance.

The ERA process within this EP has determined that, assuming the implementation of control measures (**Table 66**) the potential impacts to the marine environment and associated receptors (i.e. marine fauna and marine users) from noise emissions are likely to be medium term (**Table 37**) but would cease when the activity stops (moderate consequence rating). The control measures that are proposed are in accordance with the Environment Regulations and based on the acceptability criteria outlined in **Table 42**, as well as being consistent with relevant legislation, standards and codes.

Due to the transitory nature of the seismic vessel, the acoustic noise will be constantly moving at 4 – 5 knots throughout the Operational Area along the pre-determined survey line plan. This will assist in limiting potential impacts to fish and cetaceans as the vessel will not be focused in any particular area for a period of time. The 90 km survey lines will take up to 11 hours to complete and with 5 km spacing's between each line, further assists in the transient nature of the survey. There is expected to be some avoidance behaviour from cetaceans, fish and turtles that may be in the Operational Area based on the different zones of impact for RMS SPLs for impulsive noise events for each receptor (**Table 64**); however, these behavioural effects are expected to cease once the seismic vessel has moved further along the sail line and are predicted as worst-case due to all azimuths being modelled away from the acoustic source.

The location of the Otway Basin 2DMC MSS Operational Area is primarily located over deep oceanic water, with 89% of the Operational Area in water depths greater than 1,000 m. At the start of the stakeholder engagement programme, concerns were raised about the nearshore environment, particularly around the potential for negative impacts on the commercially important rock lobster industry. This was also supported through the research in the development of the EP and the sensitivities of the nearshore marine environment, particularly the Bonney Upwelling. As a result, in September 2018 SLB revised the Operational Area, and reduced the nearshore portion of the Operational Area by 25,000 km^2 so that the shallowest part of the Operational Area is 50 m, and 98% of the survey lines are in water depths greater than 200 m. A second revision by SLB in December 2018 saw a further 73,000 km^2 reduced from the Operational Area, primarily around the southern part closest to Tasmania, which further excluded more shallow shelf waters from the survey area, as well as significant reduction in the overlap with the West Tasmania Canyons.

There are no predicted long-term physiological effects (**Section 7.2.2.1**) or behavioural effects (**Section 7.2.2.2**) that could contribute to population level effects on any species that has been identified within the development of this EP as a result of the Otway Basin 2DMC MSS, and no adverse effects on the environmental values or the objectives of the management plans associated with the Australia Marine Parks, KEFs, and other protected areas or areas classified as important to marine conservation (**Section 7.2.2.4**).

The control measures (**Table 66**) that will be implemented as part of operational procedures for the duration of the Otway Basin 2DMC MSS have been developed in consideration and accordance with the criteria for risk acceptability (**Table 42**). These criteria are further assessed in the following sub-sections. Where uncertainty exists around the criteria or the risk, a precautionary approach was taken for the criteria of acceptance.

7.2.9.1 Ecologically Sustainable Development

The management of risk associated for the Otway Basin 2DMC MSS as a result of acoustic source emissions can be carried out in compliance with the five principles of ecologically sustainable development as defined within the EPBC Act (outlined within **Section 2.2**). These principles have been considered as part of the development of this EP and risk assessment process, and the assessment has not identified any adverse impacts to the principles of ESD, namely:

- No threats of serious or irreversible environmental damage were identified, particularly in relation to marine mammals, benthic invertebrates, fishes and seabirds;
- Inter-generational equity will not be degraded for future generations as potential disturbance impacts would be localised and medium term (being the duration of the survey ~100 days);
- The decision-making process has integrated both long-term and short-term economic, environmental, social and equitable considerations and additional control measures have been included. For example, the collection of data along the tie lines extending closer to the coastline will only be undertaken at times selected to avoid peak transit and spawning activity of important whale species, and will only be undertaken during day light hours to allow best detection and shut-down of source if species are detected within the Precaution Zones;
- Conservation of biological diversity and ecological integrity have been considered in the decision-making process as potential impacts from physical presence of the vessel were identified to be localised and short-term; and
- The control measures proposed have considered improved valuation, pricing and/or incentive mechanisms – control measures that had environmental benefits that outweighed the costs of their implementation were proposed to be undertaken.

7.2.9.2 Legislative Requirements

The Otway Basin 2D MC MSS will comply with all relevant legislative requirements (see **Section 2**), in particular the EPBC Policy Statement 2.1 Part A measures. Under Part B of the EPBC Act Policy Statement 2.1, a number of measures are recommended when the likelihood of encountering whales is moderate to high (see **Section 2.2.1.1** for definitions of likelihood). A number of control measures will be implemented for the duration of the Otway Basin 2DMC MSS in accordance with Part B of the EPBC Act Policy Statement 2.1 (**Table 66**).

As described in **Section 2.2**, conservation advice and recovery plans define the research and management actions necessary to stop the decline of, and support the recovery of, threatened species or threatened ecological communities. The relevant measures within the conservation advice and recovery plans have been considered during the development of control measures that will be implemented during the Otway Basin 2DMC MSS and are considered to consistent with these recovery plans and conservation advice notes. These are detailed further below.

A relevant interim recovery objective of the 'Conservation Management Plan for the Southern Right Whale' is to ensure that "*anthropogenic threats are demonstrably minimised*". Adoption of the EPBC Act Policy Statement 2.1 Part A measures and certain Part B measures (including spatial and temporal adaptive management procedures) (see **Section 7.2.5** and **Table 66**) will ensure that potential noise impacts and risks are **ALARP** and at **Acceptable Levels** with regard to southern right whales and align with the objectives of the southern right whale Conservation Management Plan.

Interim Objective 4 of the 'Conservation Management Plan for the Blue Whale' is to "*ensure anthropogenic threats are demonstrably minimised*" and is to be tested by Target 4-1; "*Robust and adaptive management regimes leading to a reduction in anthropogenic threats to Australian blue whales are in place*". This Conservation Management Plan listed seismic noise as a potential source of anthropogenic noise impacts, which was determined a threat with very high priority for pygmy blue whales. Listed conservation actions to ensure recovery targets are met that are applicable to the Otway Basin 2D MC MSS include:

- Assessing the effect of anthropogenic noise on blue whale behaviour;
- 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; and
- EPBC Act Policy Statement 2.1 is applied to all seismic surveys.

The effects of anthropogenic noise on blue whales have been assessed in **Section 7.2.2.1.8** of this EP. Adoption of the EPBC Act Policy Statement 2.1 Part A measures and certain Part B measures including additional measures in the blue whale BIA and during tie line acquisition will ensure that blue whales will be able to utilise the BIA without injury or significant behavioural impacts whilst the survey takes place, and the control measures that SLB will implement are consistent with the conservation actions for the blue whale.

STLM results have shown that exposure to a single pulse of the acoustic source that could elicit PTS (permanent hearing damage) for baleen whales is within approximately 50 m of the acoustic source, or if they remained within 450 – 1,200 m of the source could experience PTS due to cumulative exposure (**Table 57**). However, compliance with the extended 2 km Shut-down Zone will prevent any PTS impact from occurring to blue whales or other baleen whale species present within the Operational Area.

For TTS (temporary hearing damage), for baleen whales would occur if they were exposed to a single pulse at a distance of 80 – 130 m from the acoustic source, or for whales remaining at one location for an extended period within around 5 km of an active survey line, or around 7 km if an infill line is required (**Table 57**). Because this distance is larger than the anticipated behaviour disturbance zone, animals are expected to move away in practice and for this reason TTS in baleen whales is unlikely.

Based on the extensive control measures, with particular mention of the large reduction in Operational Area, the additional mitigations to be implemented in the blue whale BIA and during tie line acquisition, project specific STLM to assess impacts, the overall environmental risks from the Otway Basin 2DMC MSS are considered to be reduced to **ALARP** and at **Acceptable Levels** with regard to blue whales. It is considered that the measures that will be implemented and the detailed literature review, STLM analysis and risk assessment to develop the control measures that will be implemented throughout the MSS align with the objectives of the blue whale Conservation Management Plan.

Conservation and Management Actions for humpback whales have been outlined in the humpback whale Conservation Advice (approved 1 October 2015) and include "*assessing and addressing anthropogenic noise: shipping, industrial and seismic surveys*". All mitigation measures listed within the Conservation Advice are included within the proposed control measures (**Table 66**) and will be implemented throughout the Otway Basin 2DMC MSS, this also includes the adoption of all EPBC Act Policy Statement 2.1 Part A measures and certain Part B measures (including spatial and temporal adaptive management procedures and use of PAM), and the undertaking of acoustic modelling. The mitigation measures in place for the Otway Basin 2DMC MSS will adhere to the requirements of the Conservation Advice and will assist with reducing potential noise impacts and risks to **ALARP** so that any potential impacts are managed to an **Acceptable Level** with regard to humpback whales.

No further mitigation measures have been provided in the Conservation Advices for sei and fin whales to address anthropogenic noise; however, those mitigations adopted to address potential impacts on blue whales will be of substantial benefit to sei and fin whales as well. Adoption of the EPBC Act Policy Statement 2.1 Part A measures and certain Part B measures will be implemented to reduce the potential noise impacts and risks to **ALARP** and **Acceptable Levels** with regard to sei and fin whales.

Anthropogenic noise is considered to be a secondary threat to Australian sea lions under the 'Recovery Plan for the Australian sea lion (*Neophoca cinerea*)'; however, there are no specific actions within the Recovery Plan to address effects on Australian sea lions.

Although anthropogenic noise has been assessed within the '*Recovery Plan for Marine Turtles in Australia*', there are no specific actions to address effects on turtles other than the recommendation to adhere to the EPBC Act Policy Statement 2.1, particularly the use of soft start procedures, which are incorporated into SLBs control measures. Therefore, the control measures that will be implemented will be consistent with the objectives of the marine turtles Recovery Plan.

Anthropogenic noise is not considered to be a threat to albatrosses and giant petrels under the '*National Recovery Plan for Threatened Albatrosses and Giant Petrels*', and was not addressed as a threat to sub-Antarctic fur seals, southern elephant seals, fairy terns, blue petrels, and fairy prions in their relevant Conservation Advice documents, therefore no specific additional measures are required to be implemented to reduce potential noise impacts and risks to **ALARP** and **Acceptable Levels** with regard to these species.

7.2.9.3 Internal Context

The proposed management of the impact/risks from noise emissions are within **Acceptable Levels** of SLB's Environmental and QHSE Policy, as detailed in **Section 1.2**.

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS (**Section 4.5.8**).

7.2.9.4 Industry Best Practice

The proposed control measures outlined within **Table 66** follow industry best practice and best practice guidelines, including:

- Adoption of the EPBC Policy Statement 2.1 which is considered Industry Best Practice for minimising the effects of MSSs on marine mammals. Control measures will be implemented for the duration of the Otway Basin 2DMC MSS and these measures have been developed in accordance with the EPBC Act Policy Statement 2.1 (i.e. soft starts, Precaution Zones, MMOs). The use of soft starts is where the power of the acoustic source is gradually increased prior to any operations commencing to ensure that any undetected marine mammals will have an opportunity to leave the vicinity before full operational power is reached. The soft start normally takes place over a period of at least 20 minutes and no more than 40 minutes. Therefore, it is considered that the operation of the Otway Basin 2DMC MSS will be conducted in accordance with Industry Best Practice;
- The IAGC Environmental Manual for Worldwide Geophysical Operations which includes recommended mitigation measures for cetaceans to minimise acoustic disturbance during geophysical operations. These measures include, but are not limited to:

  - Use of soft-start procedures;
  - Providing basic awareness training to the entire crew; have them immediately report any cetacean observation to the bridge;
  - Reporting immediately to local authorities any animals in distress, animal carcasses, etc.; and
- The APPEA Code of Environmental Practice which includes objectives to reduce the impact on cetaceans, benthic communities and other marine life to **ALARP** and to an **Acceptable Level** by ensuring operations are in accordance with legislative requirements and demonstrate the implementation of appropriate management measures.

7.2.9.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and State government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised has been detailed in **Appendix F**. SLB are committed to ongoing stakeholder engagement and this engagement will continue for the duration of the Otway Basin 2DMC MSS (**Section 4.5.8**). Ongoing engagement will ensure that leading up to and during the MSS, all available and requested information is provided, and questions or concerns raised can be answered or addressed and if required, mitigations can be incorporated into management strategies or operational procedures if they have not been already.

There were some concerns raised during the stakeholder engagement programme, and in regard to the effects from acoustic disturbance the main concerns raised from stakeholders and what has been considered within the EP and environmental risk assessment process were:

- Effects of acoustic impact on the adult and larval stages of rock lobster;
- Effects of acoustic impact on the adult and larval stages of scallops;
- Effects of acoustic impact on squid – survival and catch rates;
- Effects of acoustic impact on southern bluefin tuna; and
- Effects of acoustic impacts on pygmy blue whales and the mitigation measures to minimise acoustic disturbance.

All responses to these submissions are provided in **Appendix F**. All concerns raised by these stakeholders were considered as part of the impact assessment within **Section 7.2** where detailed literature reviews, STLM and revisions to the survey design were included in the development of an extensive set of control measures to reduce the overall impacts from the Otway Basin 2DMC MSS to **ALARP** and an **Acceptable Level**.

The concerns from the rock lobster fishers about potential effects from the Otway Basin 2DMC MSS on their fishing activities were twofold, as it included the physical presence of the seismic vessel (displacement from fishing sites and interaction with pots) and the acoustic effects associated with the seismic source on adult and larval stages.

These concerns have been taken into consideration as part of the development of this EP, namely by the first reduction in the Operational Area (25,000 km^2) (**Figure 59**) to eliminate seismic operations in waters shallower than 50 m. As a result of these changes, 98% of the survey lines will now occur in waters deeper than 200 m. It is considered that the red rock lobster lives down to a maximum depth of 200 m (Linnane *et al*., 2018) and from the 2016-17 rock lobster stock assessment most of the catch comes from less than 60 m, with the lowest catch per unit effort in water depths greater than 90 m, it is not defined any further. From discussions with SARLA it is understood very little rock lobster effort takes place in waters beyond 200 m. The survey design has large line spacing which reduces potential acoustic effects on rock lobster larvae and a detailed literature review was undertaken as part of the development of this EP in combination with STLM to assess the potential risks associated with seismic on the larval stages of rock lobster.

7.2.9.6 Existing Environment Context

The NOPSEMA guidance note for petroleum activities and Australian Marine Parks (NOPSEMA, 2018a) requires that an EP is developed for undertaking activities such as seismic surveys to evaluate how environmental impacts and risks will be of an **Acceptable Level** and reduced to **ALARP** and demonstrate that the activity (i.e. seismic survey) will not be inconsistent with the relevant marine park management plan. The Otway Basin 2DMC MSS will be undertaken in accordance with the objectives of the *Southeast Commonwealth Marine Reserves Network Management Plan 2013-2023* and the *Bioregional Plans for the Southeast Marine Region*. The Management Plan identifies noise pollution associated with shipping, other vessels, seismic survey, offshore mining operations and offshore construction as a pressure on the conservation values of the South-east Marine Reserves Network.

Two Marine Parks exist within the Otway Basin 2DMC MSS Operational Area (Nelson and Zeehan), with a further four within the wider environment. Most of these Marine Parks are classified 'IUCN VI' ('Protected area with sustainable use of natural resources') while one zone of the Murray Marine Park (to the west of the OA) is IUCN II classified (i.e. Marine National Park). The *South-east Marine Region Profile Plan* does not directly identify acoustic disturbance as a specific concern for any species, or for the three KEF's that exist in this region (the Bonney Coast Upwelling, West Tasmania Canyons and Shelf rocky reefs and hard substrates).

The Otway Basin 2DMC MSS Operational Area overlaps or is near to the BIA for three species of whale, the white shark, Australian sea lions and 17 species of seabirds, as well as being within the foraging area of the leatherback turtle. The area is within or adjacent to several important commercial fishing areas including southern bluefin tuna, squid, shark, abalone and rock lobster, although the latter two fisheries are predominantly well inshore near the coast. Based on the STLM results, the residual risk ratings for all animal groups, except of cetaceans and pinnipeds, were assessed as **Low**. Cetaceans and pinnipeds had a **Moderate** residual risk rating. As such, it is considered that the proposed control measures (**Table 66**) provide appropriate protection to the marine environment from acoustic disturbance associated with the MSS and the associated effects to marine organisms, marine conservation, stakeholders and other marine users. Further/alternative control measures were considered but would not be practicable and the time and cost required to implement further controls are considered to be disproportionate to the environmental benefit that would be gained.

Overall, it is considered that through the implementation of the control measures, the operational procedures and the changes that have been made to the survey design (i.e. reduction to Operational Area) during the planning stages, the impacts from underwater noise emissions from the acoustic sources will not have any detrimental or long-lasting impact on the marine environment. It is furthermore considered that the Otway Basin 2DMC MSS will be conducted in accordance with the relevant IUCN principles, EPBC Act Policy Statement 2.1 and any other relevant legislation or code, and any adverse impacts to the surrounding marine environment, fauna, protected species, recognised values and sensitivities will be reduced to **ALARP** and **Acceptable Levels**.

7.2.10 Acoustic Disturbance Impact Summary

Based on the findings of this EP, with the implementation of the control measures, underwater noise emitted from the acoustic source is considered to have a **Moderate** impact on the marine environment. This impact is predicted to be a medium scale effect in terms of displacement of cetaceans away from the active acoustic source; however, it is envisaged the duration of effects would be medium term and any displacement or effects would cease as soon as the activity ceases.

Based on the extensive control measures (**Table 66**) that have been proposed for implementation in accordance with industry best practice, Environment Regulations and all other relevant regulations, in addition to those that have been considered and not taken any further, no additional controls are considered reasonable or practicable as further mitigation measures for the Otway Basin 2DMC MSS. With the control measures in place, the significantly reduced Operational Area, the survey line design favouring the deeper waters (i.e. 98% > 200 m and 91% >1,000 m), it is considered that the Otway Basin 2DMC MSS will be acquired so that the environmental risk and impacts on the marine environment and receptors within and surrounding the Operational Area from the acoustic disturbance are reduced to **ALARP**.

In accordance with the Risk Ranking Descriptions in **Table 40**, where risk cannot be reduced to '**Low**', control measures must be applied to reduce the risk to **ALARP**, as indicated in the sections above. As a result, following the implementation of the extensive control measures in **Table 66**, the impacts from acoustic disturbance associated with the Otway Basin 2DMC MSS are considered to be at an **Acceptable Level**.

7.3 Routine Permissible Waste Discharges

7.3.1 Source of Discharge

The source of routine permissible waste discharges falls into two categories:

- Biodegradable waste (sewage, greywater and galley waste); and
- Deck drainage and bilge water.

Sewage, greywater and galley waste represent the primary forms of biodegradable waste that are likely to be produced during the Otway Basin 2DMC MSS. As outlined within **Table 13**, the seismic vessel has a maximum daily sewage discharge capacity of 15 m^3, and the support vessel has a capacity of 1.1 m^3. The actual daily volumes of sewage and greywater generated during the Otway Basin 2DMC MSS will be much lower than these capacities and will be directly related to the number of personnel onboard. It is estimated that each person generates approximately 35 L of sewage/greywater per day. Therefore, with a vessel capacity of 70 persons, the seismic vessel will discharge approximately 2.5 m^3 per day, with the support vessel discharging approximately 0.5 m^3 per day on the assumption of having 14 persons onboard.

The other source of permissible waste discharges is deck drainage and bilge water. Ongoing cleaning and maintenance operations around the vessels, as well as deck drainage from rain or spray will generate deck waters which may contain remnants of spilt materials, detergents, oils and smaller solid materials (garbage). Larger chemical spills would be contained and/or cleaned up prior to entering the deck drainage systems as per the vessels emergency spill/pollution plans. Bilge water is drainage water and other fluids captured in a closed system, often from engine or machinery spaces within the vessel, for treatment prior to discharge at sea, or stored for discharge at port – as per requirements of MARPOL Annex 1.

In addition to the above, non-biodegradable waste will be generated during the Otway Basin 2DMC MSS, such as garbage. MARPOL Annex V prohibits the discharge to sea of all types of garbage unless explicitly permitted under the Annex (as detailed in previous sections). Garbage onboard the seismic and support vessels such as plastics, synthetic ropes, cooking oils, paper and cardboards, rags, packaging materials, polystyrenes/foam and wood are prohibited from being discharged into the marine environment, and these materials will be retained onboard the vessel and stored for later disposal onshore at suitable waste facilities.

7.3.2 Known and Potential Impacts to Environmental Receptors

Biodegradable waste disposed at sea is decomposed by bacteria either in the water column or on the seabed. This decomposition process increases the biochemical oxygen demand in the surrounding area which can potentially limit dissolved oxygen for other marine organisms (particularly in low flow areas where water circulates slowly). Disposal of biodegradable wastes at sea can also lead to areas of artificial nutrient enrichment (particularly phosphorus and nitrogen) which in extreme cases can trigger excessive algal growth (Perić, 2016; Wilewska-Bien *et al.*, 2016). However, the high energy open ocean within the Operational Area will likely result in rapid dilution and dispersion of discharged wastes with no discernible elevation in nutrients and/or biochemical oxygen demand.

The discharge of food wastes can also lead to increased scavenging behaviour around the vessels by seabirds and fish, sometimes leading to animals following the vessel for significant distances. Sewage and greywater (particularly untreated wastes) may also contain hazardous pathogens (e.g. faecal coliforms and viruses) which can pose risks to those in contact with the wastes and/or the water in which is discharged, as well as risks to those that might consume seafood collected from the area where discharges of these wastes occurred.

Constituents within the deck drainage and bilge water could have potential environmental impacts including:

- Toxicity to marine organisms; and
- Polluting surface waters and/or benthic sediments.

The level of impact will be directly related to the volume of the substance and the volume of water it is discharged within, their toxicity, the types of organisms present, and the receiving environment itself. Discharged chemical and hydrocarbons can cause damage to organisms across all trophic levels. Immediate impacts would mostly affect organisms within the water column but pollutants adsorbing onto particles/sediments within the water column settle to the seabed where benthic organisms may be exposed.

In order to reduce the potential impact from the discharge of routine permissible waste, SLB will conduct operations in accordance with the relevant annexures of MARPOL, Marine Orders and the PSPPS Act. Based on this, it is considered that the consequence of impact is *Negligible*, with a likelihood of seeing a measurable impact being *Unlikely* which results in an overall risk ranking of **Negligible**.

7.3.3 Control Measures

The control measures that will be implemented during the Otway Basin 2DMC MSS to manage the impacts from routine permissible waste discharges to **ALARP** have been included in **Table 70**. These control measures have been assessed to consider the environmental benefit(s) gained through implementing these controls relative to their time, effort and monetary cost. SLB will make a clear delineation of those measures which will be implemented during the Otway Basin 2DMC MSS and those which won’t, in particular where SLB considers their implementation is disproportionate to the environmental benefit gained. Justifications have been provided for each of these decisions.

Table 70 Assessment of Control Measures for Routine Permissible Waste Discharges

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
Compliance with MARPOL Annex I (Regulations for the Prevention of Pollution by Oil) Marine Order 91 (Marine Pollution Prevention – Oil) Protection of the Sea (Prevention of Pollution from Ships) Act 1983	P = Yes E = Effective	It is a legislative requirement to meet the relevant aspects of MARPOL Annex I, Marine Order 91 and the PSPPS Act.	Yes	Yes
Compliance with MARPOL Annex IV (Regulations for the Prevention of Pollution by Sewage from Ships) Marine Order 96 (Marine Pollution Prevention – Sewage)	P = Yes E = Effective	It is a legislative requirement to meet the relevant aspects of MARPOL Annex IV and Marine Order 96.	Yes	Yes
Compliance with MARPOL Annex V (Regulations for the Prevention of Pollution by Garbage from Ships) Marine Order 95 (Marine Pollution Prevention - Garbage)	P = Yes E = Effective	It is a legislative requirement to meet the relevant aspects of MARPOL Annex V and Marine Order 95.	Yes	Yes
No permissible discharge of wastes in Australian Marine Parks.	P = Yes E = Effective	The Zeehan and Nelson Australian Marine Parks lie within the boundaries of the Operational Area. Restricting discharges to outside of Australian Marine Parks will avoid any potential adverse effects from discharges on the sensitivities within the parks.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Equipment/machinery involved in the treatment of wastes will be routinely maintained	P = Yes E = Effective	Routine maintenance ensures that the requirements of MARPOL are able to be met.	Yes	Yes
All crew will participate in the vessel and environmental induction prior to the commencement of operations	P = Yes E = Effective	It is a standard industry practice to hold induction s for all onboard the vessels, with participation in induction meetings compulsory. During inductions, crew will be made aware of their responsibilities with regard to effects of the discharge of wastes to the marine environment and restrictions around the overboard discharge of waste materials.	Yes	Yes
Alternative Control Measures:				
Eliminate the discharge of sewage, greywater and galley waste	P = No E = Very Effective	As the vessel is required to be manned, the generation of sewage, greywater and galley waste is unavoidable. Although this would reduce the impact of discharges, the storage of this waste on board the survey vessel and subsequent transfer to shore will add significant operational costs (fuel etc.), and also increase the environmental risk and impact due to the additional journeys to port. It is considered that the costs associated with this control measure are disproportionate to the benefits gained as additional risks and impacts could occur from the implementation of this measure.	No	No
Eliminate the discharge of deck drainage and bilge water	P = No E = Very Effective	Similar to above, the storage of deck drainage and bilge water on board the survey vessel for transfer and disposal to shore is not considered practicable due to vessel stability. This operation would add significant costs (i.e. fuel use and vessel down time) and additional environmental risk and potential impacts to the project if a voyage back to port was made during the MSS. Therefore, it is considered the costs associated with implementing this control measure are disproportionate to the benefits gained, as additional risks and impacts could occur from the implementation of this measure.	No	No

7.3.4 Environmental Performance

The environmental performance outcomes for the effective management of environmental impacts from routine permissible waste discharges are:

- Reduce any impact to water quality and sensitive marine fauna and flora from the Otway Basin 2DMC MSS to **ALARP**; and
- No incidents of any non-compliant discharge of biodegradable waste (i.e. sewage, greywater and galley waste), bilge-water and deck drainage from the seismic and/or support vessels.

This will be achieved through compliance with relevant performance standards for routine permissible waste discharges.

The environmental performance outcome, through the implementation of the mitigation and control measures, will enable the ongoing environmental performance of the MSS activity to adhere to, or improve on, the **Acceptable Levels** of risk that is described within **Section 7.3.7**. It is critical to the environmental performance of the project that all relevant legislation is complied with for the duration of the Otway Basin 2DMC MSS to minimise or avoid any adverse effects on the environment or incidents occurring.

The environmental performance standards within **Table 71** have been defined to manage the impacts from routine permissible waste discharges to **ALARP** and an **Acceptable Level**. A number of control measures will be implemented to achieve these standards for the duration of the Otway Basin 2DMC MSS and **Table 71** also provides the measurement criteria to show how they will be assessed for compliance to reach the environmental performance outcome.

Table 71 Environmental Performance Standard and Measurement Criteria for Routine Permissible Waste Discharges

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Compliance with: MARPOL Annex I; Marine Order 91; and Protection of the Sea (Prevention of Pollution from Ships) Act 1983	An International Oil Pollution Prevention Certificate (**IOPP Certificate**) will be held by every ship of 400 gross tonnage and above involved in the MSS as per division 3 of Marine Order 91, and MARPOL Annex I.	IOPP Certificate is valid	Vessel Master
	Oil filtering equipment (of an approved design) processes oily water to meet the 15 ppm requirement of MARPOL Annex I, MP 91 and the PSPPS Act. In addition, any discharge of processed oily water will be undertaken while the vessel is underway in accordance with the above concentration requirements. Any separated oil will be retained/stored onboard and transported to shore for disposal at an approved facility.	Vessel audit confirms it is in survey and equipment is operational. Discharge logs	Vessel Master
Compliance with: MARPOL Annex IV; and Marine Order 96	An International Sewage Pollution Prevention Certificate (**ISPP Certificate**) will be held by every ship of 400 gross tonnage and above involved in the MSS, and any vessel certified to carry more than 15 persons as per division 3 of Marine Order 96, and Regulation 4 of MARPOL Annex IV.	ISPP Certificate is valid Vessel audit	Vessel Master
	When sewage is comminuted and disinfected using an approved system (as per Marine Order 96), the discharge to sea will only occur at a moderate rate when the vessel is travelling at greater than 4 knots, and when further than 3 NM from the nearest land as per MARPOL Annex IV.	Discharge logs	Vessel Master
	When sewage is not comminuted or disinfected using an approved system, the discharge to sea will only occur at a moderate rate when the vessel is travelling at greater than 4 knots, and when further than 12 NM from the nearest land as per MARPOL Annex IV.	Discharge logs	Vessel Master
	When operating vessels within 12 NM of the coast, any sewage that is not comminuted or disinfected through an approved system will be stored within holding tanks. This sewage will then either: be transferred ashore for appropriate treatment; or, discharged to sea once further than 12 NM from the coast as per the standards above.	Waste Transfer Certificate issued by licensed facility of carrier for onshore transfers. Discharge logs	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Compliance with: MARPOL Annex V; and Marine Order 95	When food wastes have been comminuted or ground down to less than 25 mm, the discharge of this waste can occur when further than 3 NM from the nearest land as per MARPOL Annex V.	Visual inspection records confirm that macerator is functional and in use. Discharge logs	Vessel Master
	When food wastes have not been comminuted or ground down to less than 25 mm, the discharge of this waste can occur when further than 12 NM from the nearest land as per MARPOL Annex V.	Discharge logs	Vessel Master
	Any vessel used for the Otway Basin 2DMC MSS over 100 gross tonnes or certified to carry 15 or more persons will hold and maintain a Garbage Management Plan for minimising, collecting, storing, processing and disposing of garbage, including the use of equipment on board, as per MARPOL Annex V and Marine Order 95.	Garbage Management Plan is valid. Garbage logs.	Vessel Master
Restriction of permissible discharges to outside of Australian Marine Park boundaries	Permissible discharges will only occur outside of the Zeehan and Nelson Australian Marine Parks	Discharge logs confirm that discharges have occurred outside of Australian Marine Parks.	Vessel Master
Participation of all crew in vessel induction	All crew will participate in a vessel induction prior to the commencement of the survey, outlining their roles and responsibilities while onboard.	Induction records show content of induction meeting and participation of crew.	Vessel Master
Routine maintenance of waste disposal machinery	Equipment/machinery involved in the treatment of sewage and galley waste will be routinely maintained	Maintenance records confirm that equipment/machinery is functioning correctly.	Vessel Master

7.3.5 Residual Risk of Impact

Following the implementation of the control measures within **Table 70**, the likelihood of a measurable impact on environmental receptors from routine permissible discharges is *Unlikely*. The consequence from routine permissible waste discharges is considered *Negligible*, based on the discussions within **Section 7.3.2.**

Therefore, using the risk matrix outlined in **Section 6.5**, the residual risk from routine permissible waste discharges, following the implementation of control measures (**Table 70**) is considered to be **Negligible** (**Table 72**).

Table 72 Residual Risk Summary for Routine Permissible Waste Discharges

Likelihood	Consequence	Residual Risk
Unlikely	Negligible	Negligible

7.3.6 Demonstration of ALARP

To demonstrate the potential impacts from routine permissible waste discharges are managed to **ALARP**, SLB has considered a number of control measures to assess the benefits of their implementation towards risk reduction (**Table 70**), based on a Hierarchy of Controls (**Table 73**). The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental impacts from routine permissible waste discharges from the vessel (i.e. bilge water, sewage and food wastes) and assessments have been undertaken to ensure that all reasonable and practicable control measures or solutions have not been overlooked. As a result through application of industry best practice and/or comparable standards to further control risk reduction, it is considered that any impacts from routine discharges have been reduced to **ALARP**, where the residual risk from adoption of the control measures is **Negligible** (**Table 72**).

Additional control measures were considered as part of the assessment process towards further risk reduction; however, it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 73 Hierarchy of Controls for Routine Permissible Waste Discharges

Eliminate	As discussed within **Table 70**, the seismic vessel is required to be manned at all times which means the generation of sewage, greywater and galley waste cannot be eliminated. In order to eliminate the discharge of waste, it would need to be stored onboard the vessel and transported to shore, adding significant operational costs, time, and additional health and safety risks. Therefore, it was considered that elimination of this permissible discharge was not practicable.
Substitute	Similar to the discussion above, the only option to substitute the discharge of this waste is the storage and transfer for disposal onshore which is not considered practicable, given the safety, hygiene and health risks involved.
Reduce	The impact from the discharge of routine permissible waste discharges will be reduced by the implementation of the control measures within **Table 70;** specifically, the fact that the oil content within oily water discharge will be reduced to 15 ppm through an approved oily water separator, and a grinder/comminuter will be utilised where required to reduce the potential impacts from the discharge of food waste is considered appropriate means of minimising effects on the marine environment and is in accordance with the regulations and guidelines.
Mitigate	Control measures have been assessed within **Table 70** in order to mitigate the impacts from the discharge of routine permissible wastes to **ALARP** and **Acceptable Levels**. These measures have also included separation distances to the nearest point of land for the discharge of certain aspects of the waste, so the more sensitive nearshore coastal margins are not exposed to any nutrient enrichment of any form. This includes no untreated sewage and putrescible wastes will be discharged within 12 NM from land and no treated sewage and putrescible wastes will be discharged within 3 NM from land.

The proposed control measures in **Table 70** to minimise and mitigate the impact from routine permissible waste discharges are considered appropriate to the localised nature and scale of potential environmental impacts during the Otway Basin 2DMC MSS. These proposed control measures are in accordance with industry best practice and guidelines. No further practicable controls have been identified that can be implemented that will effectively reduce the impact and risks to the marine environment and/or marine organisms from routine permissible waste discharges over and above what is proposed in **Table 70**.

Based on the information presented throughout this section, the relatively localised nature of effects from routine permissible waste discharges around the seismic and support vessels, combined with the scale of the Otway Basin 2DMC MSS, it is considered that the potential impacts from routine permissible waste discharges are reduced to **ALARP** and the residual risk is **Negligible** (**Table 72**).

7.3.7 Risk Acceptability

Seismic surveys are required to identify hydrocarbon reserves and there are currently no alternatives to accurately image these reserves under the seabed. At the moment there is no alternative to having these seismic vessels manned, and with that comes the generation of daily waste associated with a number of personnel living on the vessel 24 hours per day.

Total elimination of all impacts associated with routine permissible waste discharges cannot be achieved, as the generation of sewage, greywater and galley waste is unavoidable and will be discharged to sea daily in relatively small volumes, with no practicable alternatives. However, these discharges will be in accordance with the requirements of the MARPOL 73/78 Convention (as implemented in Commonwealth waters by the Protection of the Sea (Prevention of Pollution from Ships) Act 1983). Additionally, the survey and support vessel may have to discharge bilge water during the survey if required.

Routine discharges, such as the discharge of bilge water, sewage and food waste from the vessels used during the Otway Basin 2DMC MSS have the potential to cause a localised reduction in water quality. However, following the implementation of control measures (**Table 70**) the potential impacts to the marine environment and associated receptors from routine permissible waste discharges are likely to be short-term and highly localised.

The seismic vessel is continuously moving at 4 – 5 knots throughout the Operational Area under 24-hour operations so any discharged waste will not be concentrated in any particular area. The Operational Area is an open ocean environment with 89% of the water depths greater than 1,000 m. Any discharge is unlikely to impact any benthic species and a high level of mixing and dispersion of the discharged waste will occur.

There are no predicted long-term effects at a population level on any species identified in this EP, and no adverse effects on the environmental values of protected areas as a result of permissible waste discharges are expected.

The control measures (**Table 70**) that will be implemented for the duration of the Otway Basin 2DMC MSS have been developed in accordance with the criteria for risk acceptability which are detailed in **Table 42** and defined further how compliance is met in the following sub-sections. Where uncertainty exists around the criteria or the risk, a precautionary approach was taken for achieving the criteria of acceptance.

7.3.7.1 Ecologically Sustainable Development

The management of the impacts associated with the Otway Basin 2DMC MSS as a result of the discharge of routine permissible discharges can be carried out in compliance with the five principles of ecologically sustainable development as defined within the EPBC Act (outlined within **Section 2.2**). These principles have been considered as part of the development of this EP and risk assessment process. The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

7.3.7.2 Legislative Requirements

As outlined within **Table 70**, SLB will ensure that the Otway Basin 2DMC MSS will ensure that the routine permissible waste discharges (i.e. sewage, food waste and bilge water) will be undertaken in accordance with international conventions and relevant legislation, including:

- MARPOL Annex I, Annex IV and Annex V;
- Protection of the Sea (Prevention of Pollution from Ships) Act 1983;
- Marine Order 91 (Marine Pollution Prevention – Oil), 2014;
- Marine Order 95 (Marine Pollution Prevention – Garbage), 2013;
- Marine Order 96 (Marine Pollution Prevention – Sewage), 2013; and
- Marine Notices 09/2015 Guidance document for the recording operations in the Oil Record Book Part I.

7.3.7.3 Internal Context

The proposed management of the routine permissible waste discharges is consistent with SLB's QHSE Policy as detailed in **Section 1.2**.

SLB places great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

7.3.7.4 Industry Best Practice

The proposed control measures outlined within **Table 70** follow industry best practice and best practice guidelines, including:

- The IAGC Environmental Manual for Worldwide Geophysical Operations which provides guidance on waste management, including, but not limited to:
  - Vessels having a Waste or Garbage Management Plan to effectively manage waste in line with MARPOL regulations as well as local legislation;
  - Waste that cannot be incinerated will be segregated and stored for disposal ashore;
  - Prior to discharge, oily water is processed to remove oil to less than 15 ppm;
  - Greywater and sewage are dealt with according to MARPOL; and
- The APPEA Code of Environmental Practice includes an objective to reduce the impact of routine waste discharges on the marine environment to **ALARP** and to an **Acceptable Level** by ensuring discharges are in accordance with legislative requirements and predicted levels.

7.3.7.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** and **Appendix F**.

During consultation with interested stakeholders no concerns were raised in regard to possible impacts from routine permissible waste discharges, and as such no additional control/mitigation measures were expected or put in place following stakeholder engagement. The environmental impacts relating to routine permissible waste discharges from seismic survey and support vessels in accordance with industry best practice were considered to be at a socially **Acceptable Level**.

7.3.7.6 Existing Environment Context

As outlined within **Section 7.3.2**, it is considered that the discharge of routine permissible wastes will not result in a significant impact on environmental values or sensitivities, including the three KEFs (**Section 5.3.8**) and two Marine Parks (**Section 5.3.3**), within the Operational Area with the implementation of the control measures outlined within **Table 70**.

7.3.8 Routine Permissible Waste Discharge Impact Summary

Based on the discussions above, including the potential impacts on the environment and the associated control measures to be implemented, the residual risk from routine permissible waste discharges from the survey and support vessels is considered **Negligible** and to **ALARP**. Therefore, the impacts from this activity associated with the Otway Basin 2DMC MSS are considered to be at an **Acceptable Level**.

7.4 Atmospheric Emissions

7.4.1 Description of Source of the Impact

The combustion of exhaust gasses from mechanical equipment (engines, generators, winches, power-units, plant machinery etc.) and incineration of wastes represent the principle sources of potential atmospheric emissions during the Otway Basin 2DMC MSS. Most of these gaseous emissions will be in the form of carbon dioxide and carbon monoxide; however, smaller quantities of other gasses such as methane, nitric oxide, nitrogen dioxide, carbon monoxide and sulphur dioxide may be emitted particularly during any incomplete combustion.

Vessels used during the Otway Basin 2DMC MSS may have Ozone Depleting Substances (**ODS**) onboard. However, if these ODSs are onboard the vessel, they will be within closed loop systems, such as rechargeable refrigeration systems, and will not be discharged deliberately.

7.4.2 Known and Potential Impacts to Environmental Receptors

The known and potential impacts on air quality from atmospheric emissions will be a minor deterioration of local air quality due to the emissions of pollutants from the burning of hydrocarbons. Atmospheric emissions from the vessels, onboard equipment and incineration of wastes can cause a reduction in air quality in the localised area around the vessel(s). Greenhouse gas emissions such as these are linked to climate change, and atmospheric emissions are also related to a reduction in ambient air quality; leading to human health issues in populated areas such as pulmonary disease, cardiovascular disease and cancer (Steiner *et al*., 2016).

The volume of the emissions associated with this Otway Basin 2DMC MSS will centre on the survey vessel, and be relatively small in terms of the wider environment (~28 m^3 per day of fuel usage as per **Section 3.4.4**). Due to the open ocean nature of the Operational Area and the variable, moderate wind conditions the emissions from the survey vessels are likely to be quickly dispersed quickly into the atmosphere and will not impact on the onshore/nearshore interests/communities. In addition, the constant movement of the survey vessel will ensure that the discharge is not occurring in a single location for any significant period of time.

The main control measures (detailed below in **Section 7.4.3**) relate to the compliance with MARPOL Annex VI, and the use of MGO instead of Heavy Fuel Oil (**HFO**). It is considered that the consequence of this activity occurring is *Negligible*, with the likelihood of this consequence occurring being *Likely*. This results in a residual risk of **Negligible**.

7.4.3 Control Measures

The control measures that will be implemented during the Otway Basin 2DMC MSS to manage the impacts from atmospheric emissions to **ALARP** have been included in **Table 74**. These control measures have been assessed to consider the environmental benefit(s) gained through implementing the controls relative to their time, effort and monetary cost. SLB will make a clear delineation of those which will be implemented during the Otway Basin 2DMC MSS and those which won't, in particular where SLB considers their implementation is disproportionate to the environmental benefit gained. Justifications have been provided for each of these decisions.

Table 74 Assessment of Control Measures for Atmospheric Emissions

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
Compliance with: MARPOL Annex VI (Regulations for the Prevention of Air Pollution from Ships). Protection of the Sea (Prevention of Pollution from Ships) Act 1983. Marine Order 97 (Air Pollution): • Vessels >400 tonnes require a certificate to demonstrate that they comply with the requirement to prevent unnecessary air pollution; • The vessel engines do not emit excess NOx emissions; • Incinerators used are of an approved standard and it is operated correctly; • Vessels must comply with a plan for energy efficiency and implement a Ship Energy Efficiency Management Plan (**SEEMP**); • Vessels shall not emit excess sulphur emissions;	P = Yes E = Effective	It is a legislative requirement to meet the relevant aspects of MARPOL Annex VI, the PSPPS Act and Marine Order 97.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
• Noxious and toxic substances shall not be emitted through combustion of illegal substances; and • ODS shall not be deliberately released.				
Vessels will not utilise HFO.	P = Yes E = Effective	The vessels associated with the Otway Basin 2DMC MSS will be utilising MGO in order to reduce the pollutants from the combustion engines. MGO usually has less than 0.2% sulfur which aids in meeting the requirements of the legislation outlined in the control measure above.	Yes	Yes
Fuel consumption will be recorded and monitored for abnormal consumption, with corrective action taken if necessary	P = Yes E = Effective	While fuel consumption throughout the Otway Basin 2DMC MSS is inevitable, abnormal consumption results in additional atmospheric emissions as well as additional costs.	Yes	Yes
All combustion and incineration machinery will be appropriately maintained as per the manufacturer's guidelines.	P = Yes E = Effective	Routine maintenance ensures that machinery is running in accordance with the manufacturer's specifications, reducing excess emissions.	Yes	Yes
Only wastes approved by the vessel's Garbage Management Plan will be incinerated and no oil or other noxious substances will be incinerated	P = Yes E = Effective	Incineration of materials not approved by the Garbage Management Plan may lead to the release of toxic emissions and will not be compliant with MARPOL.	Yes	Yes
Incineration will only occur when the vessel is a distance greater than 12 NM from shore	P = Yes E = Effective	Incineration of wastes beyond 12 NM from shore will not result in any emissions that will make their way to shore, nor will any emissions be visible from shore.	Yes	Yes
Alternative Control Measures:				
No incineration on vessels	P = No E = Effective	Incineration of wastes on vessels is a standard industry practice and negates the need for additional visits from supply vessels to remove waste. The storage of wastes onboard the survey vessels have added risks to human health.	Yes	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Alternative fuels will be used to power vessels	P = No E = Effective	Alternative fuel sources include solar, wind, and biofuels. Such fuel sources have not been commercially proven for vessels such as those that will be used during the Otway Basin 2DMCMSS.	Yes	No
Non-essential machinery will be routinely shut-down on survey vessels	P = Yes E = Limited	Due to the limited benefit gained from shutting-down non-essential machinery, and the limited risk associated with atmospheric emissions, this control was determined to be unnecessary.	Yes	No
Eliminate atmospheric emissions during operation	P = No E = Effective	Vessels are required for the Otway Basin 2DMCMSS to collect data. Without vessels, the survey would not be able to occur.	Yes	No

7.4.4 Environmental Performance

The environmental performance outcomes for the effective management of environmental impacts from atmospheric emissions are:

- Reduce any discharge of emissions from combustion engines onboard the survey vessels so that they meet the performance standards, are compliant with relevant legislation and that any potential impact on the receiving environment is reduced to **ALARP**; and
- All discharge of emissions to the atmosphere during the survey (including GHG, NO_x, SO_x, CO, CO_2 and particulates) are complaint with relevant legislation.

This environmental performance outcome, through the implementation of the mitigation and control measures, will enable the ongoing environmental performance of the Otway Basin 2DMC MSS activity to adhere to, or improve on, the **Acceptable Levels** of risk described within **Section 7.4.7**. It is critical to the environmental performance of the project that all relevant legislation is complied with in order minimise the potential impacts from atmospheric emissions to **ALARP**.

The environmental performance standards within **Table 75** have been defined to manage the impacts from atmospheric emissions to **ALARP** and an **Acceptable Level**. Compliance with these standards will ensure that the identified environmental performance outcome above will be met for the duration of the Otway Basin 2DMC MSS.

Table 75 Environmental Performance Standard and Measurement Criteria for Atmospheric Discharges

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Compliance with MARPOL Annex VI (Regulations for the Prevention of Air Pollution from Ships), the Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and Marine Order 97 (Air Pollution).	All vessels used in the Otway Basin 2DMC MSS over 400 gross tonnage will hold an International Air Pollution Prevention Certificate (**IAPP Certificate**) as per the requirements of Marine Order 97 and MARPOL Annex VI.	IAPP Certificate is valid	Vessel Master
	The engines in the vessels used for the Otway Basin 2DMC MSS will meet the prescribed NOx emission levels set within Marine Order 97 and MARPOL Annex VI.	Vessel audit and/or inspection	Vessel Master
	The SOx content of the fuel used within the survey and support vessels will not exceed the limits set within Marine Order 97, the PSPSS Act and MARPOL Annex VI.	Bunker note or other evidence	Vessel Master
	All vessels used during the Otway Basin 2DMC MSS over 400 gross tonnage will have, and comply with, a SEEMP as per Marine Order 97 and MARPOL Annex VI.	SEEMP in place	Vessel Master
	Any Incineration onboard the vessels will be undertaken in accordance with Marine Order 97 and MARPOL Annex VI, including the prohibition of incinerating noxious and hazardous substances.	Vessel audit and/or inspection, Incineration Log	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
	An ODS Record Book will be maintained if the seismic vessel has a rechargeable system that contains ODS as per the PSPPS Act.	ODS Record Book	Vessel Master
	No ODS will be deliberately discharged during the Otway Basin 2DMC MSS, as per Marine Order 97, the PSPPS Act and MARPOL Annex XI.	ODS Record Book	Vessel Master
Vessels will not utilise HFO	MGO is the primary fuel for vessels associated with the Otway Basin 2DMC MSS, no HFO powered vessels will be used.	Bunker note	Vessel Master
Fuel consumption will be recorded and monitored	Fuel use will be recorded and monitored for excessive fuel consumption, with corrective action taken if necessary.	Daily report log	Vessel Master
Machinery will be regularly maintained	All combustion and incineration machinery will be appropriately maintained as per the manufacturer's guidelines.	Maintenance records confirm	Chief Engineer
Incineration of approved substances only	Only wastes approved by the vessel's Garbage Management Plan will be incinerated and no oil or other noxious substances will be incinerated.	Incineration Log	Vessel Master
Incineration will occur at distances greater than 12 NM from shore	Incineration will only occur when the vessel is a distance greater than 12 NM from shore.	Incineration Log	Vessel Master

7.4.5 Residual Risk of Impact

Following the implementation of the control measures within **Table 74**, the likelihood of a measureable impact on local air quality from atmospheric emissions is considered is *Likely*. The consequence from atmospheric emissions is considered *Negligible*, based on the discussions within **Section 7.4.2**.

Therefore using the risk matrix outlined in **Section 6.5**, the residual risk from atmospheric emissions, following the implementation of control measures (**Table 74**) is considered to be **Negligible** (**Table 76**).

Table 76 Residual Risk Summary for Atmospheric Emissions

Likelihood	Consequence	Residual Risk
Likely	Negligible	Negligible

7.4.6 Demonstration of ALARP

To demonstrate the potential impacts from atmospheric emissions are managed to **ALARP**, SLB has considered a number of control measures to assess the benefits of their implementation towards risk reduction (**Table 74**), based on a Hierarchy of Controls (**Table 77**). The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental impacts from atmospheric emissions from the vessels machinery and to ensure that all reasonable and practicable control measures or solutions have not been overlooked. As a result, through the application of industry best practice and/or comparable standards to further control risk reduction, it is considered that any impacts from atmospheric emissions will be reduced to **ALARP**, where the residual risk from adoption of these control measures is **Negligible** (**Table 76**).

Additional control measures were considered as part of the assessment process towards further risk reduction; however, it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 77 Hierarchy of Controls for Atmospheric Emissions

Eliminate	Fuel use and its associated atmospheric emissions cannot be eliminated as fuel is a fundamental requirement for the operation of the survey and support vessels. The deliberate discharge of ODS will be eliminated during the Otway Basin 2DMC MSS as outlined in **Table 74**.
Substitute	As outlined within **Table 74**, the survey and support vessels will use MGO to power their engines, rather than other fuels such as HFO. Although the cost of using MGO is high than that of HFO, the reduction in sulphur content is considered an important step in managing impacts to **ALARP**. No other alternative fuel sources are currently commercially viable for larger vessels.
Reduce	Similar to the discussion around substitution above, the use of MGO will reduce the contaminants discharged from the combustion engines on the vessels in order to meet the requirements of Marine Order 97, the PSPPS Act and MARPOL Annex VI.
Mitigate	The control measures within **Table 74** have been assessed to ensure that they mitigate the impacts from atmospheric emissions to **ALARP**. This is primarily done through the implementation of measures required under Marine Order 97, the PSPPS Act and MARPOL Annex VI.

The proposed control measures in **Table 74** to minimise the impact from atmospheric emissions are considered appropriate to the localised nature and scale of the potential environmental impacts during the Otway Basin 2DMC MSS. The proposed control measures are in accordance with industry best practice and relevant regulations. No further practicable controls have been identified that can be implemented that will effectively reduce the impact and risks to the atmosphere over and above what is proposed in **Table 74**.

As the impacts from the atmospheric emissions will be localised in nature, in combination with the scale of the Otway Basin 2DMC MSS, it is considered that the potential impacts from these atmospheric emissions have been reduced to **ALARP** and the residual risk is **Negligible** (**Table 76**).

7.4.7 Risk Acceptability

Total elimination of all impacts associated with atmospheric emissions cannot be achieved, as engines must be used onboard the vessel(s) and there are no practicable alternatives. Following the implementation of the control measures (**Table 74**) the potential impacts to the environment from atmospheric emissions are likely to be short-term given the spatial extent across the Operational Area that the vessel will move across.

The criteria for risk acceptability are provided in **Table 42** and the survey compliance with these criteria is detailed in the following sub-sections. The control measures that will be implemented during the Otway Basin 2DMC MSS have been developed in accordance with these criteria. Where uncertainty exists around the criteria or the risk, SLB have taken a precautionary approach.

7.4.7.1 Ecologically Sustainable Development

The management of the risk and impacts associated with atmospheric emissions proposed by SLB can be carried out in compliance with the five principles of ecologically sustainable development as defined within the EPBC Act (outlined within **Section 2.2**). These principles have been considered as part of the development of this EP and risk assessment process. The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

7.4.7.2 Legislative Requirements

As defined in **Table 74**, SLB will ensure the Otway Basin 2DMC MSS air emissions will comply with the relevant legislative requirements and applicable international conventions, including:

- MARPOL 73/78 Annex VI Prevention of Air Pollution by Ships;
- PSPPS Act, 1983 (Part IIID Prevention of Air Pollution);
- Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007;
- Marine Orders Part 97 (Marine Pollution Prevention – air pollution); and
- Marine Notice 11/2015 Measure to Reduce Greenhouse Gas Emissions from International Shipping.

7.4.7.3 Internal Context

The proposed management of atmospheric emissions is consistent with SLB's QHSE Policy shown in **Section 1.2**.

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

7.4.7.4 Industry Best Practice

The control measures outlined within **Table 74** are based on industry best practice and best practice guidelines, including:

- The IAGC Environmental Manual for Worldwide Geophysical Operations which provides guidance on engine emissions, including:
  - Ensuring vessels are fitted with appropriate emission monitoring and control systems to meet applicable flag state and vessel design class requirements;
  - Servicing of exhaust systems occurs on a regular basis to ensure that noise and emissions are kept to appropriate levels (no unburned fuels and exhaust gases to create localised pollution);
  - Require low-sulfur MGO; and
- The APPEA Code of Environmental Practice includes an objective to reduce greenhouse gas emissions to an **Acceptable Level** and reduce the risk of impacts to **ALARP**.

7.4.7.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** and **Appendix F**.

No sensitive receptors (i.e. populated areas) are within or near the Operational Area, and any impacts or risks from atmospheric emissions are likely be localised and short term.

During consultation with interested stakeholders no concerns were raised in regard to possible impacts from atmospheric emissions, and as such no additional control/mitigation measures were expected or put in place as a result. As such, the environmental impacts relating to atmospheric emissions from the seismic survey and support vessels were considered to be at a socially **Acceptable Level**.

7.4.7.6 Existing Environment Context

As outlined within **Section 7.4.2**, it is not considered that atmospheric emissions will result in a significant impact on environmental values or sensitivities, including the three KEFs (**Section 5.3.8**) and two Marine Parks (**Section 5.3.3**), within the Operational Area with the implementation of the control measures outlined within **Table 74**. Atmospheric emissions are not expected to pose a risk to the management objectives or conservation values for any protected species potentially found within the Operational Area. It is considered that the control measures will provide appropriate protection to the receiving environment and that the potential impacts and risks are at an acceptable level. Any additional or alternative control measures are not considered to provide any additional environmental protection or benefit.

7.4.8 Atmospheric Emissions Impact Summary

Based on the discussions above, including the potential impacts on the environment and the associated control measures to be implemented, the residual risk from atmospheric emissions from the survey and support vessels is considered **Negligible** and to **ALARP**. Therefore, the impacts and residual risk from this activity associated with the Otway Basin 2DMC MSS are considered to be at an **Acceptable Level**.

7.5 Artificial Light Emissions

7.5.1 Description of Source of the Impact

Suitable artificial lighting is required for the health and safety of crew onboard the seismic and support vessels (e.g. while operating at night) and is also mandatory for safe navigation of vessels underway at sea from sunset to sunrise in accordance with the COLREGS. A number of different navigation lights are required that are specific to that particular vessel and size, as well as whether the vessel is engaged in towing and restricted in its ability to manoeuvre.

The primary sources of artificial lighting in the offshore marine environment during the Otway Basin 2DMC MSS will result from deck and navigation lights onboard the seismic and support vessels. These vessels will be under way and making way at all times during the survey; therefore, the effects of this artificial lighting on the offshore marine organisms will tend be relatively transient in nature given the vessels will be travelling at approximately 4.5 knots and will result in comparably less disturbance to these organisms than fixed lighting sources.

7.5.2 Known and Potential Impacts to Environmental Receptors

There are two main ways artificial lighting is known to affect marine fauna; disorientation and behaviour modifications. These potential effects are detailed in the following sections in relation to the groups of fauna that are known to occur within or surrounding the Operational Area.

Artificial lighting on vessels at sea can attract and disorientate marine animals and affect their physiology (Davies *et al.,* 2014; Poot *et al*., 2008). The effects of artificial light can be particularly high for juvenile animals such as turtles and fledgling seabirds/novice flyers in coastal locations (Telfer *et al*., 1987), and artificial lighting has been linked to an increase risk of bird collision with vessels (particularly their rigging) (Black, 2005).

7.5.2.1 Marine Mammals

Many marine mammals have evolved specialised sight or acoustic techniques to enable successful hunting/prey capture in low light, while others are reliant on suitable levels of light and clear water to enable capture. Cetaceans for example use echolocation as their primary sense for locating and hunting prey, followed by visual means at close range (Simmonds *et al.*, 2004). Artificial lights that are fixed or stationary in the marine environment often attract aggregations of zooplankton and then baitfish and/or squid which are prey for species of pinnipeds and dolphins that take advantage of these aggregations for feeding (Golder, 2007). Increased amounts of light at night in the marine environment can also possibly be detrimental to marine mammals by allowing predators to more easily see the mammals during normally dark night times. However, a number of studies have been undertaken on the effects of artificial lighting from oil and gas exploration activities in the Great Australian Bight Marine Park on sea lions and cetaceans, and concluded that any impacts would be insignificant (Pidcock *et al*., 2003), and similar studies in NW Australia and Canada have found no evidence that cetacean feeding and breeding was being impacted from offshore installations (BHP Billiton, 2005).

The residual risk of artificial light emissions on marine mammals from vessels associated with the Otway Bsin 2DMC MSS has been assessed as **Negligible** (*minor* x *unlikely*).

7.5.2.2 Seabirds

Seventeen species of seabird have BIAs that overlap with the Operational Area (see **Section 5.2.8**), with seven of these having known breeding sites inshore of, and in close proximity to the Operational Area; including the Australasian gannet, black-faced cormorant, common-diving petrel, little penguin, short-tailed shearwater, shy albatross, white-faced storm petrel. The closest breeding colonies (Australasian Gannet) lie approximately 13 km from the nearest edge of the Operational Area.

Seabirds are known to commonly strike vessels lit with artificial light at night, particularly vessels with significant exposed rigging/lines. Artificially lit installations, vessels or structures also act to attract seabirds, particularly in otherwise dark areas and for migratory birds travelling at night (Poot *et al.*, 2008). From SLB's previous offshore seismic surveys in New Zealand and Australia, there have been no bird strikes during the night (*Expert 4 – Sensitive Information*).

As stated in the previous section on marine mammals, marine organisms such as zooplankton and small fish are often attracted to artificial light sources and these aggregations can create an enhanced food source for seabirds (Rich & Longcore, 2006) However, as the survey vessels will be continuously moving during the survey the attraction of zooplankton and baitfish will be highly unlikely to occur, particularly in comparison to fixed lighting sources (e.g. lighthouse, platforms, bridges, etc.).

The residual risk of artificial light emissions on seabirds from vessels associated with the Otway Basin 2DMC MSS has been assessed as **Low** (*minor* x *unlikely*).

7.5.2.3 Marine Reptiles

As discussed in **Section 5.2.5**, the loggerhead, green, leatherback, hawksbill and flatback species of turtle have been reported in southern Australian waters. Two of these species, the loggerhead and leatherback, have distributions which may include the Operational Area and are both listed under the EPBC Act as endangered. Neither of the species have known nesting areas along the coast inshore of the Operational Area, but are both migratory, with the leatherback a regular visitor in these areas and the loggerhead rarely seen in the area.

Light cues from natural sources are used by both juvenile and adult turtles for navigation. Adult turtles prefer to nest in areas well away from human habitation, where the beaches are darkened, thus artificial lighting can deter turtles from approaching an area where they may have previously nested reducing the number of nests (Davies *et al*., 2014; Deda *et al.*, 2007; EPA, 2010) and beyond this the number of juveniles in such areas. Post hatching juvenile turtles need to make their way to the ocean and use visual cues to do so.

Artificial lighting can disorientate the juveniles sending them in the wrong direction which could lead to delays or even failure to reach the water, risking greater chances of predation or desiccation (Davies *et al*., 2014, Deda *et al*., 2007). However, offshore light sources will influence newly hatched juvenile turtles less than sources onshore, as offshore sources will attract the juveniles towards the ocean post hatching (Pendoley, 2005). Once at sea, juveniles continue to follow visual clues to navigate away from land and remain in the surface waters. Here, artificial light emissions can distract/disorientate the juveniles and lead them to follow false clues that limit dispersion and the same artificial lighting can make them more visible to predators in the water (Salmon *et al.*, 1992).

The Environmental Protection Authority (**EPA**) *Environmental Assessment Guide No. 5 – Protecting Marine Turtles from Light Impacts* (EPA, 2010); the *Recovery Plan for Marine Turtles in Australia 2017-2027* (Commonwealth of Australia, 2017a) and the DoEE Species Profile and Threats Database have been considered as part of the preparation of this EP, and do not identify artificial light from vessels underway in the offshore marine environment as creating a risk for turtles. The EPA recommends that a darkness zone of at least 1.5 km from all significant rookeries be maintained in order to mitigate against any potential effects from lighting. Given no known breeding/nesting areas for turtles exist along the coastline inshore of the Operational Area, and the fact that the Operational Area is located beyond 1.5 km from the coastline, it is considered there are no further requirements to be placed on seismic operations to minimise any potential impacts on turtles.

As the Operational Area does not lie in a marine reptile nesting area, and therefore is not of particular importance for more sensitive juveniles, the residual risk of artificial light emissions on marine reptiles from the vessels associated with the Otway Basin 2DMC MSS has been assessed as **Negligible** (*negligible* x *rare*).

7.5.3 Control Measures

The control measures that will be implemented during the Otway Basin 2DMC MSS to manage the impacts from artificial light emissions to **ALARP** have been included in **Table 78**. These control measures have been assessed to consider the environmental benefit(s) gained through implementing the controls relative to their time, effort and monetary cost. SLB will make a clear delineation of those which will be implemented during the Otway Basin 2DMC MSS and those which won't, in particular where SLB considers their implementation is disproportionate to the environmental benefit gained. Justifications have been provided for each of the decisions.

Table 78 Assessment of Control Measures for Artificial Light Emissions

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
Directional Lighting: Outwards facing lighting reduced to minimum levels as required. Navigation lighting to be compliant with the COLREGS for safe passage at sea and specific to each vessel and the activities it is conducting. Deck/work lighting aimed inboard/downwards wherever possible, amount of lighting and duration lighting operating reduced to minimum level to safely allow deck operations to occur. Exceptional cases in event of an emergency.	P = Yes E = Effective	Outward facing lighting is required for navigation/safety/visibility at sea. Work lighting (e.g. in deck areas) will be directed inward as much as possible but still needs to supply minimum adequate lighting for safe working conditions for all areas where crew are operating on deck.	Yes	Yes
Separation Distances: The Otway Basin 2DMC MSS will be undertaken outside of Coastal Waters (i.e. a minimum distance of 3 NM (5.5 km) offshore will be maintained) to reduce potential impacts on seabird breeding/nesting sites and turtle rookeries.	P = Yes E = Effective	Remaining well offshore away from the coastline, particular in areas where known seabird breeding/nesting sites exist, during the operational phase of the survey reduces potential for vessel lighting to attract, distract or disorientate seabirds, which could result in incidences of vessel-strike. However, this control measure does not apply for the passage to and from port for crew changes, resupplies or sheltering from adverse weather as the vessels are no different to any other commercial maritime vessel working at sea.	Yes	Yes
Alternative Control Measures:				
Eliminate lighting	P = No E = Very Effective	Adequate lighting is required for safe work of all crew onboard the vessels and navigation lighting is required for collision avoidance and visibility at sea. Safety costs are disproportionate to benefits.	Yes	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Inward/downward facing lighting only	P = Partial E = Effective	Outward facing lighting is required for navigation/safety/visibility at sea, in accordance with the COLREGS. It is a regulatory requirement to have appropriate navigation lighting on all vessels from sunset to sun rise. However, there is benefit to ensuring deck/work lighting is inward/downward facing to reduce light spill as far as practicable, see directional lighting control measure above.	Yes	Partially See directional lighting above.
No acquisition during darkness hours	P = No E = Partial	This measure would effectively double the time to acquire the Otway Basin 2DMC MSS, which would take the survey into the more unsettled months of weather, would miss timing deadlines for survey acquisition and would result in increasing the time the survey vessel is in the Operational Area which would increase potential conflict and displacement with commercial and recreational fishers. Vessel would still be remaining at sea during the darkness times and would still have to display navigation lighting and provide safe amounts of deck lighting for its crew even if not acquiring data. Costs disproportionate to benefits.	Yes	No
Data acquisition only occurring outside of turtle nesting and/or seabird nesting/fledging periods	P = No E = Partial	As outlined in **Section 7.5.2.3**, the Operational Area is located over 5.5 km (due to it being outside of Coastal Waters) from any known turtle breeding areas. The wider South East Marine Region is an important feeding area for leatherback turtles, so it is considered that any individuals encountered are likely to be transiting the area which should not be significantly affected from the survey given the relatively short duration in each particular area to acquire a survey line and the transient nature of the survey vessel as it moves throughout the Operational Area. Six seabird species have known breeding sites inshore of the Operational Area. Most of these species are present in Operational Area year-round (white faced storm petrel being the exception as it is present September to February). Breeding/nesting tends to occur from late winter/spring through to mid-summer.	Yes	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
		As discussed within **Section 7.5.2**, the light source will constantly be moving; any attraction of marine organisms would be highly unlikely, particularly in comparison to a fixed light source. Therefore, any minor environmental gains from limiting data acquisition periods to outside of the period from July to February would be at a disproportionally increased cost to the survey.		
Use lighting sources with wavelengths that are less disruptive to marine organisms	P = No E = No	Given the large variety of marine organisms that may be present, and that their varying sensitives to different light wavelengths, this control measure is not regarded as being practical and is likely to be of minimal overall benefit.	Minimal	No

7.5.4 Environmental Performance

The environmental performance outcomes for the management of environmental impacts from artificial light emissions are:

- Reduce the potential adverse impacts on marine fauna from the Otway Basin 2DMC MSS to **ALARP** whilst still maintaining operational and navigation lighting in compliance with relevant regulations (i.e. COLREGS); and
- Excluding emergency situations, external lighting on seismic and support vessels will be reduced to the minimum required for safe navigations, safe deck operations and vessel safety.

The environmental performance outcome, as a result of the implementation of the mitigation and control measures, will allow the ongoing environmental performance of this activity to adhere to, or improve on, the **Acceptable Levels** described within **Section 7.5.7** whilst ensuring that the relevant legislation is complied with in order to avoid any health and safety risks as far as practicable.

The environmental performance standards within **Table 79** have been defined to manage the impacts from artificial light emissions to **ALARP** and an **Acceptable Level**. Compliance with these standards will ensure that the identified environmental performance outcome above will be met throughout the duration of the Otway Basin 2DMC MSS.

Table 79 Environmental Performance Standard and Measurement Criteria for Artificial Light Emissions

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Directional lighting	Non-essential lighting will be switched off when not in use, and those that are in use will be directed inboard and onto the deck where possible. Essential navigation lighting to maintain compliance with COLREGS and Marine Order 30 is required.	Pre-mobilisation audit and inspection prior to operations beginning, along with crew inductions.	Vessel Master
Separation distances	Survey vessel will go no closer than 3 NM (5.5 km) from shoreline during the operational/acquisition phase of survey (i.e. does not apply to the vessels steaming into/out of port).	Digital records such as AIS tracking show seismic and support vessels remain greater than 3 NM (5.5 km) from the shoreline.	Vessel Master

7.5.5 Residual Risk of Impact

Following the implementation of the control measures in **Table 78**, the likelihood of artificial light emissions having any impact on marine organisms and seabirds is *Unlikely*. The consequence from artificial light being emitted from the survey and support vessels is considered *Minor*, based on the discussions within **Section 7.5.2**.

Therefore, using the risk matrix outlined in **Section 6.5**, the residual risk of an impact occurring from artificial lights onboard the survey and support vessels, following the implementation of control measures (**Table 78**), is considered to be **Low** (**Table 80**).

Table 80 Residual Risk Summary for Artificial Light Emissions

Likelihood	Consequence	Residual Risk
Unlikely	Minor	Low

7.5.6 Demonstration of ALARP

To demonstrate the potential impacts from artificial light emissions are managed to **ALARP**, SLB has considered a number of control measures to assess the benefits of their implementation towards risk reduction (**Table 78**), based on a Hierarchy of Controls (**Table 81**). The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental impacts from artificial light emissions from the vessel and assessments have been undertaken to ensure that all reasonable and practicable control measures or solutions have not been overlooked. As a result, through the application of industry best practice and/or comparable standards to further control risk reduction, it is considered that any impacts from artificial light emissions will have been reduced to **ALARP**, where the residual risk of an impact from adoption of these control measures is **Low** (**Table 80**).

Additional control measures were considered as part of the assessment process towards further risk reduction; however, it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 81 Hierarchy of Controls for Artificial Light Emissions

Eliminate	Collision prevention and maritime regulations require specific navigation lighting to be implemented, and provision of safe working conditions at night from suitable deck lighting is required to minimise any health and safety incidents. As a result, artificial light emissions cannot be completely eliminated.
Substitute	Navigation lighting cannot be substituted given the COLGREGs, and sufficient work lighting cannot be substituted either.
Reduce	Work lighting will be extinguished wherever possible when not required, and as far as practicable work lighting will be focused inwards.
Mitigate	Control measures have been assessed within **Table 78** in order to mitigate the impacts from artificial light emissions to **ALARP** levels. Those which are appropriate and are not impracticable or unfeasible due to disproportionately large costs will be implemented during the Otway Basin 2DMC MSS.

The proposed control measures minimise the risk of impact from artificial light emissions and are considered appropriate to the localised nature and scale of potential environmental impacts during the Otway Basin 2DMC MSS. The proposed control measures are in accordance with industry best practice. No further practicable controls have been identified to reduce the impact and risks to the marine environment and/or marine organisms from artificial lighting.

Given the relatively localised nature of effects from artificial light emissions around the seismic and support vessels, combined with the large Operational Area and distance offshore, it is considered that the potential impacts from artificial light emissions are reduced to **ALARP**.

7.5.7 Risk Acceptability

Total elimination of all impacts associated with artificial lighting emissions cannot be achieved, as lighting must be used onboard the vessel(s) and there are no practicable alternatives. Following the implementation of the control measures (**Table 78**) the potential impacts to the marine environment and associated receptors from artificial light emissions are likely to be short term given the spatial extent across the Operational Area that the vessel will move across.

The criteria for risk acceptability is provided in **Table 42** and these criteria are detailed in the following sections, where the control measures that will be implemented throughout the Otway Basin 2DMC MSS have been developed in accordance with these criteria. Where uncertainty exists around the criteria or the risk, SLB have taken a precautionary approach.

7.5.7.1 Ecologically Sustainable Development

The management of the risk and impacts associated with artificial light emissions proposed by SLB can be carried out in compliance with the five principles of ecologically sustainable development as defined within the EPBC Act (outlined in **Section 2.2**). These principles have been considered as part of the development of this EP and risk assessment process. The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

7.5.7.2 Legislative Requirements

The control measures for light emissions from the Otway Basin 2DMC MSS in **Table 78** will comply with the relevant legislative requirements (i.e. COLREGS) and will also be consistent with the following relevant standards/documents:

- The Recovery plan for marine turtles recommends that best practice light management is undertaken to minimise light impacts to marine turtles, so their behaviours are not changed, and they do not become displaced from important habitats. As discussed in **Section 7.5.2.3** there are no known breeding/nesting areas for turtles long the coastline inshore of the Operational Area, which will also be situated at least 3 NM (5.5 km) from shore. The lighting control measures and transient nature of the survey mean that the planned survey approach is compliant with the objectives of the marine turtle recovery plan;
- A darkness zone of at least 1.5 km from all significant rookeries is stated within the EPA Guideline #5 - Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts (EPA, 2010). As per the above, given that there are no known turtle rookeries inshore of the Operational Area and the minimum distance to shore from the Operational Area is 6.2 km, 11 km to the nearest tie line and 22 km to the nearest non-tie line, the Otway Basin 2DMC MSS is compliant with these EPA guidelines;
- The Conservation advice notice for the soft-plumaged petrel shows that although this critically endangered species may possibly be present within the southern part of the Operational Area, its two known breeding locations are located well to the south, with the nearest location being Maatsuyker Island at the southern coast of Tasmania. The advice note does not list any recommended conservation/management actions which might relate to the seismic survey; however, the 411 km separation distance of the Operational Area and this important breeding location will reduce any impacts to **ALARP**;

- The national *Recovery Plan for Threatened Albatrosses and Giant Petrels 2011 – 2016*, has details relevant to southern and northern giant petrels, and the Antipodean, Campbell, Buller's, Indian yellow-nosed, shy, wandering, and Gibson's albatrosses, which are all known to occur within the planned Operational Area. However, the recovery plan does not mention risks/impacts of light emissions on these species; and
- Legislated requirements for safe working conditions will be met.

7.5.7.3 Internal Context

The proposed management of the impact/risks from artificial light emissions are within **Acceptable Levels** of SLB's Environmental and QHSE Policy shown in **Section 1.2**.

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

7.5.7.4 Industry Best Practice

The control measures outlined in **Table 78** to decrease artificial light emissions are based on industry best practice and best practice guidelines, including:

- The IAGC Environmental Manual for Worldwide Geophysical Operations. Geophysical vessels must ensure that their emissions are kept to appropriate levels; and
- The APPEA Code of Environmental Practice. Details within this document relate mainly to offshore operations such and offshore exploration/drilling and production facilities where light emissions are recommended to be reduced to **ALARP** and **Acceptable Levels**. Thus, a similar expectation could be expected of seismic vessels operating in offshore areas.

7.5.7.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** and **Appendix F**.

During consultation with interested stakeholders no concerns were raised in regard to possible impacts from artificial light emissions, and as such no additional control/mitigation measures were expected or put in place as a result. As such the environmental impacts relating to light emissions from seismic survey and support vessels were considered to be at a socially **Acceptable Level**.

7.5.7.6 Existing Environment Context

Given that the seismic and support vessels involved in the Otway Basin 2DMC MSS will be constantly moving and the relatively low amounts of artificial light emissions that will come from the vessels, the impacts to the marine environment from artificial light emissions is likely to be short term, highly localised, and quickly recoverable.

The survey vessels will be moving at 4 – 5 knots so any lighting will be highly unlikely to congregate plankton/baitfish and therefore unlikely to attract marine mammals or seabirds to seek out the vessels in hope of finding feeding opportunities caused by light emissions.

While the Operational Area does overlap with the BIA of several important seabird species (listed in **Table 22**), the levels of light emission will be similar or less (with mitigation measures in place) than what currently occurs from maritime traffic in the area associated with coastal shipping and fishing.

The proposed control measures provide appropriate protection to the marine environment from light emissions, and further/alternative control measures (such as no night time acquisition) would give very little or no further protection from light emissions while greatly increasing time and cost of the survey and also increase the potential conflict and displacement with the fishing industry.

7.5.8 Artificial Light Emission Impact Summary

Based on the discussions above, including the potential impacts on the environment and the associated controls measures to be implemented, the impact of artificial lights being emitted from the survey and support vessels is considered to be **Low** and reduced to **ALARP**. Therefore, the impacts and associated residual risk from this activity associated with the Otway Basin 2DMC MSS are considered to be at an **Acceptable Level**.

8 Environmental Risks from Unplanned Activities

Unplanned activities are those that are non-routine and tend to be rare during seismic survey operations. However, the potential risks of any unplanned events must be given serious consideration as their consequences can be severe.

The potential unplanned activities associated with the Otway Basin 2DMC MSS include:

- Introduction of invasive marine species (**Section 8.1**);
- Streamer loss (**Section 8.2**);
- Vessel collision or sinking and associated hydrocarbon spill (**Section 8.3**);
- Hydrocarbon response options (**Section 8.4**); and
- Accidental release of hazardous and non-hazardous materials (**Section 8.5**).

This section of the EP goes through the impact and risk evaluation for each of the unplanned activities listed above that could potentially be associated with the Otway Basin 2DMC MSS, for each of the receptors of relevance within the Operational Area and wider environment should such an incident occur, using the methodology described within **Section 6**. This evaluation will demonstrate that the impacts and risks associated with the Otway Basin 2DMC MSS will be reduced to **ALARP** and will be of an **Acceptable Level** largely through the implementation of extensive control measures, operational procedures and operating to industry best practice.

8.1 Invasive Marine Species

8.1.1 Description of Source of the Risk

Invasive marine species (**IMS**) are foreign marine aquatic plants and animals that have managed to colonise and establish new populations in areas where they are not naturally found. IMSs are typically carried as larvae or juveniles on international vessels, either in niche areas on vessel hulls or in their ballast and/or bilge water. Not all introduced species successfully colonise new environments since most species have well defined tolerances to environmental conditions, such as water temperature, salinity, sunlight exposure, etc. However, if the source environment and the destination environment are sufficiently similar, larvae may successfully establish new colonies which may outcompete and/or predate on native species, causing environmental impacts that are often difficult to control.

For an IMS to become established, there are various conditions which must be met, including surviving the introduction process, having the ability to form resting stages, life-history strategy with pelagic larval dispersal or direct development, having a high reproductive rate, ability to overcome abiotic factors and adopt to a new trophic niche and ability of the recipient environment to prevent or facility survival and establishment (Streftaris *et al.*, 2005).

An introduced species is only considered 'invasive' once it begins to cause negative consequences on its new environment (Bax *et al.*, 2003) and once established, marine pests are usually difficult to manage or eradicate (Fletcher *et al.*, 2017).

The introduction and spread of marine pests or invasive species to Australian waters during seismic surveys could occur due to international movements of the seismic vessel and/or the support vessel, and inter-regionally when the vessels operate between different Australian ports or marine regions.

8.1.2 Known and Potential Risk to Environmental Receptors

In the unlikely event of a successful introduction of an IMS, the introduced species can out-compete and/or displace native species, leading to an increase in predation and possible depletion of native flora and fauna. The potential consequence of this establishment can flow through the trophic structure and affect commercially important species and aquaculture, along with other potential impacts on other marine users which is discussed further in **Section 8.1.3**.

The risk of an IMS establishing itself as part of this application is no different than the various shipping operations (e.g. commercial shipping, cruise ships etc.) that occur within the wider Otway Basin. These vessel movements are regulated by a number of legislative requirements which are considered to be industry best practice. These requirements have been utilised to form the basis of the control measures outlined in **Section 8.1.4** below. It is considered that the risk of introducing IMS as part of this proposal is **Moderate** (*severe x rare*) due to the implementation of industry best practice.

8.1.3 Known and Potential Risk to Stakeholders and Other Marine Users

Potential risks from the establishment of an IMS to stakeholders and other marine users include:

- Impacts on human health through presence and/or release of toxins or toxic tissues;
- Predation (leading to depletion) and competition with commercial stocks including wild fisheries and aquaculture, and/or impacts to habitats of commercial species;
- Nuisance biofouling causing damage and/or smothering of industrial marine equipment or local infrastructure;
- Impacts to shipping; and
- Reduction of aesthetics in coastal environment and/or water column.

A number of identified stakeholders and other marine users associated with the Otway Basin 2DMC MSS Operational Area rely on the presence and use of native flora and fauna. As outlined above, in the unlikely event of the establishment of an IMS, these native flora and fauna could be displaced either through direct establishment of the IMS or through increased predation, competition, etc.

The residual risk introducing IMS during the Otway Basin 2DMC MSS has been assessed as **Moderate** (*severe* x *rare*). Overall, it is considered that the risk of this establishment is reduced to **ALARP** through the implementation of the control measures included within **Table 82**.

8.1.4 Control Measures

Control measures that will be put in place during the Otway Basin 2DMC MSS to manage the potential risk/impacts associated with IMS have been listed in **Table 82**. The listed control measures that will be adopted are those that have been assessed and it was considered that the sacrifice (in terms of time, cost and/or effort) was not grossly disproportionate to the environmental benefits gained.

Table 82 Assessment of Control Measures for Invasive Marine Species

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
Internationally sourced ballast water will not be discharged within 12 NM of emergent land or in water <50 m deep and preferably beyond 200 NM from nearest land in water >200 m deep. Ballast waters sourced from Australian waters may be discharged within 12 NM of emergent land or in water <50 m deep (including ports/harbours)	P = Yes E = Effective	Adherence to this control measure will enable compliance with the Department of Agriculture and Water Resources 'Ballast Water Management Requirements, 2017'. Compliance with these requirements will reduce the risk of potential IMS from establishing within the Otway Basin from the discharge of ballast water.	Yes	Yes
Ballast Water Management Plan in place in accordance with Regulation B-1 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments	P = Yes E = Effective	As each ship is different, so are ballast water management practices. As such, having a Ballast Water Management Plan appropriately maintained for each relevant vessel is important so that the potential for the introduction and establishment of IMS is reduced to **ALARP**.	Yes	Yes
Effective anti-fouling systems and management practices are adopted for each vessel	P = Yes E = Effective	Anti-fouling paint systems are one of the primary methods for preventing the establishment and translocation of fouling species. Therefore, having an effective anti-fouling system in place onboard the survey and support vessels will reduce the potential for IMS to attach to the vessels, and subsequently establish in new areas. Each vessel to have documented anti-fouling management procedures, involving periodic in-water and/or dry-dock inspections.	Yes	Yes
All vessels will have 'clean' hull and niche areas upon arrival	P = Yes E = Effective	Checking or evidence of recent inspection that the vessel hulls and niche areas are clean prior to arrival within the Operational Area will reduce the likelihood of any IMS travelling with the vessel en-route to the area. Due to this fact, the ability for an IMS to establish itself due to the proposed activities will be reduced to **ALARP**.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Survey equipment to be cleaned and dried prior to use in the Operational Area	P = Yes E = Effective	As per the above, checking that equipment proposed to be used for the Otway Basin 2DMC MSS is clean prior to use will reduce the potential for IMS to be transferred into the area and ensure the management of these risks are **ALARP**.	Yes	Yes
Implementing a Biofouling Risk Assessment tool (similar to that required by Western Australia Department of Fisheries)	P = Yes E = Effective	Similar seismic surveys conducted in Western Australia used the Department of Fisheries biofouling risk assessment tool (https://vesselcheck.fish.wa.gov.au/) to demonstrate that all reasonable measures to minimise IMS transfer had been undertaken. The costs associated with developing and implementing such a tool is low, particularly compared to cost of a potential IMS introduction/establishment	Yes	Yes
Reporting sighting or suspicion of any IMS on vessel(s), in niche areas or in ports/harbours	P = Yes E = Effective	Reporting of any sighted or suspected IMS will allow an effective response to the presence of IMS and reduce the risk of further establishment of that species. Therefore, if an IMS is sighted or suspected, SLB will report this within 24 hours by email (biosecurity@fish.gov.au) or telephone (Fishwatch tel. 1800 815 507).	Yes	Yes
Alternative Control Measures:				
Ballast the vessel using only finely filtered water or freshwater	P = No E = Partly Effective	Ballast water requirements change frequently and supplying the required large volumes of finely filtered seawater, or freshwater is either not possible quickly enough, or would require large redesign of vessel(s) to create enough storage. Making freshwater, and/or filtering seawater requires a large amount of energy, decreasing efficiency and sustainability. Therefore, the costs are disproportionate to benefits. Using 'local' water as ballast provides an effective means of reducing IMS introductions to **ALARP**.	Yes	No
Source survey vessel within Australia	P = No E = Partly Effective	Still a risk of an undetected IMS being present on/near the vessel at its Australian Port. Additional time and resources required to find and assess suitable vessels within Australia, if any are present and available. Costs are disproportionate to benefits.	No	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Niche areas and deployed equipment built/redesigned to reduce IMS attachment or stowage	P = No E = Effective	Design of vessels, niche areas and the seismic equipment make them as efficient as possible at their task. Additional redesign adds significant cost and may decrease the efficiency of equipment. Even the addition of some antifouling coatings can affect performance of sensitive equipment. Costs are disproportionate to benefits.	Minor	No

8.1.5 Environmental Performance

The environmental performance outcomes for the management of IMS are:

- No introduction or establishment of any IMS during the Otway Basin 2DMC MSS;
- Enable control measures to avert the introduction and establishment of IMS in the Otway Basin marine environment from ballast water exchange within the Operational Area; and
- Enable control measures to avert the introduction and establishment of IMS in the Otway Basin marine environment from seismic and support vessel biofouling on the hull, niche areas and survey equipment.

The environmental performance outcome, as a result of the implementation of the mitigation and control measures, will allow the ongoing environmental performance of this activity to adhere to, or improve on, the **Acceptable Levels** described within **Section 8.1.8** whilst ensuring that the relevant legislation is complied with in order to avoid any health and safety risks as far as practicable.

The environmental performance standards within **Table 79** have been defined to manage the impacts from IMS to **ALARP** and an **Acceptable Level**. Compliance with these standards will ensure that the identified environmental performance outcome above will be met throughout the duration of the Otway Basin 2DMC MSS.

Table 83 Environmental Performance Standard and Measurement Criteria for Invasive Marine Species

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Ballast water discharge restrictions	Ballast water discharges must comply with the relevant requirements of the Biosecurity Act 2015 and Australian Ballast Water Management Requirements (2017). Internationally sourced ballast water will not be discharged within 12 NM of emergent land or in water <50 m deep and preferably beyond 200 NM from nearest land in water >200 m deep. Internationally sourced ballast water will be replaced with 'local' ballast water prior to the seismic vessel arriving within the Otway Basin 2DMC MSS Operational Area. Ballast water exchange will be conducted offshore in accordance with the distance and water depth limits indicated in the above paragraph. Ballast waters sourced from Australian waters may be discharged within 12 NM of emergent land or in water <50 m deep (including ports/harbours).	All Ballast Water exchanges recorded in Ballast Water Logbook. Approved Ballast Water Treatment system onboard and certification of approval held on vessel. Biosecurity Clearance attained from Department of Agriculture and Water Resources using the Maritime Arrivals Reporting System.	Vessel Master
Ballast Water Management Plan	A Ballast Water Management Plan is maintained in accordance with Regulation B-1 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments	Copy of Approved Ballast Water Management Plan onboard each vessel.	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Anti-fouling system	Vessel anti-fouling systems are maintained in compliance with international Convention on the Control of Harmful Anti-fouling Systems on Ships.	Vessel Pre-mobilisation inspection/audit checks for current International Anti-fouling System Certificate.	Vessel Master
All vessels will have 'clean' hull and niche areas upon arrival	Vessel will have had recent dry-docking or IMS hull inspection and show certification	Vessel Pre-mobilisation inspection/audit for IMS Inspection certificate and dry-dock and/or anti-fouling application certification.	Vessel Master
Survey equipment to be cleaned and dried prior to use in the Operational Area	All seismic survey equipment deployed from vessel (e.g. streamers, birds, tail-floats, etc.) must be thoroughly cleaned, and then dried for at least 24 hours prior to being deployed in the Operational Area for the first time	Onboard records of equipment maintenance and cleaning	Vessel Master
Biofouling Risk Assessment tool	Completion of the Department of Fisheries Vessel Check biofouling risk assessment tool: https://vesselcheck.fish.wa.gov.au/ with any actions required from this assessment being completed	Biofouling Risk Assessment Report received once Vessel Check completed	Vessel Master
Report sighting or suspicion of any IMS on vessel(s), in niche areas, and in ports/harbours	Suspected or confirmed presence of any marine pests or disease must be reported to authorities within 24 hours by email (biosecurity@fish.gov.au) or telephone (Fishwatch tel. 1800 815 507).	Incident reporting form, records of communication	Vessel Master

8.1.6 Residual Risk

Following the implementation of the control measures in **Table 82**, the likelihood of the establishment of an IMS is *Rare*. The consequence from the establishment of an IMS is considered *Severe*, based on the discussions within **Section 8.1.2**. Therefore, using the risk matrix outlined in **Section 6.5**, the residual risk of an impact occurring from the establishment of an IMS following the implementation of control measures (**Table 82**), is considered to be **Moderate** (**Table 84**).

Table 84 Residual Risk Summary for Invasive Marine Species

Likelihood	Consequence	Residual Risk
Rare	Severe	Moderate

8.1.7 Demonstration of ALARP

To demonstrate that any potential risks from the establishment of an IMS are managed to **ALARP**, a number of control measures have been considered to determine the benefits of their implementation and to ensure continual risk reduction (**Table 82**), based on a Hierarchy of Controls methodology (**Section 6.6**) as summarised in **Table 85**. The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental risks from the establishment of an IMS arriving on one of the survey vessels and assessments have been undertaken to ensure that reasonable and practicable control measures or solutions have not been overlooked. As a result, through the application of industry best practice and/or comparable standards to further control risk reduction, it is considered that any impacts from an IMS establishing or being introduced to Australian waters are reduced to **ALARP**, where the residual risk is **Moderate** (**Table 84**).

Additional control measures were considered as part of the assessment process towards further risk reduction; however, it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 85 Hierarchy of Controls for Invasive Marine Species

Eliminate	The main way to completely eliminate the risk of the establishment of IMS is by eliminating the transportation mechanism, i.e. the vessel. However, the Otway Basin 2DMC MSS cannot be conducted without the use of a seismic vessel.
Substitute	As per the above, there are no practicable substitutes for gathering the data, apart from a survey vessel undertaking the seismic survey.
Reduce	Control measures to reduce the risk of the establishment of IMS have been detailed within **Table 82**. These include restriction to the discharge of ballast water, adequate anti-fouling systems and cleanliness of the vessels undertaking the seismic survey.
Mitigate	Control measures have been assessed within **Table 82** in order to mitigate the risks of an IMS establishing within the Operational Area. Generally speaking, the risks of unplanned activities should be eliminated, substituted or reduced, with mitigation primarily used for those activities in which impacts will occur. However, SLB will report any sighting or suspicion of IMS as per the measure outlined in **Table 82** in order to mitigate the potential impacts to **ALARP**.

The proposed control measures minimise the risk of establishment of an IMS and are considered appropriate to the localised nature and scale of potential environmental impacts during the Otway Basin 2DMC MSS. The proposed control measures are in accordance with industry best practice. No further practicable controls have been identified to reduce the impact and risks to the marine environment and/or marine organisms from establishment of an IMS.

Given the unlikely event of the establishment of an IMS, along with the control measures outlined within **Table 82**, it is considered that the potential risk of the establishment of an IMS has been reduced to **ALARP**.

8.1.8 Risk Acceptability

Complete elimination of the risk of IMS is not possible as the Otway Basin 2DMC MSS will require the use of vessels and deployed equipment which could be subject to biofouling, and ballast water will be required for each vessel to operate safely and efficiently. Following the implementation of the control measures detailed in this assessment (**Table 82**), the residual risks to the marine environment and associated receptors from establishment of IMS is **Moderate** (**Table 84**).

The criteria for risk acceptability is defined in **Table 42** and detailed in the following sub-sections, where the control measures that will be implemented throughout the Otway Basin 2DMC MSS have been developed in accordance with these. Where uncertainty exists around the criteria or the risk, SLB have taken a precautionary approach.

8.1.8.1 Ecologically Sustainable Development

The management of the risk proposed by SLB associated with the introduction of IMS can be carried out in compliance with the five principles of ecologically sustainable development as defined within the EPBC Act (outlined within **Section 2.2**). These principles have been considered as part of the development of this EP and risk assessment process. The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

8.1.8.2 Legislative Requirements

The proposed control measures for IMS introduction and establishment during the Otway Basin 2DMC MSS are consistent with the following relevant standards/documents:

- Biosecurity Act 2015;
- Australian Ballast Water Management Requirements 2017;
- International Convention for Control & Management of Ship Ballast Water & Sediments 2004;
- National System for the Prevention and Management of Marine Pest Incursions;
- IMO Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species; and
- Anti-fouling and In-Water Cleaning Guidelines.

8.1.8.3 Internal Context

The proposed management of the risks of establishment of IMS and its associated impacts are within **Acceptable Levels** of SLB’s Environmental and QHSE Policy (**Section 1.2**).

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

8.1.8.4 Industry Best Practice

The control measures outlined within **Table 82**, which are based on industry best practice to decrease the risk of IMS introduction/establishment, including:

- The IAGC Environmental Manual for Worldwide Geophysical Operations. This manual recommends ballast water management plans need to be in place and followed to ensure IMS are not translocated between regions/countries, including recommendations to regularly exchange ballast water, clean ballast tanks, etc.; and

- The APPEA Code of Environmental Practice, which recommends that geophysical surveys should have an environmental objective to reduce the risk of IMS introduction to **ALARP** and **Acceptable Levels**, including having evidence of appropriate quarantine management measures.

8.1.8.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** and **Appendix F**. This section also lists the additional control/mitigation measures that were agreed upon with stakeholders to address concerns that they raised in regard to the seismic survey.

During consultation with interested stakeholders no concerns about IMS or biosecurity were raised, and as such no additional control/mitigation measures were expected or put in place. As such, the environmental impacts relating to IMS and biosecurity during the Otway Basin 2DMC MSS were considered to be at a socially **Acceptable Level**.

8.1.8.6 Existing Environment Context

The majority of the Otway Basin 2DMC MSS Operational Area is within relatively deep water (89% >1,000 m water depth), where the seabed is largely composed of soft sediments, and where the likelihood of benthic IMS establishing is unlikely. Small pelagic, planktonic forms of IMS would be the more likely scenario for IMS to be introduced into Australian waters.

The potential for an IMS introduction would be when the survey vessel was in shallow waters and for the case of the Otway Basin 2DMC MSS, this would be limited to brief occurrences when the survey or support vessels visit ports/harbours for refuelling and supplies. During acquisition of the survey, the vessels will be continually moving in offshore areas which make the potential attachment or translocation of IMS more difficult.

It is considered that the control measures in place will provide appropriate protection to the existing marine environment, and that the potential for any impacts and associated risks from the introduction of an IMS are at an **Acceptable Level**.

8.1.9 Invasive Marine Species Risk Summary

Based on the discussions above, including the potential impacts on the environment and the associated controls measures to be implemented, the residual risk of the introduction/establishment of an IMS from the seismic survey vessel is considered to be **Moderate** and to **ALARP**.

In accordance with the Risk Ranking Descriptions (**Table 40**), where risk cannot be reduced to ‘Low’, control measures must be applied to reduce the risk to **ALARP**. These actions require continued tracking and recorded action plans. With respect to IMS, the control measures include effective and documented anti-fouling management for each vessel, as indicated in the sections above.

The impacts from IMS associated with the Otway Basin 2DMC MSS are considered to be at an **Acceptable Level**.

8.2 Streamer Loss

8.2.1 Description of Source of the Risk

There are a number of ways in which potential damage and resultant loss of streamers could occur; these include snagging with floating debris, rupture from abrasions or shark bites, or loss from severance, e.g. if another vessel were to accidentally cross the streamer. Solid streamers, such as what is proposed to be used during the Otway Basin 2DMC MSS, are negatively buoyant and would sink if severed.

8.2.2 Known and Potential Risks to Environmental Receptors

Direct contact between the streamer and the seabed as a result of damage or loss will result in physical damage to the benthic habitat and any sensitive communities in the area. Should this equipment be irretrievably lost and persist on the seabed as debris, it has the potential to entangle with marine fauna or fishing equipment.

In the event that the streamer does make contact with the seabed, it is useful to note that areas of archaeological interest or cultural significance within the Otway Basin 2DMC MSS Operational Area are typically associated with intertidal and shallow subtidal coastal environments. The offshore nature of the Operational Area affords low potential for impacts on such values, and it is very unlikely that a sinking streamer would drift outside of the Operational Area.

The seabed is composed of soft mud/sand sediments, and a lost streamer is likely to marginally disturb the seabed as it lands, with potential resuspension of fine-grained sediments. Soft sediment communities may be affected in the landing area, but the sediments and faunal communities would recover over time as the disturbed sediments naturally settle and redistribute under the local conditions.

A number of control measures will be implemented during the Otway Basin 2DMC MSS (**Table 86**), including, but not limited to, the utilisation of a solid streamer, having self-recovery devices and real-time positioning of the streamer. The streamer will have ‘streamer recovery devices’ that are pressure activated self-inflating buoys, that activate if the streamer is severed and sinks, and provide sufficient positive buoyancy to keep the damaged streamer at the sea surface, enabling recovery by the support vessel or work boat.

Overall, it is considered that the risk of streamer loss occurring is minimised to **ALARP**, with the ability for recovery if it does occur reducing the potential impacts to an **Acceptable Level**.

8.2.3 Control Measures

The control measures that have been considered during the Otway Basin 2DMC MSS to manage any potential impacts from the loss of the seismic streamer to **ALARP** have been included in **Table 86**. These control measures have been assessed to consider the environmental benefit(s) gained through implementing the controls relative to their time, effort and monetary cost. SLB will make a clear delineation of those which will be implemented during the Otway Basin 2DMC MSS and those which won’t, in particular where SLB considers their implementation is disproportionate to the environmental benefit gained. Justifications have been provided for each of the decisions.

Table 86 Assessment of Control Measures for Streamer Loss

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
Solid Streamer	P = Yes E = Effective	The utilisation of a solid streamer contains no fluids which could leak into the marine environment following damage or loss of the streamer.	Yes	Yes
Streamer-recovery devices	P = Yes E = Effective	Streamer recovery devices will be fitted at intervals along the streamer and programmed to automatically deploy at water depths that are shallower than the depth of the ocean where seismic data acquisition is occurring. This will allow a damaged and/or severed streamer to return to the sea surface before impacting the seabed.	Yes	Yes
Depth control 'birds'	P = Yes E = Effective	Depth control birds will allow vessel to control depth of streamer and avoid streamer sinking too low in the water column and possible impacting seabed, or going too deep and activating streamer recovery devices, which could add additional strain on the streamer while underway and making way.	Yes	Yes
Real time positioning of streamer	P = Yes E = Effective	The exact position of the streamer will be monitored at all times utilising Intrinsic Ranging by Modulated Acoustics, allowing its position to be seen relative to any potential hazards.	Yes	Yes
Adherence to vessel Standard Operation Procedure (**SOP**) for streamer deployment and retrieval	P = Yes E = Effective	All crew will know and adhere to SOP documents relating to the preparation, deployment, operation and recovery of the seismic equipment to reduce risk of streamer damage and potential loss.	Yes	Yes
Inspections and maintenance of streamer and associated equipment	P = Yes E = Effective	Regular inspections and maintenance of streamers and associated equipment (e.g. cables and attachment points) ensures that any 'wear-and-tear' is identified and fixed, reducing the potential for the breaking (and subsequent loss) of equipment.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Recovery of lost streamer	P = Partially E = Somewhat effective	Lost equipment will be relocated and recovered where safe and practicable in accordance with SLB's Non-Routine Equipment Recovery Procedures.	Yes	Yes
Avoid areas < 50 m depth	P = Yes E = Effective	The minimum water depth of the Operational Area surrounding the proposed survey lines is 50 m which will provide ample separation distance with the proposed tow depth to ensure that the streamer does not contact the seabed.	Yes	Yes
Reporting of all incidents of lost equipment	P = Yes E = Effective	The recording and reporting of incidents, including those associated with lost equipment is standard in the industry.	Yes	Yes
Alternative Control Measures				
Alternative data acquisition method	P = No E = Effective	The Otway Basin 2DMC MSS cannot acquire seismic data without the use of a streamer and its associated equipment. Implementation of this control measure would render the survey inoperable.	Yes	No
Laying the streamer on the sea floor, also known as ocean bottom cable, as opposed to towing the streamer.	P = No E = Effective	Using this methodology for seismic would effectively eliminate the risk associated with the potential loss of a streamer, but it still requires an acoustic source to be towed behind a source vessel. The towed recording device will not pose a significant risk to marine life within the water column and would require less source locations to deliver an equivalent data set and achieve the survey objectives. Deploying the recording array on the seabed takes significantly more time and will introduce additional health and safety risks. The costs would be prohibitively expensive and impracticable for a survey of this size, especially given the large water depths. The proposed methodology is the most efficient way of conducting the surface in the shortest amount of time and will reduce the time that the seismic vessel is in the area.	Yes	No

8.2.4 Environmental Performance

The environmental performance outcome for the management of risks from the loss of the streamer is:

- No physical damage to the benthic environment from the loss of the streamer during the Otway Basin 2DMC MSS.

The environmental performance outcome, as a result of the implementation of the mitigation and control measures, will allow the ongoing environmental performance of this activity to adhere to, or improve on, the **Acceptable Levels** described within **Section 8.2.7,** while ensuring that the relevant legislation is complied with in order to avoid any health and safety risks as far as practicable.

The environmental performance standards within **Table 87** have been defined to manage the impacts from the loss of a streamer to **ALARP** and an **Acceptable Level**. Compliance with these standards will ensure that the identified environmental performance outcome above will be met for the duration of the Otway Basin 2DMC MSS.

Table 87 Environmental Performance Standard and Measurement Criteria for Loss of a Streamer

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Solid Streamer	A single, solid streamer will be deployed from the seismic vessel during the Otway Basin 2DMC MSS	Pre-mobilisation audit and inspection confirms solid streamer	Vessel Party chief
Pressure Activated Streamer Recovery Devices	Streamer fitted with Pressure Activated Streamer Recovery Devices at intervals along its length.	Pre-mobilisation audit and inspection confirms presence and operative capability of devices.	Vessel Party Chief
Streamer depth controlled using depth control 'birds'	Depth control 'birds' on the streamer ensure streamer remains at correct depth along its entire length, which facilitates data acquisition and prevents the streamer hitting the seabed.	Pre-mobilisation audit and inspection confirms presence and capability of 'birds'. Survey data records tow depth of streamer.	Vessel Party Chief
Real time positioning of streamer	Intrinsic ranging by modulated acoustics (**irMA**) will be utilised for the real time positioning of the streamer.	Survey data and irMA data shows streamer position	Vessel Party Chief
Regular inspections and maintenance of streamer and associated equipment	Streamers and associated equipment (such as tow points etc.) will be regularly inspected and maintained.	Inspection records confirm equipment is fit-for-purpose and records any maintenance work that is required/carried out	Vessel Party Chief
Adherence to vessel SOP's	Survey equipment prepared, deployed, used and retrieved in accordance with relevant vessel SOPs for each equipment type.	Vessel inspection/maintenance records show checks have been completed and operating checklists in the SOP are filled and signed.	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Reporting of all incidents of lost equipment	Loss of streamer and associated equipment (including in the event that lost equipment is successfully retrieved) will be recorded in an incident report. If the streamer cannot be retrieved all relevant stakeholders will be notified as soon as possible through the communication pathways that will be in place with GPS coordinates and all other relevant information passed on. Any lost equipment will be notified to AMSA as soon as possible as a potential navigation hazard. Any complaints received regarding loss of equipment will be recorded in a complaint register.	Vessel incident report/record	SLB Project Manager
Recovery of lost streamer	Lost streamer will be located and recovered if safe and practicable to do so by seismic vessel and/or support vessel, in accordance with SLB's Non-Routine Equipment Recovery Procedures.	Vessel incident report/record	SLB Project Manager

8.2.5 Residual Risk

Following the implementation of the control measures in **Table 86**, the likelihood a lost streamer impacting on marine species is *Remote*. The consequence from the streamer contacting the seabed is considered *Minor*, based on the discussions within **Section 8.2.2**. Therefore, using the risk matrix outlined in **Section 6.5**, the residual risk of an impact occurring from the loss of the streamer following the implementation of control measures (**Table 86**), is considered to be **Low** (**Table 88**).

Table 88 Residual Risk Summary for Streamer Loss

Likelihood	Consequence	Residual Risk
Remote	Minor	Low

8.2.6 Demonstration of ALARP

To demonstrate that any potential impacts from the loss of the streamer are managed to **ALARP**, SLB has considered a number of control measures to assess the benefits of their implementation towards risk reduction (**Table 86**), based on a Hierarchy of Controls methodology (**Section 6.6**), and as summarised in **Table 89**. The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental impacts from a streamer loss and assessments have been undertaken to ensure that all reasonable and practicable control measures or solutions have not been overlooked. As a result, it is considered that any impacts from routine discharges have been reduced to **ALARP**, where the residual risk is **Low** (**Table 88**).

Additional control measures were considered as part of the assessment process towards further risk reduction however it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 89 Hierarchy of Controls for Loss of Streamer

Eliminate	The survey cannot be conducted without the use of a streamer.
Substitute	There are no practicable substitutes for a streamer from the seismic vessel.
Reduce	Streamer recovery devices will float a lost/broken streamer, or section of streamer, to facilitate recovery by the survey vessel and/or support vessel before it can contact the seabed. The streamer and associated towing equipment will be regularly inspected and maintained for wear-and-tear and any worn or 'tired' parts replaced.
Mitigate	Control measures have been assessed within **Table 86** in order to mitigate the impacts from loss of a streamer to **ALARP** levels. Those which are appropriate and are not impracticable or unfeasible due to disproportionately large costs will be implemented during the Otway Basin 2DMC MSS.

The proposed control measures minimise the risk of impact from loss of the streamer and are considered appropriate to the localised nature and scale of potential environmental impacts during the Otway Basin 2DMC MSS. The control measures are in accordance with industry best practice. No further practicable controls have been identified to reduce the impact and risks to the marine environment and/or marine organisms from losing the streamer.

Given the relatively localised nature of effects from loss of the streamer, combined with the scale of the Otway Basin 2DMC MSS within the Operational Area (i.e. line spacing 5 km apart), the potential impact from streamer loss is reduced to **ALARP**.

8.2.7 Risk Acceptability

Total elimination of all impacts associated with the loss of a streamer cannot be achieved, as a streamer must be towed to acquire the seismic data and there are no practicable alternatives. Following the implementation of the control measures (**Table 86**) the potential impacts to the marine environment and associated receptors from loss of a streamer are likely to be highly localised and short-term.

The criteria for risk acceptability are defined in **Table 42** and are detailed in the following sub-sections, where the control measures that will be implemented throughout the Otway Basin 2DMC MSS have been developed in accordance with these criteria. Where uncertainty exists around the criteria or the risk, SLB have taken a precautionary approach.

8.2.7.1 Ecologically Sustainable Development

The management of the risk associated with streamer loss proposed by SLB can be carried out in compliance with the five principles of ecologically sustainable development as defined within the EPBC Act (outlined within **Section 2.2**). These principles have been considered as part of the development of this EP and risk assessment process. The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

8.2.7.2 Legislative Requirements

There are no relevant legislative requirements identified for the management of the risks and impacts from the potential loss of equipment (i.e. streamer). However, implementation of control measures will be used to mitigate potential risks and impacts.

8.2.7.3 Internal Context

The proposed management of the risks of streamer loss and its associated impacts are within **Acceptable Levels** of SLB's Environmental and QHSE Policy (**Section 1.2**).

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

8.2.7.4 Industry Best Practice

The control measures outlined in **Table 86** to decrease the risk of streamer loss follow industry best practice and best practice guidelines and include:

- The IAGC Environmental Manual for Worldwide Geophysical Operations, which recommends that operators:
  - Document and communicate their contingency plans for retrieving any equipment that is lost to help mitigate environmental impacts from that equipment;
  - Notify appropriate regulatory agencies in event of equipment loss;
  - Make a reasonable effort to retrieve lost equipment as soon as possible after loss occurs; and
- The APPEA Code of Environmental Practice, which recommends that geophysical surveys should have an environmental objective to reduce the impacts from loss of equipment to **ALARP** and **Acceptable Levels**, including having evidence of appropriate management procedures and an emergency response plan.

8.2.7.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** and **Appendix F**.

During consultation with interested stakeholders, no concerns were raised in regard to possible impacts from the loss of a streamer, and as such no additional control/mitigation measures were expected or put in place as a result. The environmental impacts relating to the loss of a streamer from the seismic survey vessel were considered to be at a socially **Acceptable Level**.

8.2.7.6 Existing Environment Context

Following implementation of proposed control/mitigation measures the potential impacts to water quality, and marine flora and fauna from the loss of a streamer is unlikely to pose a risk to management objectives for protected areas (such as marine parks, marine reserves etc.) and no impacts on KEFs are predicted.

The NOPSEMA guidance note for petroleum activities and Australian Marine Parks (NOPSEMA, 2018a) requires that an EP is developed for undertaking activities such as seismic surveys. The EP evaluates how environmental impacts and risks will be of an **Acceptable Level** and reduced to **ALARP** and demonstrates that the activity (i.e. seismic survey) will not be inconsistent with the relevant marine park management plan. The *South-east Commonwealth Marine Reserves Network Management Plan 2013-2023* does not directly identify marine debris as a pressure on the conservation values of the South-east marine Reserves Network. Two Marine Parks areas exist within the Otway Basin 2DMC MSS Operational Area (Nelson and Zeehan), with a further six within the wider environment. Most of the Marine Parks are classified 'IUCN VI' ('Protected area with sustainable use of natural resources') while the Murray Marine National Park (to the west of the Operational Area) is IUCN II classified (although it also has IUCN VI classification on the inshore extent).

The South-east Marine Region Profile Plan does not directly identify marine debris as a specific concern for any species, or for the KEFs that exist in this region (Commonwealth of Australia, 2015), neither does the South-East Commonwealth Marine Reserves Network Management Plan, 2013-2015. However, it is possible that a lost streamer reaching the seabed could cause physical damage to sensitive benthic communities found in some areas of the Operational Area. However, the proposed control measures in place to reduce the risk of streamer loss and subsequent environmental impact will ensure that the integrity of the IUCN reserve management principles will be maintained throughout the survey. For example, the use of streamer recovery devices will prevent a lost streamer from sinking to the seabed and allow the equipment to be quickly retrieved.

The Otway Basin 2DMC MSS Operational Area overlaps or is near the BIA for three species of whale, the white shark, Australian sea lions and 17 species of seabirds. It also sits within or adjacent to several important commercial fishing areas including southern bluefin tuna, squid, shark, abalone and rock lobster, although the latter two fisheries predominantly occur well inshore of the proposed survey lines. The proposed control measures (**Table 86**) provide appropriate protection to the marine environment from the risk of a lost streamer and associated effects (physical seabed damage), and further/alternative control measures provide little or no further protection from streamer loss while greatly increasing time and cost of the survey and increasing the potential conflict with the fishing industry.

8.2.8 Streamer Loss Risk Summary

Based on the discussions above, including the potential impacts on the environment and the associated controls measures to be implemented, the residual risk of the loss of the streamer from the seismic survey vessel is considered to be **Low** and to **ALARP**. Therefore, the potential risk from a lost streamer during the Otway Basin 2DMC MSS is considered to be at an **Acceptable Level**.

8.3 Vessel Collision or Sinking and Associated Hydrocarbon Spill

8.3.1 Description of Source of the Risk

In 2011 AMSA commissioned a study to estimate the risk of pollution from marine oil spills in Australian ports and waters (DNV, 2011). Part of this study assessed the breakdown of spills by accident type as a frequency per year; this assessment found that spill frequencies are dominated by drift grounding (21.6%), transfer spill (19.9%) and powered grounding (19.1%); whereas the frequency of a collision causing a spill is 11.6%.

The survey vessels will be operating in deep offshore waters, with the vast majority (98.5%) of the survey lines being in waters deeper than 200 m, or beyond the shelf edge. In addition, as outlined within **Section 3.4.6**, bunkering of the seismic vessel and support vessel will be undertaken in port, not at sea. These two factors fundamentally decrease the potential risk of a hydrocarbon spill associated with the Otway Basin 2DMC MSS as they remove the most likely scenarios (as per the DNV, 2011 study) of a hydrocarbon spill occurring. Therefore, the main remaining cause of spill occurrence during the Otway Basin 2DMC MSS is through vessel collision/sinking; hence, the reason for assessing both the collision and spill within the one section of this EP.

A collision between the seismic or support vessel and another vessel (e.g. passing merchant vessels, fishing vessels, passenger vessels, etc.) has the potential to cause widespread environmental impacts. The most significant potential environmental impact associated with vessel collision is related to the vessel(s) sinking and making contact with the sea floor, or damage to the vessel(s) and associated release of on-board hazardous substances, specifically the oil, fuel and lubricants, and the effects of these substances on the marine and coastal environment.

As a result of vessel collision/sinking, the integrity of the hull of the vessel(s) may be compromised, leading to the release of MGO or other hydrocarbon products into the marine environment. The very worst-case scenario for a hydrocarbon spill would likely arise where the entire contents of the seismic survey vessel's fuel tanks (approximately 1,679 m^3 at 95% full) were released into the surrounding ocean. However, compartmentalised fuel storage systems will be on the vessels to be utilised during the Otway Basin 2DMC MSS, which effectively reduced the volume of a spill that could occur if the vessel was damaged (complete rupture of the largest fuel tank at 100% full would result in the release of 572 m^3). In addition, onboard emergency procedures include transferring contents of a ruptured tank into other tanks, where possible.

Debris released into the marine environment as a result of a collision at sea may sink to the seabed or float on the sea surface. As the majority of debris that could be released as a result of a collision does not decompose, such materials may remain in the marine environment indefinitely or until removed.

However, a collision at sea is unlikely due to routine seagoing procedures undertaken by the crew and master (in accordance with COLREGs), the slow speeds at which the seismic and support vessels will be operating (4 – 5 knots), notifications issued to other marine users (i.e. Notice to Mariners), as well as state of the art navigational systems (i.e. transmitting and receiving AIS and radar) which are typically found on seismic vessels, and which support the seismic data acquisition.

8.3.2 Known and Potential Risk to Environmental Receptors

The known effects of hydrocarbon spills on the marine environment are well documented (McConnell, 2014) and include, but are not limited to:

- Direct and indirect toxicity effects;
- Removal and damage to, or exclusion from habitats and other important areas;
- Bioaccumulation in the food chain, disruption of food chains and predator/prey interactions;
- Loss of waterproofing, buoyancy, swimming ability, filtering capabilities, and thermoregulatory abilities from external oiling (especially in pinnipeds and seabirds); and
- Exclusion of users of the marine environment due to contamination/tainting of edible species or altered perception.

Potential effects on the marine environment in a specific location will be influenced by factors such as the weather at the time of any spill (including sea/swell state), the specific characteristics of the hydrocarbon, whether clean-up/response measures are/were in-place and their effectiveness, and the particular sensitivity of the environment/organisms that exist in the area where a spill occurs.

The chemical characteristics of the compounds involved in the spill will influence the behaviours, fate and weathering of any hydrocarbons that might be spilled. Weathering may involve dispersion, dissolution, biodegradation and photo-oxidation of hydrocarbons over time with light oils (such as marine diesel) containing more volatile fractions that weather faster than heavier products such as HFO. MGO is the fuel that will be carried by the seismic and support vessels during the Otway Basin 2DMC MSS and a release of this hydrocarbon to the open ocean would disperse rapidly while weathering, evaporating and small amounts of material becoming dispersed deeper into the water column. Given these characteristics significant impacts to marine fauna in the open ocean areas of the Otway Basin from MGO are unlikely as the majority of organisms are relatively mobile and able to display avoidance behaviours.

In contrast, shallow benthic environments and coastal ecosystems could be at risk of being contacted by a hydrocarbon spill if a release event were to occur along the inshore edges of the Otway Basin 2DMC MSS Operational Area. However, the magnitude of impact would be dependent on weather and sea conditions at the time, with wind and surface currents influencing the direction and speed of spill movement.

8.3.2.1 Potential Physical Environment Impacts

A vessel collision has the potential to affect the local marine environment by impacting the surrounding water and air quality in the vicinity of the incident. In the unlikely event of a vessel collision/sinking these effects are predicted to be localised and temporary, and conditions will quickly return to background levels on account of weathering of spilled MGO, on-site response actions (if required), and in-water dilution effects.

Large spills of hydrocarbons close to the coast pose potential longer-term impacts if the spill reaches the shore. As it has the potential to interfere with intertidal species (infauna, epifauna and algae) that inhabit these areas, either through habitat modification, or through the smothering of their feeding, respiratory and/or locomotory structures. MGO undergoes rapid dispersion and evaporation and the mechanical action of the waves will also help break up the MGO if any was released into the marine environment. The Operational Area is located a significant distance offshore, so it will have to be under certain environmental conditions (i.e. winds, currents and tides) that the MGO would make its way to shore. If any MGO made its way to shore, the wave action with each tidal cycle and the flood tide, would also assist in the natural flushing of the intertidal zone which would quickly assist in reducing any long-term impacts from an MGO spill.

Localised seabed damage and disturbance could occur in the event that vessel debris makes contact with the seabed. Across much of the Otway Basin 2DMC MSS Operational Area the seabed is likely to be composed of soft mud/sand sediments and sinking debris would marginally disturb the seabed as it lands, with potential resuspension of fine-grained sediments.

Where possible, damaged vessels resulting from collision would be salvaged and returned to a suitable facility for repair or disposal, and smaller items of debris would be recovered.

Based on the above, the residual risk of a vessel collision and associated hydrocarbon spill on the physical marine environment has been assessed as **Low** (*minor* x *rare*).

8.3.2.2 Potential Biological Environment Impacts

In the event of a vessel collision/sinking, the greatest impact to the biological environment will be associated with the release of hydrocarbons. Light oils, such as the MGO proposed to be used onboard the Otway Basin 2DMC MSS survey vessels, are significantly more toxic to marine organisms than heavy crude oils (NOAA, 2018a), although lighter oils are less persistent in the marine environment due to evaporation of volatile components. Ecological impacts from contamination with light oil falls into five categories (Moore & Dwyer, 1974):

- Direct lethal toxicity through ingestion, inhalation or absorption;
- Sub-lethal disruption of physiological and behavioural activities, or reduction in reproductive success;
- Effects of coating/contamination of insulation fur or feathers;
- Incorporation of hydrocarbons in organisms which may cause tainting or bioaccumulation in the food chain; and
- Changes in biological habitats.

Environmental impacts from the release of MGO following vessel collision/sinking in the marine environment will primarily be restricted to those species that inhabits the sea surface, mainly marine mammals, seabirds and marine reptiles, although fish, cephalopods and plankton may also be impacted.

Notwithstanding the above, in some situations the release of hydrocarbons can impact benthic species, with invertebrates such as molluscs and echinoderms considered to be more vulnerable to adverse effects of MGO pollution than vertebrates. Diesel oil pollution, with effects similar to MGO, has resulted in mortality of starfish and sea urchins, with as little as a 0.1% emulsion of oil needed to inactivate urchin's tube-feet (Smith, 1970).

Marine mammals in the area could potentially ingest MGO when feeding in open water, or they could get coated with MGO when they surfaced to breath. However, given MGO has a low stickiness, it is likely that it would wash off the dorsal surfaces of cetaceans as they dived into deeper waters. When cetaceans surface to breath, if they surfaced where a slick of MGO was present, there is the potential for volatile hydrocarbons to be inhaled, these could include aromatic hydrocarbons such as benzene, toluene, ethylbenzene and xylene, although these chemicals would be more prevalent if the spill was fresh/recent.

Oiling, or external contamination of pinnipeds and seabirds is particularly problematic and can lead to a loss of insulation, buoyancy, and in the case of seabirds, the ability to fly or swim (e.g. penguins). Fur seals and seabirds, for example will groom/preen themselves in an attempt to remove any contamination, leading to ingestion and further toxicity effects from any MGO which might have adhered to their fur/feathers. Nervous abnormalities have also been observed in seabirds affected by diesel spills, suggesting inhibition of anti-cholinesterase activity; affected birds become overly sensitive and incapable of tolerating environmental fluctuations, with small fluctuations enough to induce physiological stress (Smith, 1970). However, MGO has a dispersive nature and majority of seabirds are highly mobile so if any MGO was spilt, a significant impact is unlikely given the properties of MGO. Pinnipeds are also highly mobile but cannot escape the water if a spill occurred in close proximity to their location in the water. The degree of impact on pinnipeds would depend on the rate of breakdown, evaporation and mixing of the MGO if a spill occurred.

Marine reptiles are also particularly at risk from a hydrocarbon spill as they need to surface for breathing, and may be exposed to ingestion, inhalation and/or skin contact with hydrocarbons on the ocean surface. MGO has a low stickiness so it is unlikely to stick to turtles in large amounts and would likely wash of skin surfaces; however, MGO may cause skin irritation to sensitive organs such as eyes. If MGO reached the shoreline in large amounts which coincided with turtle hatchlings going to sea, then this could have an impact on the survival of those turtles. However, during the development of this EP, available information has shown that turtles are migratory through the South-east Marine Area of Australia and there are no known BIAs or critical habitats in or nearby the Operational Area, in addition, there are no known breeding/nesting areas for turtles along the coastline inshore of the Operational Area that have been identified through the development of this EP. Therefore, potential effects of an MGO spill would be low on marine reptiles.

Fish and cephalopods do not rely on air for breathing and are therefore less directly at risk of the effects of a MGO spill; however, should they come into contact with a spill, fish may experience similar toxicity effects to marine mammals and seabirds. Fish eggs and larvae may experience reduced survival rates, although due to the likely relatively localised nature of any spill and their deeper position within the water column (eggs and larvae are generally not at the sea surface), eggs and larvae are less likely to come into direct contact with the bulk of any MGO spill.

Similar to fish and cephalopods, plankton and primary producers tend to occur throughout the water column, rather than being concentrated at the very surface and although there is potential for these organisms to come into contact with contaminated surface waters and suffer from toxicity effects, these effects, if they occur, would be very localised, affecting a small proportion of the overall standing stock of the planktonic community.

Potential adverse effects on the marine environment from marine debris released during a sinking event include entanglement and ingestion. Entangled individuals may drown, suffer from injury, or be subject to reduced foraging efficacy and/or predator avoidance. Ingestion of foreign debris is also a possibility which could lead to blocked digestive tracts, internal injury, and suppressed appetite (Laist, 1987). However, the majority of marine debris released through a vessel collision/sinking event would not be of the nature that would cause such effects (i.e. entanglement and ingestion is particularly problematic for plastics and discarded fishing gear), and the majority of such debris would likely remain contained within their collection receptacles onboard the vessel.

Debris that reached the seabed following a collision/sinking (e.g. a severely damaged vessel or large heavy items), could provide additional hard substrate for colonisation by benthic species. While every practicable attempt would be made to salvage as much debris from the seabed as possible during the clean-up following a collision/sinking, some items may not be found or may be impossible to recover. In these cases, some of the debris could facilitate the formation of artificial reefs. While this may be considered a positive effect on some level, or be benign and have no further effects on the marine environment, artificial structures may facilitate the establishment or spread of invasive species which more easily establish on such artificial habitat (see **Section 8.1**) or impact commercial fishing activities (see the **Section 7.1.3.1**).

Similar to sunken debris at the seabed, floating debris can sometimes act as a medium for colonisation of marine organisms and may facilitate the spread of invasive species. Floating debris will be recovered as soon as possible after an incident. Based on the above discussion, the residual risk of a vessel collision and associated hydrocarbon spill on environmental receptors (i.e. marine mammals, seabirds, marine reptiles, fish, zooplankton and plankton) has been assessed as **Low** (*minor x rare*).

8.3.3 Known and Potential Risk to Stakeholders and Other Marine Users

Commercial fisheries and coastal shipping operations are considered the most at risk of vessel collisions due to their presence in, or transiting through, the Otway Basin 2DMC MSS Operational Area. Due to the low potential volumes of an MGO spill that resulted from a collision/sinking event, socio-economic impacts on existing interests are likely to be low.

There may be some temporary disruption to fishing activities if a spill occurred and entrained or surface hydrocarbon plume moved through a fishing ground, where it could have potential to coat the buoys and ropes of rock lobster pots. In the worst-case would be if nursery habitats in intertidal margins for commercial fish species were impacted by a spill; however, through the literature no specific locations were identified as standing out as being important such as this. Given the distance offshore of the Operational Area, it is expected if a spill occurred, by the time any MGO made it to shore, it would not be at the volumes that would decimate an intertidal community.

The most obvious effect from a vessel collision/sinking to existing interests in/around the Operational Area is the potential for casualties and injury. Released debris may float, either at the surface or partially submerged, creating a navigation hazard to other users of the marine environment, while hydrocarbons released from the vessel(s) will likely disperse and weather with time, unless making landfall where risks to the public could occur.

8.3.3.1.1 Potential Risks to Commercial Fishing

Following a collision/sinking large debris that settles on the seabed, such as a vessel itself, pose a risk to commercial trawl fisheries. Trawling would not be safe around such debris as trawl gear may become entangled.

Potential effects of a hydrocarbon spill (such as MGO) on fisheries include effects on fish populations, contamination of equipment (e.g. nets, and boats), displacement from fishing grounds, contamination of catch, loss of revenue from disruption, and negative public perception of fish quality and safety. Given the low volume of MGO that might potentially escape in the event of a collision/sinking, the likely impacts to commercial fisheries would be relatively short-lived, and reasonably localised around the vessel collision/sinking location.

Any fishing equipment such as nets and lines that contacts a spill may become fouled by hydrocarbons, for example fishing nets towed through spill areas or lifted through surface slicks. However, it is highly unlikely that fishermen will knowingly enter into a spill area, making fouling of equipment unlikely. A more likely effect comes from displacement of fishing vessels from regular fishing grounds, possibly reducing the potential of a vessel to catch their quota or increasing the time and fuel consumption costs by having to travel to other unaffected fishing areas.

Economic impacts from loss of revenue and profit due to inability to fish in certain areas following a hydrocarbon spill will initially impact the fishing companies. However, trickle-down effects also occur, with the potential for employees to suffer from loss of wages and job cuts (McCrea-Strub *et al.*, 2011), as well as sub-contractors and supply companies becoming effected.

The Otway Basin and particularly the Bonney Upwelling areas are important fishery areas for a number of species including squid and shark (see **Section 5.5.2**), with inshore coastal areas having nationally important fisheries including rock lobster and abalone.

The consequence of a hydrocarbon spill associated with a vessel collision, if it occurred, impacting commercial fisheries is Moderate to Severe, depending on the spill location and proximity to coastal areas; however, the likelihood of a collision occurring is Remote due to the extensive control measure that will be in place. In addition, all other maritime user, out at sea also have many control measures in place to prevent collisions as well and keep their crew and vessel safe and reduces the risk of an incident. Seismic surveys take place all around the world and have done so for many years, and from investigations undertaken as part of the development of this EP, there have been no incidents found that have occurred during a seismic survey that have resulted in a release of MGO to the marine environment. Consequently, a vessel collision/sinking and subsequent hydrocarbon spill provides a worst-case residual risk ranking of **Low** (*Severe* x *Remote*).

8.3.3.1.2 Potential Risks to Marine Aquaculture

Section 5.5.2.6 describes the marine aquaculture as dominated by southern bluefin tuna, yellowtail kingfish, pacific oysters, blue mussels and abalone in South Australia, and salmon in Tasmania; although the main aquaculture areas in both regions are well outside of the Otway Basin 2DMC MSS Operational Area.

Hydrocarbon spills are more likely to impact aquaculture species than the wild fish populations due to the immobility of the farmed species (Law & Hellou, 1999), and the often-higher animal densities associated with farmed species, tends to make them more susceptible to hydrocarbon contamination leading to mortality, disease, or growth abnormalities compared to wild populations.

Hydrocarbon spills can foul and contaminate marine farming structures, particularly where structures are located at the surface of the water. Intertidal farms, such as oyster farms that use racks are most at risk from a hydrocarbon spill, because farm structures and stock are re-exposed to the floating hydrocarbons as the tide rises and fall. These intertidal rack-based farms can also suffer more long-term effects when spills contact the surrounding intertidal sediments leading to persistent contamination (Berthou *et al.*, 1987).

The economic impacts to marine farming from a hydrocarbon spill include loss of product (e.g. direct mortality or destruction of contaminated product), interruption to business (e.g. temporary harvesting bans), lower yields at harvest from reduced growth (previously seen in mussels (Peteiro *et al.*, 2006)), and loss of customers due to a perception of possibly contaminated product being unsafe for consumption. Changes in public perception on fish safety observed following the Exxon Valdez oil spill, as noted for offshore fisheries above, were equally apparent for marine farmed seafood, which saw local consumers reluctant to accept results showing that harvested seafood were uncontaminated by PAHs and untainted (Fall & Fields, 1996).

Invertebrates remain contaminated for longer periods than vertebrates exposed to the same levels of hydrocarbon contamination (Law & Hellou, 1999). Consequently, aquaculture areas culturing shellfish may be affected for longer periods by harvesting closures than fish farms. For example, following the Exxon Valdez oil spill, PAHs persisted in mussels longer than in salmon (Neff & Burns, 1996), although it is important to note that this spill was of crude oil and recontamination of mussels may have occurred, leading to more persistent effects (Law & Hellou, 1999).

Debris and hydrocarbon spills released from a vessel collision/sinking event occurring within the Operational Area are unlikely to directly impact the areas of aquaculture in South Australia, Victoria and Tasmania. However, a range of mitigation measures will be implemented to prevent a collision/sinking from occurring during the Otway Basin 2DMC MSS which will reduce the risk from marine debris and spilled hydrocarbons. Given the significant distances from the Operational Area to aquaculture facilities, the residual risk ranking is **Low** (*Moderate* x *Rare*).

8.3.3.1.3 Potential Risks to Commercial Shipping

While there are no designated shipping lanes through or close to the Otway Basin 2DMC MSS Operational Area, the area does overlap with the most direct major shipping routes around southern Australia (**Figure 54**). Vessels most likely to be utilising these routes are cargo vessels and tankers, followed by commercial fishing vessels and support vessels for existing offshore developments in the Otway Basin and Bass Strait. Inshore of the Otway Basin 2DMC MSS Operational Area recreational fishing and tourist vessels are likely to be more common.

Debris left floating in the ocean following a vessel collision/sinking provides a hazard to marine shipping traffic and may force vessels to reduce speed in the known area of a debris field, or alter courses to avoid the area, reducing efficiency. In the event of a hydrocarbon spill from a collision/sinking vessel masters would be advised via safety communications and Notices to Mariners to alter regular routes to avoid movement through contaminated areas and areas involving clean-up activities. This impact would apply to both offshore and coastal routes.

Due to advance communications and vessel's ability to alter course to avoid floating debris and/or hydrocarbon spills, the environmental risk and subsequent effect of a vessel collision/sinking on commercial shipping would be **Low** (*minor x rare*).

8.3.3.1.4 Potential Risks to Tourism and Recreation

The majority of tourism and recreation activities in the area occur along or relatively close to the coastline inshore of the Operational Area (fishing, diving, surfing, winter whale watching, walking, photography, local produce dining etc.), although some deep-sea fishing (recreational and charter), as well as aerial whale spotting venture further off the coast and may enter the Operational Area (see **Section 5.5.5**).

Debris released from a collision/sinking may pose a temporary and localised navigational risk to recreational and tourism vessels plying the coastal waters and drifting or washed up debris cold have negative effects on the aesthetic qualities of the area for tourists. Effects of a hydrocarbon spill on tourism and recreational activities include lost abilities to carry out activities due to loss of habitats (e.g. contamination of beaches), displacement of tourism/recreational vessels from areas (e.g. within oil slicks and during clean-up activities), displacement of marine organisms (which may have attracted tourists) by presence of slicks, and loss of revenue from changes in public perception including reduced aesthetic qualities of coastal environments where hydrocarbons land or persist. As a result of these potential impacts to tourism and recreational activities if a spill occurred, the impacts are considered to be **Low** (*minor* x *rare*).

8.3.4 Control Measures

The potential control measures implemented during the Otway Basin 2DMC MSS to manage any potential impacts from vessel collision/sinking and associated hydrocarbon spill to **ALARP** have been included in **Table 90**. These control measures have been assessed to consider the environmental benefit(s) gained through implementing the controls relative to their time, effort and monetary cost, with a clear delineation of those which will be implemented during the Otway Basin 2DMC MSS and those which won't. Justifications have been provided for each of the decisions.

Table 90 Assessment of Control Measures for Vessel Collision or Sinking and Associated Hydrocarbon Spills

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
No refuelling will occur at sea	P = Yes E = Effective	Refuelling operations are one of the most likely causes of a hydrocarbon spill occurring during marine operations. The removal of this operation significantly reduces the potential risk of a hydrocarbon spill occurring in the first place, and the potential impacts of a spill on the environment. Removing the refuelling operations at sea from the Otway Basin 2DMC MSS will potentially increase the risks to the health and safety of employees, and the environment with additional trips to port; however, SLB considers removing the risks associated with refuelling outweigh this.	Yes	Yes
Vessel will only utilise MGO	P = Yes E = Not Effective	Although utilising a certain fuel type is not effective in reducing the risks of a vessel collision and hydrocarbon spill, it is importance to consider in terms of the responses required, which will ultimately reduce the risks of impacts to the environment as MGO will not need the same level of response and clean-up as other heavier oils	No	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Compliance with COLREGS	P = Yes E = Effective	At all times during the survey the crew of the seismic and support vessel will comply with COLREGS, including maintaining a visual watch and undertaking a full radar scanning watch for the presence of any other vessels in close proximity or any vessel on a course heading towards them or the other vessel involved in the survey. Early detection of approaching vessels will allow survey and support vessels to attempt to communicate with approaching vessels to avoid chances of collision. The slow speed of the seismic and support vessels during the operational phase of the survey (4 – 5 knots) will then also allow the vessels plenty of time to attempt communication following early detection and if required make appropriate evasive manoeuvres. In addition to the above, having navigational lighting and day-shapes compliant with COLREGS for safe passage at sea and specific to each vessel and its activities will provide further means in reducing the chance of vessel collisions.	Yes	Yes
Compliance with Marine Order 21 (Safety and Emergency Arrangements) 2016	P = Yes E = Effective	Marine Order 21 provides information about safety measures such as manning, bridge visibility etc. and emergency procedures. Complying with these requirements will reduce the potential risk of a collision at sea, and also mean compliance is maintained with the respective aspects of the International Convention of the Safety of Life at Sea (**SOLAS**).	Yes	Yes
Compliance with Marine Order 30 (Prevention of Collisions) 2016	P = Yes E = Effective	Complying with the requirements of Marine Order 30 will ensure all measures (such as lighting, signals etc.) to prevent collisions are maintained to reduce the risk to **ALARP**.	Yes	Yes
Radio communications watch kept at all times.	P = Yes E = Effective	Seismic and support vessels will keep open radio communications between each other as well as scanning local working channels and the emergency channel (VHF 16) for contact with other vessels that may be operating in the vicinity, and therefore reduce the potential for collision.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Vessel fuel to be stored in compartmentalised and/or multiple separate onboard fuel tanks.	P = Yes E = Effective	Fuel systems onboard the seismic and support vessels (carrying MGO) will consist of multiple smaller tanks throughout the vessel or larger tanks built of multiple separate compartments. This will reduce the potential volumes of MGO that could be released to the environment in the event of a tank being ruptured during a collision/sinking event	Yes	Yes
Emergency Response Plan for Hydrocarbon Spills that complies with Marine Order 91.	P = Yes E = Effective	If MGO spill does occur following a vessel collision/sinking SLB will implement the response strategy in accordance with the Shipboard Oil Pollution Emergency Plan (**SOPEP**), and also in line with relevant legislation and industry standards. SLB will also undertake all required notification and reporting during planning stages of mobilisation phase of survey. In the event of a vessel collision/sinking and there is a resultant MGO release, notification will be provided to AMSA and regulatory agencies in accordance with the Implementation Strategy – Reporting **Section 10.6**.	Yes	Yes
Testing of SOPEP	P = Yes E = Effective	Prior to the commencement of survey operations, the SOPEP will be tested including testing of communications and a vessel-based drill in hydrocarbon spill response.	Yes	Yes
Utilising accurate weather forecasting information for planning operations	P = Yes E = Effective	SLB will subscribe to a weather monitoring service that will provide updated forecasts (including wind, waves/seas and currents) four times daily allowing vessel masters to best plan the vessels movements and operations to occur when and where in the Operational Area the weather is safest/most-suitable.	Yes	Yes
Contract in place with appropriate service provider to initiate real-time modelling in case of a spill	P = Yes E = Effective	Undertaking real-time modelling will provide assurances that response options can be tailored to the specific spill situation. The modelling will be based continuous weather monitoring which will be utilised in conjunction with hindcast data to predict the potential beaching locations (if any exist).	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
In case of a spill, SLB will implement relevant Type I Operational Monitoring	P = Yes E = Effective	Type I Operational Monitoring (such as using the support vessels to monitor the spill) will be undertaken in the unlikely event of a hydrocarbon spill to provide up-to-date information on the fate of hydrocarbon in the water. This monitoring will allow appropriate response options to be established with the Control Agency.	Yes	Yes
Type II Scientific Monitoring undertaken in case of spill if real-time modelling shows the spill will impact land, in consultation with the Control Agency	P = Yes E = Effective	Depending on the fate of any hydrocarbon spill, based on the real-time modelling and operational monitoring described above, Scientific Monitoring may be required (if directed by the Control Agency) to monitor the impacts from a spill occurrence.	Yes	Yes
Hydrocarbon spill response training and competencies will be maintained throughout the Otway Basin 2DMC MSS to avoid unplanned environmental impacts due to human error	P = Yes E = Effective	Ensuring all staff members have appropriate training is vital in responding to a hydrocarbon spill. Drills will also be undertaken to ensure all staff are competent in responding to spills under the vessel specific SOPEP; these drills will be conducted at regular intervals to ensure the competencies are maintained throughout the operation.	Yes	Yes
Automated Identification System transponders fitted to survey vessels and tail buoy.	P = Yes E = Effective	AIS transponders will transmit key information to all vessels able to receive AIS data and will include details such as vessel GPS position, identity, type, speed, course and caution notes). The AIS system will also receive AIS information from other vessels in the area.	Yes	Yes
All crew will participate in the vessel and environmental induction prior to the commencement of operations	P = Yes E = Effective	It is a standard industry practice to hold inductions for all onboard the vessels, with participation in induction meetings compulsory. During inductions, crew will be made aware of their responsibilities with regard to effects of discharges to the marine environment and their roles with regard to clean-up of any accidental discharges.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Notice to Mariners issued prior to commencement of survey	P = Yes E = Effective	A Notice to Mariners will be submitted to the AHO prior to the beginning of the survey to inform affected parties of the location of the survey and activities that will occur, so that other vessels using the area are informed and know the best course of action to avoid interacting with the survey vessel and associated equipment.	Yes	Yes
Spill response equipment will be available and maintained onboard each vessel and located in close proximity to hydrocarbon areas. And crew onboard will be trained in how to respond to any incident utilising the response equipment available.	P = Yes E = Effective	The availability of spill response equipment in close proximity to any hydrocarbon areas allows a quick response to any hydrocarbon spills into the marine environment. Vessel master will authorise actions in accordance with the vessel-specific SOPEP and the survey specific OPEP to limit the escape of hydrocarbons.	Yes	Yes
Alternative Control Measures:				
Eliminate vessels	P = No E = Very Effective	There are no practicable methods for undertaking the Otway Basin 2DMC MSS without the use of vessels.	Yes	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Undertake hydrocarbon spill modelling prior to EP submission	P = Yes E = Not Effective	Undertaking hydrocarbon spill modelling prior to the submission of this EP was not considered effective in reducing potential risks of vessel collision or hydrocarbon spills. As the Operational Area covers a very wide area it is very difficult to determine the ideal location to base the modelling on. This is further complicated by the fact that the survey vessel will be continuously moving and will not be in the same place more than once; hence, a fixed point to base modelling off is very unlikely to result in reliable information to inform spill response and would require multiple modelling locations across the Operational Area to be undertaken. As outlined in the control measures to be implemented above, SLB will implement real-time modelling in the event of a spill which will provide more detailed and realistic areas of potential beaching along the coastline to assist in responding to a spill occurrence. The cost of undertaking hydrocarbon spill modelling at multiple spill modelling locations at a number of locations across the Operational Area had a significant expense that was not justified when the vessel would only be at that one location for a very brief point in time. Therefore, it was not considered that the expense of hydrocarbon spill modelling would provide any additional environmental benefit to the programme or reduce the impact to **ALARP**.	No	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Pre-activity monitoring programme and development of detailed Type II Monitoring Plans	P = No E = Not Effective	It is not considered practical to undertake a pre-activity monitoring programme, or the development of detailed Type II Monitoring Plans prior to a hydrocarbon spill occurring. This is due to the fact that the risks of a spill occurring are highly unlikely, and in the event of a spill occurring from vessel collision the likely location of beaching is difficult to determine with such a wide spread Operational Area. In addition to it not being practical, the numerous control measures outlined within the EP will result in the likelihood of a vessel collision, and subsequent hydrocarbon spill, occur are reduced to **ALARP**. However, if a spill did occur, SLB would implement Type II scientific monitoring in accordance with the Oil Pollution Emergency Plan (**OPEP**) in **Section 10.7** focusing on potential impacts to key environmental and sensitive receptors. SLB has insurance policies in place that would cover the costs of any Type II scientific monitoring required in the event of a large hydrocarbon spill resulting from its activities in the Otway Basin, or to cover the clean-up costs if any remediation costs were required following any spill. These policies will cover any such activities within the State waters and Australian Commonwealth waters, which includes the Otway Basin 2DMC MSS Operational Area.	No	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Eliminate presence of other hydrocarbon fluids onboard vessels (e.g. lubricants, hydraulic fluids)	P = No E = Effective	Lubricating and hydraulic fluids are required for the normal operation and maintenance of the vessels and equipment and as such cannot be completely eliminated. Storage in suitably bunded areas as detailed above will reduce risk associated with these fluids. Lubricating oils and hydraulic fluids are typically stored in 50 – 200 L steel drums either in a designated storage room, or a bunded area on deck. Therefore, any potential spills of these substances on deck are likely to be <200 L in a contained area. Hydrocarbons which occur in greater (>200 L) quantities on the seismic vessel, for example waste engine oil, hydraulic fluid and main engine lubricating oils, are generally stored in designated storage tanks below deck and therefore are unlikely to be a direct hazard for deck spills (unless smaller quantities have been transported to the deck to be used for deck activities). It is possible that spills or leaks from hydraulic hoses on hydraulically operated equipment such as cranes and winches may occur, but if so, the fluid is likely to be contained within a bund or drip tray, and the volume of fluid loss will be low (<1 L). It is therefore highly unlikely that a non-contained spill of hydrocarbon fluids will occur onboard vessels; however, should such fluids enter the marine environment, their impact is likely to be low-minimal as the small volumes will quickly evaporate, disperse and weather.	Yes	No

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Substitute MGO for an alternative fuel or wind-powered vessels	P = No E = Not Effective	MGO is already a vast improvement over HFO, and lighter alternative fuels or wind power are not feasible to use in the seismic and support vessels that will be utilised for the survey as they have not been commercially proven for use in large vessels. It is expected that the high energy marine environment in which the Operational Area is located will aid in the rapid dispersion (in the direction of the prevailing wind and current) and evaporation of MGO should it enter the marine environment. Warmer water temperatures during summer months will further accelerate this process.	No	No
Use a survey vessel with smaller fuel and oil tank sizes	P = No E = Effective	This would mean more frequent trips to port for refuelling which would increase costs and the duration of the survey, as well as result in greater risks. Furthermore, implementing this control measure would likely lead to a delay in the timing of data acquisition due to the time needed to contract an appropriate survey vessel. Data delivery to clients would consequently be delayed and requirements not met.	Yes	No
Seismic survey will be restricted to daylight hours	P = No E = Effective	The cost of the survey would increase substantially as the survey duration would double. Health and safety risks and potential impacts to marine life (e.g. cetaceans) would also increase due to the longer survey duration.	Yes	No
Reduce size of the Operational Area to decrease chance of spills reaching emergent lands	P = No E = Effective	The size of the Operational Area has already been reduced substantially (~ 100,000 km^2 see **Section 7.1.3.1**). Further reductions would result in SLB being unable to fulfil primary objectives of the survey and data requirements. The likelihood of vessel collision or sinking and an associated hydrocarbon spill is extremely unlikely and is no greater than that for other vessels that may enter the Operational Area and surrounding waters.	Yes	No

8.3.5 Environmental Performance

The environmental performance outcome for the management of environmental risks from a vessel collision/sinking (and associated hydrocarbon spill) is:

- Zero vessel collisions during the Otway Basin 2DMC MSS, including zero incidents of release of hydrocarbons to the marine environment resulting from vessel collision.

The environmental performance outcome, as a result of the implementation of the mitigation and control measures, will allow the ongoing environmental performance of this activity to adhere to, or improve on, the **Acceptable Levels** described within **Section 8.3.8** while ensuring that the relevant legislation is complied with to avoid any health and safety risks as far as practicable.

The environmental performance standards within **Table 91** have been defined to manage the impacts from a vessel collision/sinking and associated hydrocarbon spill to **ALARP** and an **Acceptable Level**. Compliance with these standards will ensure that the identified environmental performance outcome above will be met throughout the duration of the Otway Basin 2DMC MSS.

Table 91 Environmental Performance Standard and Measurement Criteria for Vessel Collision/Sinking and associated Hydrocarbon Spill

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
No refuelling will occur at sea	All refuelling operations for the seismic and support vessels will be undertaken at port.	Bunker documentation	Vessel Master
Vessel will only utilise MGO	MGO is the primary fuel for vessels associated with the Otway Basin 2DMC MSS; no HFO powered vessels will be used.	Bunker documentation	Vessel Master
Adherence to COLREGs	Essential navigation lighting and day-shapes to maintain compliance with COLREGs.	Pre-mobilisation audit and inspection prior to beginning of survey will confirm correctly functioning lighting and communication equipment.	Vessel Master
Compliance with MARPOL Annex I and Marine Order 91.	IOPP is held where required under vessel class	IOPP Certificate is valid Vessel logs Discharge audit	Vessel Master
Compliance with Marine Order 21	The manning of the survey and support vessels are kept above minimum standards and visibility from the bridge is maintained as per Chapter V Regulation 22 of SOLAS.	Bridge log shows appropriate manning of vessels.	Vessel Master
Compliance with Marine Order 30	The seismic vessel will display the relevant day shapes, lights and reflective tail buoys to indicate the vessel is towing a seismic streamer in order to identify the lack of manoeuvrability	Pre-mobilisation audit and inspection prior to beginning of survey will confirm that the relevant equipment is onboard, tested and operational.	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Radio communications	Vessels will monitor local working channels as well as emergency channel 16 and agreed working channel between seismic and support vessel	Daily vessel report from each watch includes communication checks and records of any communication/ interaction with other vessels.	Vessel Master
Vessel fuel storage	Fuel tanks onboard the survey vessel will be compartmentalised or consist of multiple smaller tanks throughout the vessel	Pre-mobilisation audit and inspection prior to beginning of survey will confirm	Vessel Master
Emergency Response Plan for hydrocarbon spill	SOPEP formulated, known to all staff and kept up to date onboard seismic and support vessels so that in the event of a collision where hydrocarbons are released there is a plan in place to contain or clean-up. Vessel master will authorise actions in accordance with the vessel-specific SOPEP and the survey specific OPEP to limit the escape of hydrocarbons. Notification procedures will be implemented, including AMSA and regulatory agencies.	In event of vessel collision/sinking and release of MGO all appropriate forms will be completed and submitted to relevant authorities to provide notification including: • AMSA report notification • NOPSEMA reports • Regulatory agencies • SLB incident report • Pollution report - (**POLREP**)	SLB Project Manager and Vessel Master
Testing of SOPEP	Prior to the commencement of survey operations, the SOPEP will be tested including testing of communications and a vessel-based drill in hydrocarbon spill response.	Induction and daily records confirm testing of SOPEP has occurred and drills have been carried out.	Vessel Master
Accurate, up-to-date weather forecasting	Seismic and support vessels, as well as onshore project team, to receive wind, wave and current information for the Operational Area four times daily from subscription service.	Copies of the forecasts will be included with the daily reports/logs and kept on file.	SLB Project Manager and Vessel Masters
Real-time modelling contract in place	Prior to the commencement of the Otway Basin 2DMC MSS, SLB will secure services (signed contract) with a third party for provision of real-time modelling if and when required	Service contract in place prior to commencement of Otway Basin 2DMC MSS.	SLB Project Manager
Type I Operational Monitoring	If health & safety requirements permit, support vessels undertaking the Otway Basin 2DMC MSS are used to monitor the spill.	Incident report.	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Type II Scientific Monitoring	Prior to the commencement of the Otway Basin 2DMC MSS, SLB will secure services (signed contract) with a third part for standby services in order to undertake Type II monitoring,	Service contract in place prior to commencement of Otway Basin 2DMC MSS.	SLB Project Manager
Hydrocarbon spill response training and competencies	Prior to the commencement of the Otway Basin 2DMC MSS an audit is conducted to ensure all staff are trained and inducted satisfactorily to ensure they are competent in responding to a hydrocarbon spill.	Pre-mobilisation audit results	SLB Project Manager and Vessel Master
AIS tracking vessel location	Seismic and support vessel(s), and associated survey equipment (e.g. tail buoys) will have correctly fitted and functioning AIS transponder.	Pre-mobilisation audit and inspection prior to beginning of survey confirms correct operation of all AIS transponders.	Vessel Master
Communication of Survey start, status and completion.	Best available information released to possibly affected parties on the water via Notices to Mariners submitted to AHO at the implementation of the survey and where any changes may occur to plan.	Inspection of Notices to Mariners publications to formally confirm notice has been issued. Copies kept on file.	SLB Project Manager
Spill response equipment	Spill response equipment will be available and maintained/re-stocked onboard each vessel and located in close proximity to hydrocarbon areas. Crew will be trained in using response equipment.	Inspection records confirm equipment is fit-for-purpose and records any re-stocking of supplies as required.	Vessel Master
Insurance Policies in place	SLB will have insurance policies in place to cover the costs of any scientific monitoring or clean-up costs if any remediation is required in the event of a large hydrocarbon spill.	Insurance policies to include the State waters and Australian Commonwealth waters.	SLB Project Manager

8.3.6 Residual Risk

Following the implementation of the control measures detailed in **Table 90** the likelihood of an impact from vessel collision/sinking and associated hydrocarbon spill is *Remote*. The worst-case consequence from a collision/sinking relates to a significant hydrocarbon spill and is considered *Severe* based on discussions within **Section 8.3.2**. Therefore, using the risk matrix outlined in **Section 6.5** the residual risk from an impact occurring from vessel collision/sinking and associated hydrocarbon spill, following the implementation of control measures (**Table 90**), the residual risk ranking is **Low** (**Table 92**).

Table 92 Residual Risk Summary for Vessel Collision/Sinking

Likelihood	Consequence	Residual Risk
Remote	Severe	Low

8.3.7 Demonstration of ALARP

To demonstrate that any potential impacts from vessel collision/sinking and associated hydrocarbon spill are managed to **ALARP**, SLB has considered a number of control measures to determine the benefits of their implementation towards risk reduction (**Table 90**), based on a Hierarchy of Controls methodology described within **Section 6.6** above, and as summarised in **Table 93**. The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are appropriate to reduce the environmental impacts from a vessel collision/sinking and assessments have been undertaken to ensure that all reasonable and practicable control measures or solutions have not been overlooked. As a result, it is considered that any impacts that may arise from a vessel collision have been reduced to **ALARP**, where the residual risk from adoption of these control measures is reduced to **Low** (**Table 92**).

Additional control measures were considered as part of the assessment process towards further risk reduction; however, it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 93 Hierarchy of Controls for Vessel Collision/Sinking and Associated Hydrocarbon Spill

Eliminate	The use of vessels cannot be eliminated as a seismic survey vessel and support vessel have to be used to undertake the required data collection. The Operational Area is also an open ocean area where other vessels (fishing, shipping, cargo, recreational) are not restricted from entering and may pass through any part of the area (within reason) at any time thus other vessels cannot be eliminated either. A support vessel is also needed for a number of reasons and cannot be removed from the operations. Refuelling at sea has been eliminated from the Otway Basin 2DMC MSS resulting in a highly reduced risk of spills of hydrocarbons into the marine environment.
Substitute	There are no suitable substitutes for use of a seismic vessel to undertake the survey in the required location.
Reduce	SLB aims to reduce the amount of time the seismic and support vessels are in the Operational Area by working 24/7 whenever possible. Reducing the number of survey vessels by removing the presence of a support vessel could reduce the risk of a collision/sinking. But at the same time this reduction could increase the risk of a collision between other vessels and the seismic vessel and/or its towed equipment. Thus, a reduction in the number of vessels isn't a practicably feasible option.
Mitigate	Control measures have been assessed within **Table 90** in order to mitigate the impacts from a possible vessel collision/sinking to **ALARP** levels. Those which are appropriate and are not impracticable or unfeasible due to disproportionately large costs will be implemented during the Otway Basin 2DMC MSS.

The proposed control measures minimise the risk of a vessel collision/sinking and associated hydrocarbon spill and are considered appropriate to the possible scale of potential environmental impacts that may occur in this rare instance. The proposed control measures are in accordance with industry best practice. No further practicable controls have been identified to reduce the impact and risks to the marine environment and/or marine organisms from a vessel collision/sinking.

Given the highly unlikely event of a vessel collision (due to the control measures outlined within **Table 90**), combined with the fact that the Otway Basin 2DMC MSS will be a temporary activity and hence the risk will be limited to that specific time period, it is considered that the potential risks of a vessel collision/sinking and its associated impacts (such as a hydrocarbon spill) have been reduced to **ALARP**.

8.3.8 Risk Acceptability

Total elimination of all risks associated with potential vessel collision/sinking cannot be achieved as there are no practicable alternatives to using vessels to undertake the survey safely and effectively, in particular vessels powered by hydrocarbon fuel supplies. Following the implementation of the control measures detailed in this assessment (**Table 90**), the impacts/risks to the marine environment and associated receptors from vessel collision/sinking could have *Severe* consequences. In the remote likelihood of a collision/sinking which results in a hydrocarbon and/or debris release, impacts to the marine environment are not expected to be long-term, given the properties of MGO in the ocean, with full recovery in time.

The criteria for risk acceptability are defined in **Table 42** and detailed in the following sub-sections, where the control measures that will be implemented throughout the Otway Basin 2DMC MSS have been developed in accordance with these criteria. Where uncertainty exists around the criteria or the risk, SLB have taken a precautionary approach.

8.3.8.1 Ecologically Sustainable Development

The management of the impacts associated with vessel collision/sinking and its associated impacts (such as a hydrocarbon spill) proposed by SLB can be carried out in compliance with principles of ecologically sustainable development as defined within the EPBC Act (outlined in **Section 2.2**). The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

8.3.8.2 Legislative Requirements

The proposed control measures for vessel collision/sinking during the Otway Basin 2DMC MSS are consistent with the following relevant legislation:

- The Navigation Act which requires approved navigation systems for maritime safety, navigation efficiency and management of marine pollution;
- The PSPPS Act;
- The Environment Regulations; and
- Control measures relating to hydrocarbon spills to the ocean are consistent with MARPOL (Annex 1 Regulations for Prevention of Pollution by Oil) and Marine Order 21, 30 and 91, including having an approved and tested SOPEP for all vessels involved in the survey.

8.3.8.3 Internal Context

The proposed management of the risks of vessel collision/sinking and its associated impacts are within **Acceptable Levels** of SLB's Environmental and QHSE Policy (**Section 1.2**).

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

8.3.8.4 Industry Best Practice

The proposed control measures to decrease vessel collision/sinking follow industry best practice and best practice guidelines, including:

- The IAGC Environmental Manual for Worldwide Geophysical Operations which contains recommendations for SOPEPs, the mitigation of spills and leaks, and incident reporting; and
- APPEA Code of Environmental Practice: offshore geophysical surveys are recommended to have environmental objectives to reduce impacts from spills and disturbance to seabed (e.g. in event of sinking), including having evidence of appropriate management procedures and emergency response plans being in place.

8.3.8.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** and **Appendix F**.

During consultation with interested stakeholders no concerns were raised in regard to possible impacts from hydrocarbon spills as a result of vessel collision/sinking.

During consultation with interested stakeholders no concerns were raised in regard to possible impacts from vessel collision/sinking, and as such no additional control/mitigation measures were expected or put in place. As such the environmental impacts relating to vessel collision/sinking were considered to be at a socially **Acceptable Level**.

8.3.8.6 Existing Environment Context

Following implementation of control measures the potential impacts to water quality from vessel collision/sinking are unlikely to pose a risk to management objectives for protected areas (such as marine parks etc.) where water quality is identified as a conservation value.

The NOPSEMA guidance note for petroleum activities and Australian Marine Parks (NOPSEMA, 2018a) requires that an EP is developed for undertaking activities such as seismic surveys to evaluate how environmental impacts and risks will be of an **Acceptable Level** and reduced to **ALARP** and demonstrate that the activity (i.e. seismic survey) will not be inconsistent with the relevant marine park management plan.

The *South-east Commonwealth Marine Reserves Network Management Plan 2013-2023* identifies oil pollution associated with shipping, other vessels and offshore mining operations as a pressure on the conservation values of the South-east Marine Reserves Network. Two Marine Parks covered by the *South-east Commonwealth Marine Reserves Network Management Plan 2013-202*3 exist within the Otway Basin 2DMC MSS Operational Area (Nelson (**Section 5.3.3.2.1**) and Zeehan (**Section 5.3.3.2.2**), with a further six within the wider environment (**Section 5.3.3.3**). Most of these Marine Parks are classified 'IUCN VI' ('Protected area with sustainable use of natural resources') while the Murray Marine Park (to the west of the OA) is IUCN II classified (**Section 5.3.3.3.1**). The *South-east Marine Region Profile Plan* does not directly identify hydrocarbon spills as a specific concern for any species, or for the two KEF's that exist in this region (the Bonney Coast Upwelling (**Section 5.3.8.1**) and the West Tasmania Canyons (**Section 5.3.8.2**)) (Commonwealth of Australia, 2015).

Oil pollution response, environmental monitoring and remediation activities can be undertaken with IUCN Category VI zones, when undertaken in accordance with a NOPSEMA approved EP that has met all required environmental management arrangements for the activity covered in the class approval. However, any oil pollution incident that may affect other IUCN category zones requires prompt consultation with Director of National Parks.

Any spill occurring within, or likely to impact, any marine park should be notified to the Director of National Parks as soon as possible, by contacting the Marine Park Compliance Duty Officer (0419 293 465). Notifications must include time and location of the incident, response arrangements as per the OPEP and contact details for titleholder and response coordinators.

Inshore of the Operational Area, 69 Onshore Protected Areas border the coastlines within the wider environment (**Section 5.3.2**), roughly a quarter of which are IUCN Category 1A or II, and a further half are IUCN Category V or VI.

The Otway Basin 2DMC MSS Operational Area overlaps or is near to the BIA for three species of whale, the white shark, Australian sea lions and 17 species of seabirds (**Section 5.3.9**). The area is also within or adjacent to several important commercial fishing areas including southern bluefin tuna, squid, shark, abalone and rock lobster (**Section 5.5.2**), although the latter two fisheries are predominantly well inshore of the proposed survey line plan. Also inshore of the Operational Area along the coastline are important nesting, rookery and roosting areas for several different seabird species (**Section 5.2.8**). The proposed control measures (**Table 90**) provide appropriate protection to the marine environment from the risk of vessel collision/sinking and associated effects (debris and hydrocarbon release), and further/alternative control measures would give very little or no further protection from vessel collision/sinking while greatly increasing time and cost of the survey and also increase the potential conflict and displacement with the fishing industry.

The Implementation strategy for the Otway Basin 2DMC MSS (**Section 10**) covers details of the notifications that would be undertaken in the event of reportable and recordable incidents (**Section 10.6.4**) as well as SLB's OPEP (**Section 10.7**) which details SLB's arrange for responding to a hydrocarbon spill event.

8.3.9 Vessel Collision/Sinking and Associated Hydrocarbon Spill Risk Summary

Based on the discussions above, including the potential impacts on the environment and the associated controls measures to be implemented, the residual risk of a vessel collision/sinking and associated hydrocarbon spill is considered to be **Low**.

The risks of a vessel collision occurring are reduced in a number of ways, including the adherence to legislative requirements and industry best practice, along with operating conditions (such as vessel operating at slow speeds). In addition, SLB has removed the chance of a hydrocarbon spill occurring at sea from vessel refuelling as these operations will be undertaken in port. Therefore, the risks associated with a vessel collision and any associated hydrocarbon spill is considered to be **ALARP**.

Should an unlikely vessel collision occur, which results in a hydrocarbon spill, SLB has put in place numerous measures to ensure monitoring of the situation is maintained to allow appropriate remediation.

Therefore, the residual risk of a vessel collision occurring, with the associated controls in place, is considered to be at an **Acceptable Level**.

8.4 Hydrocarbon Spill Response

8.4.1 Description of Source of the Risk

In the unlikely event that a hydrocarbon spill occurs within the marine environment from a vessel associated with the Otway Basin 2DMC MSS, a number of spill response options can be initiated for a clean-up response. The following is an assessment of the response options that could be used should a hydrocarbon spill occur.

The potential response actions will be based on a Net Environmental Benefit Analysis (**NEBA**) approach which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response. NEBA takes into account the hydrocarbon type, the sensitivities within the wider area of the spill, and the potential impacts, both positive and negative, of the proposed response strategy. This analysis is used for the preliminary assessment to determine the level of spill response required. During a spill event, the NEBA will be revisited regularly as more information becomes available on weather conditions at spill location, spill trajectory and locations of sensitive receptors in the surrounding areas.

The residual risk to environmental receptors from the response methods utilised to clean up a hydrocarbon spill have been assessed as **Low** (*minor* x *rare*).

Table 94 provides an overview of the response options available with an assessment on the advantages and disadvantages of each option, and their appropriateness for use if a spill occurred during the Otway Basin 2DMC MSS.

Table 94 Assessment of Spill Response Options

Response Option	Advantages of use	Disadvantages of use	Appropriateness of use
Source control (securing cargo / trimming)	Reduction in volume of MGO entering the marine environment.	No disadvantages identified.	This response option is suitable to both Level 1 and Level 2 responses and will be adopted in accordance with the SOPEP onboard the vessels. In the event of a fuel tank rupture, or hydrocarbon storage spill occurring, cargo of the affected tank/storage containers is to be secured by any available means, including transfer to another storage area, another vessel or through pumping in water to create a water cushion. Trimming the vessel may also be used to avoid further damage to intact tanks. These actions will minimise the volume of MGO spilled.
Natural weathering (monitor and evaluate – vessel/aerial surveillance and trajectory modelling)	Provides valuable information for situational awareness to inform response options. Surveillance results can also be used to assist in escalating or de-escalating response strategies as required.	Does not directly reduce potential impacts from the spill. Potential increase in the vessel/aviation activity in the area resulting in increased disturbance to fauna, including increased risk of collisions	Vessel surveillance will be done for level 1 and level 2 spills using available vessels on scene for opportunistic surveillance operations. However, priority for human health and safety will take place should a significant vessel casualty occur. SLB will have a contract in place with an appropriate service provider to initiate real-time modelling in the case of a spill. These modelling outputs can be used to guide appropriate response options. Monitoring requirements and approach will be assessed by the relevant Control Agency.
Physical break-up (vessel prop-washing)	Enhances natural degradation processes through the water column.	Increased vessel activity – additional noise, light, and atmospheric emissions. Increased health and safety risks from the presence of additional vessels. Potential for reduced evaporation of MGO by entraining it into the water column	This response option may be utilised during the Otway Basin 2DMC MSS. Vessel prop washing promotes entrainment within the water column and reduces potential evaporation, potentially keeping the substance in the water for longer periods. However, this option would only be undertaken if requested by the Control Agency, which their decision-making process would be dependent on the spill location and a NEBA.

Response Option	Advantages of use	Disadvantages of use	Appropriateness of use
Application of dispersants	No advantages identified for MGO as it is not a persistent hydrocarbon. MGO has a high natural dispersion rate in the marine environment.	Additional release of chemicals into the marine environment that may have toxic effects on marine fauna.	This response option is not recommended for the Otway Basin 2DMC MSS as it is not a beneficial for reducing the net environmental impact of a MGO spill. It has a low probability of increasing the dispersal rate of the spill whilst introducing more chemicals into the marine environment.
Contain and recover (booms and skimming)	MGO potentially removed from the environment. Reduces chances for fauna to become oiled.	Use is restricted by surrounding weather conditions – i.e. in rough weather conditions, booms and skimmers will not work. Increased vessel activity – additional noise, light, and atmospheric emissions. Very labour intensive with an increased volume of waste generated.	This response option is not recommended for the Otway Basin 2DMC MSS as the fast spreading rates of MGO and the low viscosity will cause the slick to break-up and disperse quickly resulting in a reduced ability to contain and recover the MGO from the ocean.
Protect and deflect (booms etc.)	MGO potentially removed from the environment. Reduces chances for shoreline fauna to become oiled.	Increased activity – additional noise, light, and atmospheric emissions. Very labour intensive with an increased volume of waste generated. Potential additional damage to intertidal and benthic habitats from equipment.	This option is not recommended for the Otway Basin 2DMC MSS as MGO is not expected to be persistent and corralling of MGO is generally not effective. Tidal flushing and bioremediation are expected to be sufficient in the worst-case scenarios to prevent any significant environmental impact.
Shoreline clean-up (physical removal, surf washing, flushing, natural dispersion)	MGO potentially removed from the environment. Reduces chances for shoreline fauna to become oiled.	Increased activity – additional noise, light, and atmospheric emissions. Very labour intensive with an increased volume of waste generated. Potential damage to sensitive shoreline species. Weather dependant.	This option is not recommended as it is an intrusive response that requires careful site-specific planning in order to reduce secondary impacts of beach erosion and spreading oil beyond shorelines. This response has the potential to cause more harm due to secondary disturbance compared to the initial potential light oiling. Therefore, if light shoreline contact occurs, SLB considers that any onshore response options would best occur under the National Plan.
Oiled Wildlife Response (capture and rehabilitation)	Aids recovery of oiled wildlife.	Increased activity – additional noise, light, and atmospheric emissions. Approaching marine fauna could flee and dive into spilled MGO as a result of activity.	Undertaking this response option has the potential to result in more harm if poorly executed.

Response Option	Advantages of use	Disadvantages of use	Appropriateness of use
		Pre-emptive capture may result in reduced survival.	Activities such as hazing (dispersing) of birds will not be undertaken given the low likelihood of a spill of a size presenting a significant risk of oiling wildlife unless at the direction of, and under direct supervision of trained personal from the Control Agency. Capture and rehabilitation may be undertaken under the National Plan.

The activities associated with a response to a hydrocarbon spill introduce further risks to marine fauna and flora, including:

- Increased disturbance of avifauna (both shore and sea birds) and marine mammals;
- Increased risk of vessel strikes with an increased number of vessels in the area conducting the response;
- Potential inclusion of additional chemical agents into the marine environment (i.e. dispersants);
- Potential physical damage to habitats from deployment of booms in the intertidal zone; and
- Potential damage to intertidal habitats from trampling (via foot or vehicles), removal of oiled sediment, chemical control agents and dispersants.

8.4.2 Control Measures

Control measures that have been considered for the Otway Basin 2DMC MSS to manage the potential risk/impacts associated with hydrocarbon spill response options are listed in **Table 95**. The control measures that will be adopted are those that have been considered that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefits gained.

Table 95 Assessment of Control Measures for Hydrocarbon Spill Response

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
The SOPEP will be implemented for first strike response to level 1 and level 2 spills	P = Yes E = Effective	SLB will implement the response strategy in accordance with the SOPEP, and also in line with relevant legislation and industry standards.	Yes	Yes
Operational monitoring will be undertaken in order to inform and update the Control Agency about the behaviour of the spill	P = Yes E = Effective	Operational Monitoring (such as using the support vessel to monitor the spill) will be undertaken in the unlikely event of a hydrocarbon spill to provide up-to-date information on the fate of any hydrocarbon spill in the water. This monitoring will allow appropriate response options to be established with the Control Agency.	Yes	Yes
Contract in place with appropriate service provider to initiate real-time modelling in case of a spill	P = Yes E = Effective	Undertaking real-time modelling will provide assurances that response options can be tailored to the specific spill situation. The modelling will be used to predict the potential beaching locations (if any exist).	Yes	Yes
Hydrocarbon spill response training and competencies will be maintained throughout the Otway Basin 2DMC MSS to avoid unplanned environmental impacts due to human error	P = Yes E = Effective	Ensuring all crew have appropriate training is vital in responding to a hydrocarbon spill. Drills will also be undertaken to ensure all crew are competent in responding to spills under the vessel specific SOPEP. These drills will be conducted at regular intervals to ensure competencies are maintained for the duration of the Otway Basin 2DMC MSS.	Yes	Yes
A hydrocarbon spill will be immediately reported from the SLB onboard representative to SLB in Perth to ensure all notifications are provided as per **Section 10.7.4.2**	P = Yes E = Effective	Notifications will ensure quick and appropriate response to a spill scenario and will be in accordance with SOPEP and in accordance with relevant legislation and industry standards.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Fishing industry and other relevant marine users will be notified	P = Yes E = Effective	Communication with marine users allows those potentially affected by a hydrocarbon spill to plan activities in a manner that reduces the risk of interactions.	Yes	Yes
NEBA to be conducted prior to response actions	P = Yes E = Effective	Response actions will be based on a NEBA approach which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response	Yes	Yes
Alternative Control Measures:				
Eliminate vessels to avoid spill, and hence avoid impacts from response options.	P = No E = Very Effective	There are no practicable methods for undertaking the Otway Basin 2DMC MSS without the use of specialist seismic and support vessels.	Yes	No
Pre-activity monitoring program and development of detailed Type II Monitoring Plan	P = No E = Fairly Effective	SLB do not consider it practicable to undertaken monitoring or development of a detailed Type II monitoring program in response to the unlikely risk of a hydrocarbon spill. The characteristics of MGO will likely result in rapid dispersion. In addition, SLB will implement various controls that will reduce the risks of vessel collision; implementation of SOPEP to prevent loss of an entire tank contents.	No	No
Additional response equipment on board support vessels	P = No E = No	It is not reasonable for additional resources to be provided and maintained on support vessels in the unlikely event of a spill. These vessels are already equipped to best practice levels and supported by the National Plan. In order to carry the additional equipment (such as booms), additional vessels may be required.	No	No
Arrangements for aerial monitoring	P = No E = No	It is not considered that these resources could be mobilised faster than what can already be achieved under the National Plan arrangement.	No	No

8.4.3 Environmental Performance

The environmental performance outcomes for the response to a hydrocarbon spill are:

- Avoid secondary impacts as a result of spill response options; and
- Spill response undertaken in a manner that minimises impacts to the environment and implemented in accordance with accepted plans.

The environmental performance outcomes, as a result of the implementation of the control measures, will enable ongoing environmental performance of Otway Basin 2DMC MSS to adhere to, or improve on, the **Acceptable Levels** described within **Section 8.1.8** whilst ensuring that relevant legislation is complied with in order to avoid any health and safety risks as far as practicable, should a spill occur.

The environmental performance standards within **Table 96** have been defined to manage any potential impacts arising from responding to a hydrocarbon spill to **ALARP** and an **Acceptable Level**. Compliance with these standards will ensure that identified environmental performance outcomes above will be adhered to for the duration of the Otway Basin 2DMC MSS.

Table 96 Environmental Performance Standard and Measurement Criteria for Hydrocarbon Spill Response

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Implementation of SOPEP	In the event of a hydrocarbon spill, the vessel master will implement available controls and resources in the SOPEP	Incident Report	Vessel Master
Operational Monitoring	Support vessels undertaking the MSS are used as vessels of opportunity to monitor the spill if safe to do so and where NEBA identifies a net benefit to do so, as agreed with the Control Agency	Incident Report NEBA Report	Vessel Master
Real-time Spill Modelling	Prior to the commencement of the Otway Basin 2DMC MSS, SLB will secure services (signed contract) with a third party for provision of real-time modelling if and when required	Service contract in place prior to commencement of Otway Basin 2DMC MSS.	SLB Project Manager
Hydrocarbon spill response training and competencies	Prior to the commencement of the Otway Basin 2DMC MSS an audit is conducted to ensure all staff are trained and inducted satisfactorily to ensure they are competent in responding to a hydrocarbon spill.	Pre-mobilisation audit results	SLB Project Manager and Vessel Master
Reporting of hydrocarbon spill	Undertake initial SOPEP reporting requirements and immediately notify SLB Perth. External notifications in the event of a level 1 or level 2 spill will be carried out as per **Section 10.7.4.2**	Phone/email records. Consultation records	Vessel Master SLB Project Manager

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
48-hour look-ahead	When requested, a 'look-ahead plan' will be provided to relevant stakeholders that provides at least 48 hours' notice of the Otway Basin 2DMC MSS schedule.	Documentation of consultation and issuing of 48-hour look-ahead plans demonstrate compliance. Will be issued every 24 hours. Forms part of ongoing consultation strategy	SLB Project Manager
Conducting NEBA	Response actions will be based on a NEBA approach in consultation with Control Agency	NEBA Report	Vessel Master

8.4.4 Residual Risk

Following the implementation of the control measures in **Table 95**, the likelihood of impacts from the response to a hydrocarbon spill is *Rare*. The consequence from impacts from the response to a hydrocarbon spill is considered *Minor*, based on the discussions within **Section 8.4.1**. Therefore, using the risk matrix outlined in **Table 39**, the residual risk of an impact from the response to a hydrocarbon spill following the implementation of control measures (**Table 95**), is considered to be **Low** (**Table 97**).

Table 97 Residual Risk Summary for Hydrocarbon Spill Response

Likelihood	Consequence	Residual Risk
Rare	Minor	Low

8.4.5 Demonstration of ALARP

To demonstrate that any potential risks from the response to a hydrocarbon spill are managed to **ALARP**, a number of control measures have been considered to determine the benefits of their implementation and to ensure continual risk reduction (**Table 95**), based on a Hierarchy of Controls methodology (**Section 6.6**) as summarised in **Table 98**. The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental risks from the response to a hydrocarbon spill and assessments have been undertaken to ensure that reasonable and practicable control measures or solutions have not been overlooked. As a result, through the application of industry best practice and/or comparable standards to further control risk reduction, it is considered that any impacts from the response to a hydrocarbon spill are reduced to **ALARP**, where the residual risk is **Low** (**Table 97**).

Additional control measures were considered as part of the assessment process towards further risk reduction however it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 98 Hierarchy of Controls for Hydrocarbon Spill Response

Eliminate	The response to a hydrocarbon spill is required; however, those methods that increase the risks to the environment have been eliminated (such as chemical dispersant) as the benefit of using these methods does not outweigh the risks associated with their use. In order to fully eliminate the effects of a response would require the elimination of the seismic vessel which is required for the data acquisition and cannot be achieved.
Substitute	There are no suitable substitutes for the response to a hydrocarbon spill event.
Reduce	The methods will also be analysed in consultation with the Control Agency through a NEBA process to ensure the most appropriate method is used in responding to a spill event. Any reduction in the impacts of a response to a hydrocarbon spill will be weighed against the net environmental benefit achieved.
Mitigate	Control measures have been assessed within **Table 95** to mitigate impacts from the responding to a hydrocarbon spill to **ALARP** and **Acceptable Levels**. Those measures which are appropriate and are not impractical or unfeasible will be implemented during the Otway Basin 2DMC MSS.

The proposed control measures minimise the risk of impacts from the response to a hydrocarbon spill and are considered appropriate to the localised nature and scale of potential environmental impacts during the Otway Basin 2DMC MSS. The proposed control measures are in accordance with industry best practice. No further practicable controls have been identified to reduce the impact and risks to the marine environment and/or marine organisms from the response to a hydrocarbon spill.

Given the unlikely event of a hydrocarbon spill in the first place, and then the unlikely impact from responding to it, along with the control measures outlined within **Table 95**, it is considered that the potential risk of impacts from the response to a hydrocarbon spill has been reduced to **ALARP**.

8.4.6 Risk Acceptability

Complete elimination is not possible as the response to a hydrocarbon spill is required. Following the implementation of the control measures detailed in this assessment (**Table 95**), the residual risks to the marine environment and associated receptors from the response to a hydrocarbon spill is **Minor** (**Table 97**).

The criteria for risk acceptability is defined in **Table 40** and detailed in the following sub-sections, where the control measures that will be implemented throughout the Otway Basin 2DMC MSS have been developed in accordance with these. Where uncertainty exists around the criteria or the risk, SLB have taken a precautionary approach.

8.4.6.1 Ecologically Sustainable Development

The management of the risk proposed by SLB associated with the response to a hydrocarbon spill can be carried out in compliance with the five principles of ecologically sustainable development as defined within the EPBC Act (outlined within **Section 2.2**). These principles have been considered as part of the development of this EP and risk assessment process. The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

8.4.6.2 Legislative Requirements

The proposed control measures for responding to a hydrocarbon spill during the Otway Basin 2DMC MSS are consistent with the following relevant standards/documents:

- Australian Maritime Safety Authority Act 1990;
- International Convention on Oil Pollution Preparedness, Response and Cooperation 1990;
- United Nations Convention on the Law of the Sea 1982;
- International Convention for the Prevention of Pollution from Ships 1973;
- Protection of the Sea (Civil Liability for Bunker Fuel Pollution Damage) Act 2008;
- EPBC Act;
- EPBC Regulations; and
- Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and its associated Marine Order 91 (Marine Pollution Prevention – Oil).

8.4.6.3 Internal Context

The proposed management of the risks of an impact from the response to a hydrocarbon spill are within **Acceptable Levels** of SLB's Environmental and QHSE Policy (**Section 1.2**).

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

8.4.6.4 Industry Best Practice

The NEBA controls are in line with industry best practice with the depth of controls provided considered to reflect best practice and reasonable for the nature and scale of the activity.

The APPEA Code of Environment Practice objectives with respect to reducing the impact from events such as spills to a level which is ALARP and acceptable are met by demonstrating the adoption of appropriate management procedures for the activity and having an appropriate emergency response plan.

The IAGC Environmental Manual for Worldwide Geophysical Operations sets objectives in relation to hazardous materials for spill leak response which is met by the Otway Basin 2DMC MSS.

8.4.6.5 Stakeholder Engagement

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4**, **Appendix B** and **Appendix F**. This section also lists the additional control/mitigation measures that were agreed upon with stakeholders to address concerns that they raised in regard to the seismic survey.

During consultation with interested stakeholders no concerns about the impacts from responding to a hydrocarbon spill were raised and as such no additional control/mitigation measures were expected or put in place. As such, the environmental impacts relating to responding to a hydrocarbon spill were considered to be at a socially **Acceptable Level**.

8.4.6.6 Existing Environment Context

Following implementation of control measures the potential risk of any impacts occurring to water quality, and marine flora and fauna in the surrounding marine environment from the response to a hydrocarbon spill is unlikely. It is also highly unlikely to pose a risk to the management objectives for protected or sensitive areas (i.e. Marine parks, KEFs etc.) as a result of their location to the Operational Area, habitats (i.e. subtidal), fauna and flora present as discussed in **Section 5.3.** **A**s a result, no impacts are predicted on these existing environments that are within or surrounding the Otway Basin 2DMC MSS Operational Area from a response to a hydrocarbon spill.

Due to the open ocean nature of the Operational Area, in the unlikely event that a spill occurs, the MGO would undergo rapid and significant dilution as soon as it entered the receiving environment, and concentrations of the MGO would quickly dilute and disperse. The resulting response to a spill of this nature would be to primarily monitor and observe the spill, with the resulting impacts of such a respond principally being from additional vessels within the Operational Area.

The *South-east Commonwealth Marine Reserves Network Management Plan 2013-2023* identifies oil pollution associated with shipping, other vessels and offshore mining operations as a pressure on the conservation values of the South-east Marine Reserves Network. Two Marine Parks covered by this plan exist within the Otway Basin 2DMC MSS Operational Area (Nelson and Zeehan), with a further six within the wider environment. Most of these Marine Parks are classified 'IUCN VI' ('Protected area with sustainable use of natural resources') while the Murray Marine Park (to the west of the OA) is IUCN II classified. The *South-east Marine Region Profile Plan* does not directly identify the response to a hydrocarbon spills as a specific concern for any species, or for the two KEF's that exist in this region.

Oil pollution response, environmental monitoring and remediation activities can be undertaken with IUCN Category VI zones, when undertaken in accordance with a NOPSEMA approved EP that has met all required environmental management arrangements for the activity covered in the class approval. However, any oil pollution incident that may affect other IUCN category zones requires prompt consultation with Director of National Parks.

The proposed control measures (**Table 95**) provide appropriate protection to the marine environment from the response to a hydrocarbon spill, and from a detailed assessment process it is considered that any further/alternative control measures would give very little or no further protection from the response to a hydrocarbon spill.

The Implementation strategy for the Otway Basin 2DMC MSS (**Section 10**) provides further details of SLB's OPEP (**Section 10.7**) which details SLB's arrangements for responding to a hydrocarbon spill event.

8.4.7 Hydrocarbon Spill Response Risk Summary

Based on the discussions above, including the potential impacts on the environment and the associated controls measures to be implemented, the residual risk from the response to a hydrocarbon spill is considered to be **Low** and to **ALARP**. Therefore, the potential risk of impacts occurring from the response to a hydrocarbon spill during the Otway Basin 2DMC MSS is considered to be at an **Acceptable Level**.

8.5 Accidental Release of Hazardous and Non-Hazardous Materials

8.5.1 Description of Source of the Risk

The seismic and support vessels utilised during the Otway Basin 2DMC MSS will use and/or carry a range of chemicals onboard as part of standard day to day operations (including paints, hydraulic fluids, cleaning products etc.), and will also create a range of wastes both solid and liquid (including sewage, bottles, cardboard, paper, cans, domestic garbage and liquid wastes). Routine discharges of biodegradable wastes have been assessed in **Section 7.3** and incineration of wastes have been assessed in **Section 7.4**, while garbage waste not able to be macerated or incinerated will be stored onboard the vessel for onshore disposal at suitable facilities. The following section deals with risks and impacts associated with accidental releases of hazardous and non-hazardous materials to the marine environment during the Otway Basin 2DMC MSS. Release of hydrocarbon liquids (spills) is covered in **Section 8.3**.

Hazardous and non-hazardous materials can be accidentally released to the marine environment through machinery failure, malfunction, or operator error (such as split hydraulic hoses releasing fluids), leak from containment or inadequate clean-up of hazardous substances (such as following a split container), or if materials are lost overboard during bad weather or while transferring between vessels.

8.5.2 Known and Potential Risk to Environmental Receptors

These hazardous chemicals/liquid wastes could reduce water quality in isolated areas where discharge has occurred. This could impact on marine organisms from plankton through to large marine mammals, fish and seabirds as a result of toxic and/or sub-lethal effects. The small volumes of hazardous materials that could potentially be accidentally released from the seismic and/or support vessel are likely to be rapidly dispersed and diluted, to a point where concentrations are below levels expected to cause effects to marine organisms. The majority of any onboard spill would be contained on the vessel and cleaned up in accordance with the SOPEP and standard clean-up procedures, decreasing chances of a major release to the marine environment.

Due to the deep water and offshore nature of the Operational Area, sensitive marine habitats are unlikely to be affected as these exist primarily on the seabed and/or nearer the coastline, and the localised nature of any hazardous material release would not reach these areas. Potential decreases in water quality and effects on pelagic species following an accidental release of hazardous material would be highly localised and temporary, if any.

Non-hazardous materials such as paper, cardboard, wood, packaging can also potentially cause impacts if accidentally released into the marine environment including physical impacts to marine organisms (strangling, choking) or the benthic environment if materials sink (localised crushing, smothering), or reducing water quality (e.g. breakdown into smaller components and/or leaching of chemicals contained within the materials). However, controls are in place for the management of this waste to prevent any such discharge overboard.

The residual risk to environmental receptors arising from an accidental release of hazardous and non-hazardous materials during the Otway Basin 2DMC MSS has been assessed as **Low** (*minor* x *unlikely*).

8.5.3 Control Measures

The potential control measures that have been considered during the Otway Basin 2DMC MSS to manage any potential impacts from the accidental release of hazardous and non-hazardous materials to **ALARP** have been included in **Table 99**. These control measures have been assessed to consider the environmental benefit(s) gained through implementing the controls relative to their time, effort and monetary cost, with a clear delineation of those which will be implemented during the Otway Basin 2DMC MSS and those which won't. Justifications have been provided for each of the decisions.

Table 99 Assessment of Control Measures for Accidental Release of Hazardous and Non-Hazardous Materials

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
Implemented Control Measures:				
All wastes will be stored in suitably capped/lidded receptacles to ensure they remain secure on the vessel under all conditions.	P = Yes E = Effective	Ensuring all waste is securely stored aboard the vessel will prevent hazardous and non-hazardous wastes from being accidentally lost overboard into the marine environment. No domestic, maintenance, hazardous, solid or plastic waste will be intentionally discharged to the ocean. Such wastes will be stored onboard to be disposed at suitable facilities onshore.	Yes	Yes
All hazardous substance storage areas will be designed and maintained to have some form of containment/bunding.	P = Yes E = Effective	Containment/bunding will be in place around all locations where hazardous substances/materials are stored onboard the vessels to prevent any spilled substances/materials from entering the marine environment.	Yes	Yes
All hazardous substances carried onboard the vessel must have Material Safety Data Sheets (**MSDS**) with all crew trained in their location and use.	P = Yes E = Effective	MSDS contain detailed information about each hazardous substance and required information for handling and clean-up procedures in event of a spill, which will assist with minimising risk to the environment and workers in the event of an incident.	Yes	Yes
Suitable spill kits will be located close to location of hazardous substances to allow timely response and clean-up in event of a spill/incident	P = Yes E = Effective	Hazardous substances carried onboard the vessel will be stored in different areas and may require different methods to contain/clean-up a spill. Suitable spill kits will be located in close proximity to storage and areas of use to allow timely response and minimise risk of release to the marine environment. Crew will be appropriately trained in the use of the spill kits.	Yes	Yes
Every reasonable effort must be made to retrieve any materials lost to the marine environment and inform other marine users if any objects are lost overboard.	P = Yes E = Effective	In event materials are lost overboard, for example packaging/pallets, crew should make all reasonable efforts to retrieve the items. Where items cannot be retrieved, or cannot be found, communication with other marine users in the area should be undertaken, e.g. Notices to Mariners for large items.	Yes	Yes

Control Measure	Practicability/ Effectiveness	Justification	Impact Reduction?	Will it be adopted?
All equipment shall be regularly serviced and maintained in accordance with original manufacturer's specifications and the vessels planned maintenance schedules.	P = Yes E = Effective	To reduce the risks of equipment failure leading to accidental release of hazardous/non-hazardous materials all equipment should be regularly serviced and maintained to detect early faults/defects that could cause failures.	Yes	Yes
Vessel and equipment will be operated by trained and experienced crew	P = Yes E = Effective	Accidental release of materials may occur as a result of improper/incorrect use of onboard equipment during normal operations. Crew will not operate equipment/machinery they are not trained/experienced in operating and will follow SOP or manufacturers guidelines for operation.	Yes	Yes
All crew will participate in the vessel and environmental induction prior to the commencement of operations	P = Yes E = Effective	It is a standard industry practice to hold inductions for all onboard the vessels, with participation in induction meetings compulsory. During inductions, crew will be made aware of their responsibilities with regard to effects of discharges to the marine environment and their roles with regard to clean-up of any accidental discharges.	Yes	Yes
All equipment located on the vessel's deck that uses hydrocarbons will be surrounded by primary bunding (e.g. deck edge lip), as a minimum	P = Yes E = Effective	Accidental release of materials may occur as a result of the use of machinery on deck. Bunding contains materials onboard the vessel and allows for an appropriate clean-up response.	Yes	Yes
Deck scupper plugs will be available beside all deck drainage points that lead overboard	P = Yes E = Effective	Deck scupper plugs allow for drainage to be blocked off, stopping wastes (including hazardous wastes) from entering the marine environment through deck drainage systems.	Yes	Yes
Alternative Control Measures:				
All packaging, handling and containers to be made of biodegradable materials.	P = No E = Somewhat Effective	Some materials/substances carried onboard cannot be safely contained within biodegradable containers and attempting to do so may place crew at greater danger and increase risk of incident which could result in risk to environment.	No	No
No generation of hazardous/non-hazardous wastes onboard the vessels which require storing.	P = No E = Very Effective	Health and safety of crew requires that foods, materials, equipment be appropriately packaged for storage onboard the vessel for use at later date, thereby generating packaging wastes which must be stored aboard the vessel to be later disposed of onshore.	Yes	No

8.5.4 Environmental Performance

The environmental performance outcome for the management of environmental impacts from accidental release of hazardous and non-hazardous materials is:

- No accidental (or intentional) release of hazardous/non-hazardous materials to the marine environment from the seismic and/or support vessels during the Otway Basin 2DMC MSS.

The environmental performance outcome, as a result of the implementation of the mitigation and control measures, will allow the ongoing environmental performance of this activity to adhere to, or improve on, the **Acceptable Levels** described within **Section 8.5.7** whilst ensuring that the relevant legislation is complied with in order to avoid any health and safety risks as far as practicable.

The environmental performance standards within **Table 100** below have been defined to manage the impacts from accidental release of hazardous and non-hazardous materials to **ALARP** and an **Acceptable Level**. Compliance with these standards will ensure that the identified environmental performance outcome above will be met throughout the duration of the Otway Basin 2DMC MSS.

Table 100 Environmental Performance Standards and Measurement Criteria for Accidental Release of Hazardous and Non-Hazardous Materials

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Secure storage of generated wastes.	Generated solid wastes will be separated and securely stored in tightly capped/lidded containers/areas for later disposal onshore.	Pre-mobilisation inspection confirms suitable storage areas for generated wastes which are labelled and have appropriate means of preventing wastes from escaping.	Vessel Master
Containment/bunding of hazardous substance areas.	Areas of vessel where hazardous substances stored and used will be isolated from marine environment by suitable bunding/containment to prevent spills from being able to enter.	Pre-mobilisation inspection confirms appropriate storage and handling of hazardous materials on-board.	Vessel Master
Deck scupper plugs	Deck scupper plugs will be available beside all deck drainage points that lead overboard.	Pre-mobilisation inspection confirms presence of deck scupper plugs	Vessel Master
Bunding surrounding deck machinery/equipment	All equipment located on the vessel's deck that uses hydrocarbons will be (as a minimum) surrounded by primary bunding (e.g. deck edge lip).	Pre-mobilisation inspection confirms appropriate bunding around deck machinery/equipment	Vessel Master
MSDS for hazardous substances	MSDS for all hazardous substances (as defined in the International Maritime Dangerous Goods Code) onboard the vessel will be kept readily available in locations known to all crew.	Pre-mobilisation inspection confirms correct and in-date MSDS are onboard for all hazardous substances	Vessel Master

Control Measure	Environmental Performance Standard	Measurement Criteria	Responsible Party
Spill Kits located throughout vessels.	Spill kits of appropriate size and composition for the type/class of hazardous substance will be located close to location of these hazardous substances. Crew will be appropriately trained in how to use the spill kits and dispose of any soiled spill kits following clean up.	Pre-mobilisation inspection confirms correct type and size of spill kit and their proximity to the hazardous substance location.	Vessel Master
Participation of all crew in vessel induction	All crew will participate in a vessel induction prior to the commencement of the survey, outlining their roles and responsibilities while onboard.	Induction records show content of induction meeting and participation of crew.	Vessel Master
Prompt clean-up of spills/leaks	All leaks/spills will be cleaned up immediately upon discovery of the leak/spill with soiled response-equipment appropriately disposed of.	Vessel incident records verify actions taken to clean up any spills.	Vessel Master
Accidental releases will be documented as incidents and other marine users notified.	Hazardous/non-hazardous materials will be appropriately stored and handled and in event of accidental release the incident will be correctly reported and documented, including issuing of warnings to other marine users.	Accidental release of hazardous or non-hazardous materials occurring aboard vessels involved in the survey must be appropriately recorded in incident reports. Objects unable to be found/retrieved must be documented and communicated to other marine users nearby, such as via Notice to Mariners for large items	Vessel Master and SLB Project Lead
Vessel and equipment serviced and maintained appropriately and operated by trained and experienced crew.	Risk of equipment failure (leading to accidental material releases) reduced by regular service and maintenance according to vessel SOP, original equipment manufacturer's recommendations and vessel service schedule. All equipment to be correctly operated only by trained and experienced staff.	Pre-mobilisation inspection confirms equipment is in current test/certification and maintenance records show completed work. Staff training records show which crew hold suitable certification/training to operate equipment.	Vessel Master

8.5.5 Residual Risk

Following the implementation of the control measures in **Table 99**, the likelihood of a risk to the marine environment from accidental release of hazardous and non-hazardous materials is *Unlikely*. The consequence of accidental release of hazardous and non-hazardous materials from the survey and support vessels is considered *Minor*, based on the discussions within **Section 8.5.2**. Therefore, using the risk matrix outlined in **Section 6.5**, the residual risk of an impact occurring from an accidental release of hazardous and non-hazardous materials from the survey and/or support vessel, following the implementation of control measures (**Table 99**) is considered to be **Low** (**Table 101**).

Table 101 Residual Risk Summary for Accidental Release of Hazardous and Non-Hazardous Materials

Likelihood	Consequence	Residual Risk
Unlikely	Minor	Low

8.5.6 Demonstration of ALARP

To demonstrate that the risk from any potential impacts from accidental release of hazardous and non-hazardous materials are managed to **ALARP**, a number of control measures have been considered to assess the benefits of their implementation and to ensure continual risk reduction (**Table 99**), based on a Hierarchy of Controls methodology described within **Section 6.6** above, and as summarised in **Table 102**. The adopted control measures that will be implemented throughout the Otway Basin 2DMC MSS are considered appropriate to reduce the environmental impacts from accidental release of hazardous and non-hazardous materials from the vessel during the MSS and an assessment was undertaken to ensure that all reasonable and practicable control measures or solutions have not been overlooked. As a result, through application of industry best practice and/or comparable standards to further control risk reduction, it is considered that any impacts from the accidental release of hazardous or non-hazardous materials has been reduced to **ALARP**, where the residual risk of an impact from adoption of these control measures is reduced to **Low** (**Table 101**).

Additional control measures were considered as part of the assessment process towards further risk reduction; however, it was considered that they did not provide any further environmental benefit or were not reasonably practicable to implement. In addition, the costs (based on the experience of SLB) of implementing such measures would be disproportionate to the benefits that would be gained through their implementation.

Table 102 Hierarchy of Controls for Accidental Release of Hazardous and Non-Hazardous Materials

Eliminate	Hazardous and non-hazardous wastes will be generated during the voyage and hazardous materials are required to keep the vessels operational, thus these cannot be completely eliminated from the survey.
Substitute	While the least harmful substance that will perform the specified role will be chosen during the survey, and materials with biodegradable/recyclable packaging will be used where possible, some materials cannot be safely substituted without placing greater risk on the vessel/crew and increasing risk of accidental release.
Reduce	Waste storage areas will be tightly secured/closed to prevent accidental release overboard of materials. Equipment will be serviced and maintained appropriately, and operated only by trained and experienced personnel, to reduce risk of equipment failure which can lead to accidental releases.
Mitigate	Control measures have been assessed within **Table 78** in order to mitigate the risk of impacts from accidental release of hazardous and non-hazardous materials to **ALARP** levels. Those which are appropriate and are not impracticable or unfeasible due to disproportionately large costs will be implemented during the Otway Basin 2DMC MSS.

The proposed control measures minimise the risk of impact from accidental release of hazardous and non-hazardous materials and are considered appropriate to the localised nature and small scale of potential environmental impacts during the Otway Basin 2DMC MSS. The proposed control measures are in accordance with industry best practice. No further practicable controls have been identified to reduce the risk of impact and risks to the marine environment and/or marine organisms from the accidental release of hazardous and non-hazardous materials.

Given the likely localised nature of effects from the accidental release of hazardous and non-hazardous materials (excluding fuel/hydrocarbons), combined with the large scale of the Otway Basin 2DMC MSS, it is considered that the risk of potential impacts from accidental release of hazardous and non-hazardous materials are reduced to **ALARP**.

8.5.7 Risk Acceptability

Total elimination of all risks associated with accidental release of hazardous and non-hazardous materials cannot be achieved, as hazardous substances must be used onboard the vessel and these materials along with non-hazardous materials and the packaging that holds all these materials must be stored onboard the vessel during the survey and there are no practicable alternatives. Following the implementation of the control measures (**Table 99**) the potential risk of impacts to the marine environment and associated receptors from accidental release of hazardous and non-hazardous materials are likely to be short-term given the large spatial extent of the Operational Area in which the vessel will be working.

The criteria for risk acceptability are listed in **Table 42** and summarised in the following sub-sections, where the control measures that will be implemented throughout the Otway Basin 2DMC MSS have been developed in accordance with these criteria. Where uncertainty exists around the criteria or the risk, SLB have taken a precautionary approach.

8.5.7.1 Ecologically Sustainable Development

The management of risks by SLB associated with an accidental release of hazardous and non-hazardous materials can be carried out in compliance with principles of ecologically sustainable development as defined within the EPBC Act (outlined within **Section 2.2**). The assessment has not identified any adverse impacts to the principles of ESD, with no threats of serious or irreversible damage, no impacts to biological diversity and ecological integrity, no degradation of inter-generational equity, or negative effects on the social and economic integrity in the short or long-term.

8.5.7.2 Legislative Requirements

The proposed control measures during the Otway Basin 2DMC MSS are consistent with the following relevant standards/documents:

- MARPOL Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form;
- MARPOL Annex V Prevention of Pollution by Garbage from Ships;
- The PSPPS Act;
- Marine Order 94 (Marine pollution prevention – packaged harmful substances) 2014;
- Marine Order 95 (Marine pollution prevention – garbage) 2013; and
- Marine Notice 2017/4 MARPOL Annex V Discharges.

8.5.7.3 Internal Context

The proposed management of the impact/risks the accidental release of hazardous and non-hazardous materials is within **Acceptable Levels** of SLB's Environmental and QHSE Policy shown in **Section 1.2**.

SLB place great importance on ensuring human health, operational safety, environmental protection, quality enhancement and community goodwill. SLB have a strong focus on communication with stakeholders and the sharing of knowledge. This commitment has been made by SLB for the Otway Basin 2DMC MSS, where SLB will continue to engage regularly with all stakeholders throughout and following the completion of the Otway Basin 2DMC MSS.

8.5.7.4 Industry Best Practice

The proposed control measures to decrease the risk of an accidental release of hazardous and non-hazardous materials follows industry best practice and best practice guidelines for seismic surveys, including:

- The IAGC Environmental Manual for Worldwide Geophysical Operations which recommends that:
  - Vessels ensure they have MSDS for all hazardous materials and that they are up to date (i.e. within four years of issue date);
  - Carry suitable spill kits;
  - No direct discharge of any products into the sea;
  - Vessels ensure hazardous materials are handled and stored correctly;
  - Records are kept of hazardous material use, storage, disposal and incidents/spills; and

- The APPEA Code of Environmental Practice which recommends that suitable waste management practices are used based on preventing, minimising, recycling, treating and disposing of wastes in accordance with any statutory requirements and procedures.

8.5.7.5 Stakeholder Expectations

Stakeholder consultation has been undertaken with a large range of groups across South Australia, Victoria and Tasmania, as well as local and central government. A full breakdown of the stakeholder consultation undertaken, including the groups engaged with and any areas of concern that they raised have been detailed in **Section 4** and **Appendix F**.

During consultation with interested stakeholders no concerns were raised in regard to the risks of accidental release of hazardous and non-hazardous materials. As such the risk of environmental impacts relating to accidental releases of hazardous and non-hazardous materials from seismic survey and support vessels were considered to be at a socially **Acceptable Level**.

8.5.7.6 Existing Environment Context

Following implementation of proposed control/mitigation measures the potential risk of impacts to water quality, and marine flora and fauna from the accidental release of hazardous and non-hazardous materials is unlikely to pose a risk to management objectives for protected areas (i.e. marine parks) and no effects on KEFs are predicted.

A spill of a hazardous liquid substance would likely to be limited to the size of the container within which it is transported, generally 20 L or smaller, or the volume of a line or fluid vessel within a failed piece of equipment (e.g. a hydraulic fluid line or cylinder). Due to the open ocean nature of the Operational Area in the event that this volume of substance reached the ocean there would be rapid, significant dilution in the receiving environment, and concentrations of any harmful substance would become quickly diluted and dispersed. Impacts to marine organisms in this situation, if any, would likely be very localised and short-term in duration.

The *South-east Marine Region Bioregional Plan* does not directly identify marine debris as a specific concern for any specific species, or for the three KEFs that exist in this region (the Bonney Coast Upwelling, the West Tasmania Canyons and Shelf Rocky Reefs and Hard Substrates). However, in the event accidentally released solid materials sinking and reaching the seabed, this could potentially cause physical damage to fragile benthic communities that exist around the West Tasmania Canyons, although only in the very small area where the material landed. The proposed control measures in place to reduce the risk of accidental release of hazardous and non-hazardous materials and subsequent potential environmental impacts will ensure that the integrity of the IUCN reserve management principles will be maintained throughout the survey.

The Otway Basin 2DMC MSS Operational Area overlaps or is near to the BIA for three species of whale, the white shark, Australian sea lions and 17 species of seabirds, as well as being within the foraging area of the leatherback turtle. The area is within or adjacent to several important commercial fishing areas including southern bluefin tuna, squid, shark, abalone and rock lobster, although the latter two fisheries are predominantly inshore near the coast. Marine debris such as plastic wastes and/or packaging can potentially pose a choking/strangulation risk for many marine organisms. The proposed control measures (**Table 99**) provide appropriate protection to the marine environment from the a potential accidental release of hazardous and non-hazardous materials and the associated effects (physical seabed damage, reduction in water quality, floating marine debris), and further/alternative control measures would give very little or no further protection from accidental release of hazardous and non-hazardous materials while greatly increasing time and cost of the survey.

8.5.8 Accidental Release of Hazardous and Non-Hazardous Material Risk Summary

Based on the discussions above, including the potential impacts on the environment and the associated controls measures to be implemented, the residual risk of an accidental release of hazardous and non-hazardous materials from the survey and support vessels is considered to be **Low** and to **ALARP** levels. Therefore, the impacts from this activity associated with the Otway Basin 2DMC MSS are considered to be at an **Acceptable Level**.

9 Cumulative Effects

Cumulative effects of seismic energy are possible due to a number of different scenarios, including:

- Multiple MSS being conducted in the same area, at the same time – acoustic footprints overlap in space and time;
- Multiple MSS undertaken consecutively - two or more MSS undertaken across the same area within a short period of time;
- Multiple exposures during a single MSS – including infill of seismic data gaps within the same survey; and
- Interaction between different sources of sound – e.g. vessel noise and seismic energy.

Any of these scenarios could increase the overall underwater sound exposure for key receptors to levels that are above those associated with the conduct of a single MSS. Acoustic energy from multiple seismic surveys and shipping traffic are of particular interest as these are the two most likely potential contributors to cumulative effects of underwater noise in the Otway Basin. There is also a high likelihood that infill of seismic data gaps will be required. The noise impacts of infill lines have been identified throughout **Section 7.2**

9.1 Concurrent Marine Seismic Surveys

To check for the potential occurrence of concurrent seismic surveys in the Otway Basin, an online search of NOPSEMA's 'Activity Status and Summaries' web page was undertaken to identify any EP applications, or recently approved EPs that overlaps with the Otway Basin 2DMC MSS Operational Area or are scheduled to occur within nearby areas. Four EPs were identified in this process with their details and status provided in **Table 103**.

Table 103 Marine Seismic Survey Environmental Plans recently submitted to NOPSEMA

Survey Name	Applicant	Date of EP submission	Status
Otway Deep Marine Seismic Survey	Spectrum Geo Australia Pty Ltd	08/05/2018	Under Assessment – Opportunity to modify EP. Resubmission due 1/03/2019
Duntroon MC2D/3D	PGS Australia Pty Ltd	27/02/2017	Accepted EP Approved on 14/01/2019
Dorrigo 3D Marine Seismic Survey	3D Oil T49P Pty Ltd	30/01/2019	Under Assessment Request for further information – due 14/4/2019
CGG Gippsland Marine Seismic Survey	CGG Services (Australia) Pty Ltd	8/10/2018	Accepted EP Approved on 25/02/2019

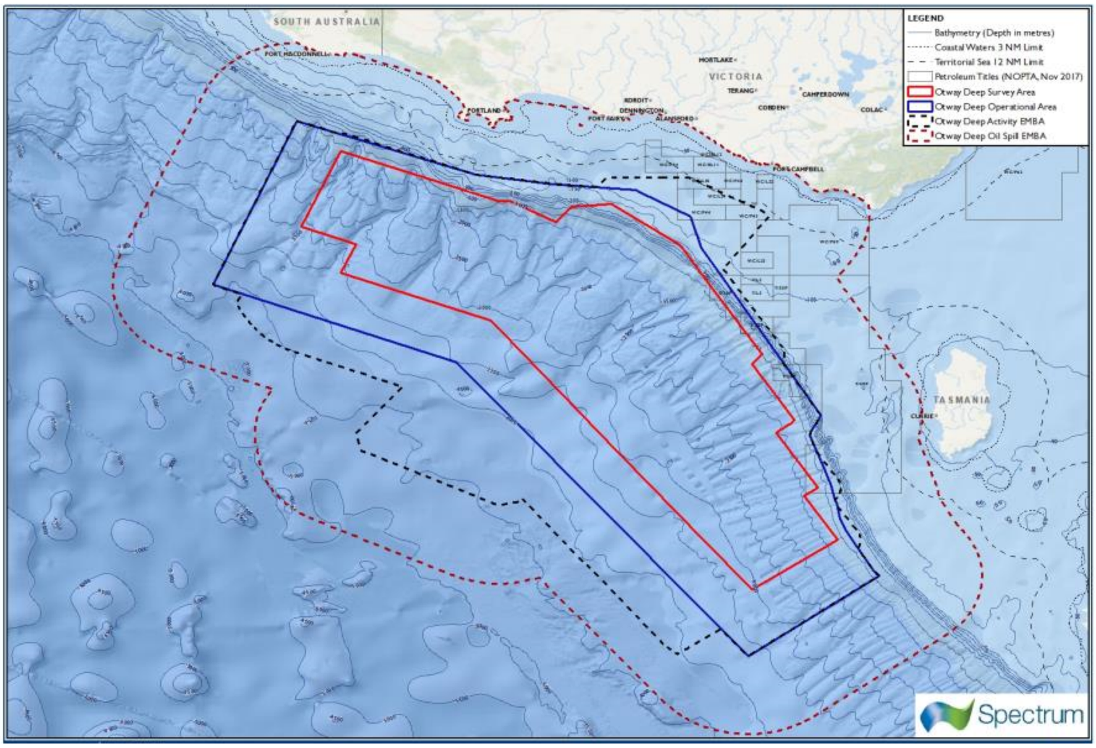
Spectrum Geo's Otway Deep 3D MSS is proposed for an area that is similar to SLB's proposed Otway Basin 2DMC MSS (**Figure 74**). The proposed Otway Deep MSS encompasses 23,620 km^2 and is scheduled to occur between 1 October 2018 and the end of February 2020 with the survey duration being a maximum of 120 days duration. Spectrum Geo's EP was not accepted as NOPSEMA were not reasonably satisfied and provided Spectrum Geo with the Opportunity to modify their EP. SLB are uncertain of their timing for resubmission or their intended acquisition date; however, to assess for worst-case it has to be assumed that there is the potential for an overlap spatially and temporally with the Otway Basin 2DMC MSS.

Further west, PGS had their EP accepted by NOPSEMA in January 2019 for the Duntroon MC2D and MC3D MSS in the Great Australian Bight (**Figure 75**). The Operational Area encompasses 30,100 km^2 and the surveys are scheduled to be acquired from 1st September to 30th November 2019 (Season 1), with further provision from the 1st September to 30th November 2020 (Season 2). There is potential that the Duntroon MSS could overlap temporally with the Otway Basin 2DMC MSS; however, they will not spatially overlap as the two Operational Areas are 300 km apart, which is more than seven times the 40 km separation distances proposed to separate concurrent MSS.

To the east, 3D Oil are proposing to undertake the Dorrigo 3D MSS in the Otway Basin, located 18 km to the west of King Island and 56 km south of Cape Otway (**Figure 76**). The proposed 3D survey has an Operational Area of 4,350 km^2, with 1,580 km^2 of 3D data coverage to be acquired within this area. 3D Oil are proposing that the survey if approved would commence between 1 September 2019 and 31 October 2019; which would potentially result in a temporal overlap with the Otway Basin 2DMC MSS. The EP was submitted to NOPSEMA on 30th January 2019 and NOPSEMA have put the application on hold and requested further information from 3D Oil on the application.

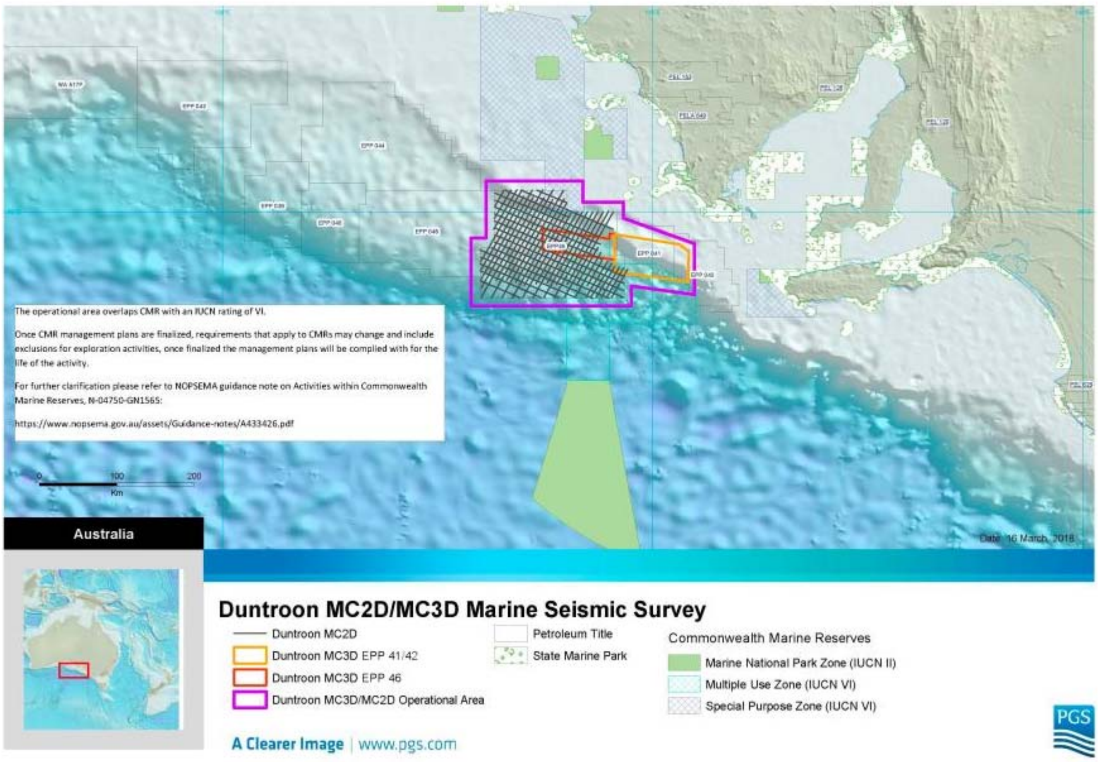
Further to the east in the Gippsland Basin offshore Victoria, CGG have recently being granted approval for their 3D multi-client MSS, located approximately 125 km offshore (**Figure 77**). The Operational Area is 13,421 km^2 with a proposed acquisition of 3D data covering 11,161 km^2. The exact timing of the survey is yet to be confirmed but will have a duration of 6.5 months and will be conducted between March 2019 and the end of July 2020. With the proposed timing it is likely that there will be a temporal overlap with the Otway Basin 2DMC MSS; however, the Operational Area is located 400 km from the Otway Basin 2DMC MSS Operational Area which is ten times the 40 km separation distance proposed to separate concurrent MSSs.

Figure 74 Proposed Operational Area for the Spectrum GEO Otway Deep 3D MSS



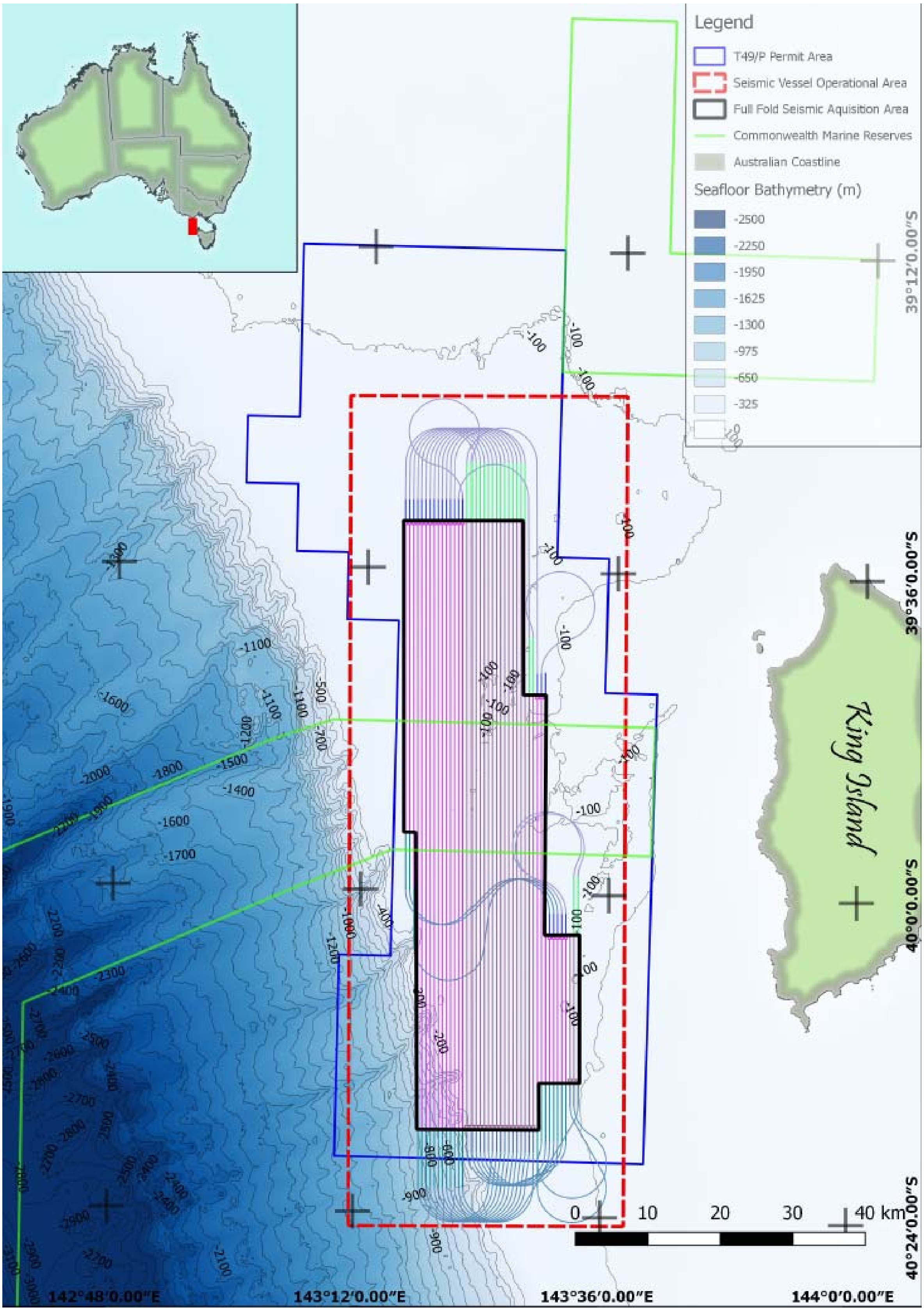
Source: https://www.nopsema.gov.au/environmental-management/activity-status-and-summaries/details/434

Figure 75 Operational Area for the PGS Duntroon MC2D and MC3D MSS



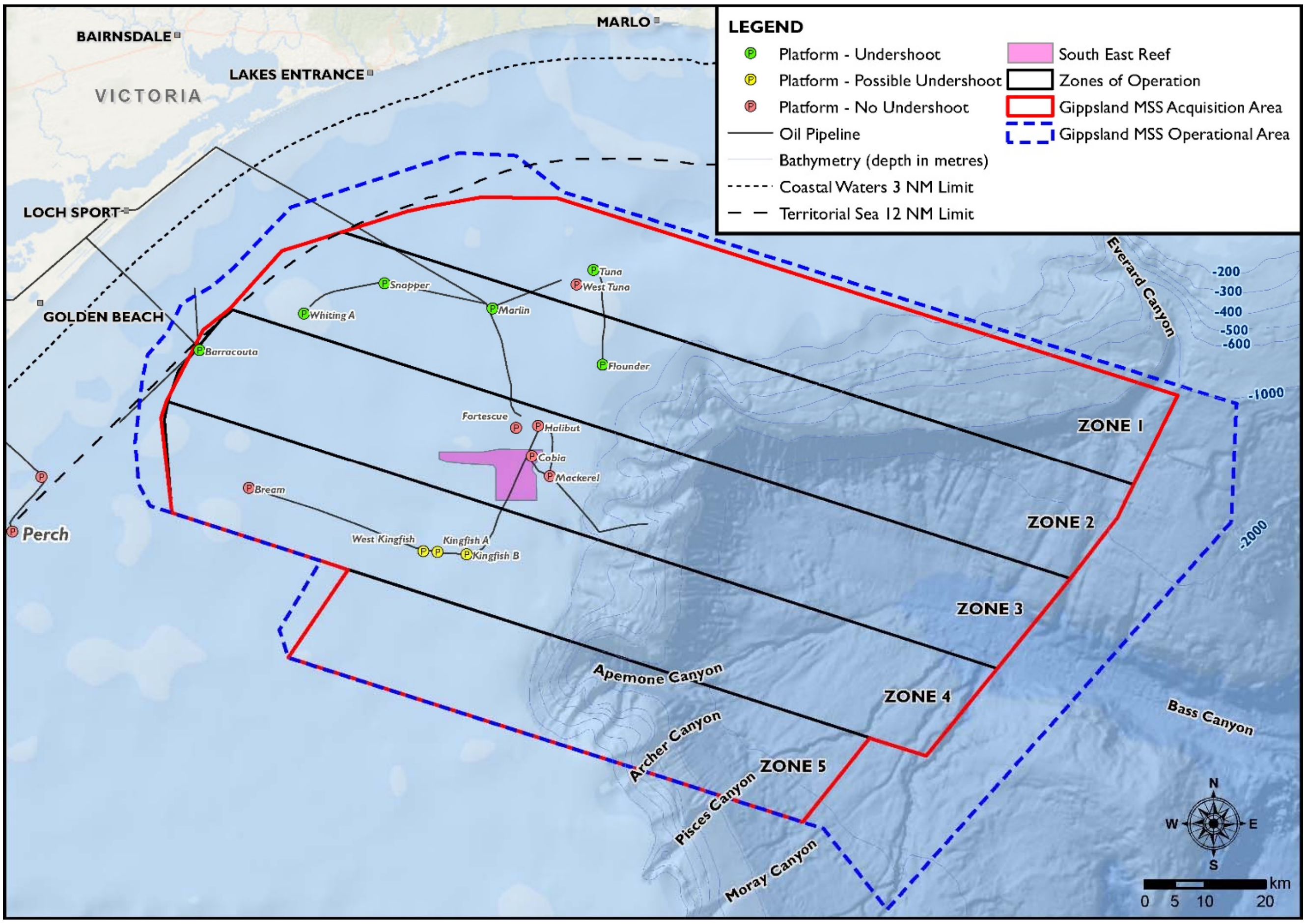
Source: https://www.nopsema.gov.au/environmental-management/activity-status-and-summaries/details/387

Figure 76 Proposed Operational Area for the 3D Oil Dorrigo 3D MSS



Source: https://www.nopsema.gov.au/environmental-management/activity-status-and-summaries/details/462

Figure 77 Operational Area for the CGG Gippsland 3D MSS



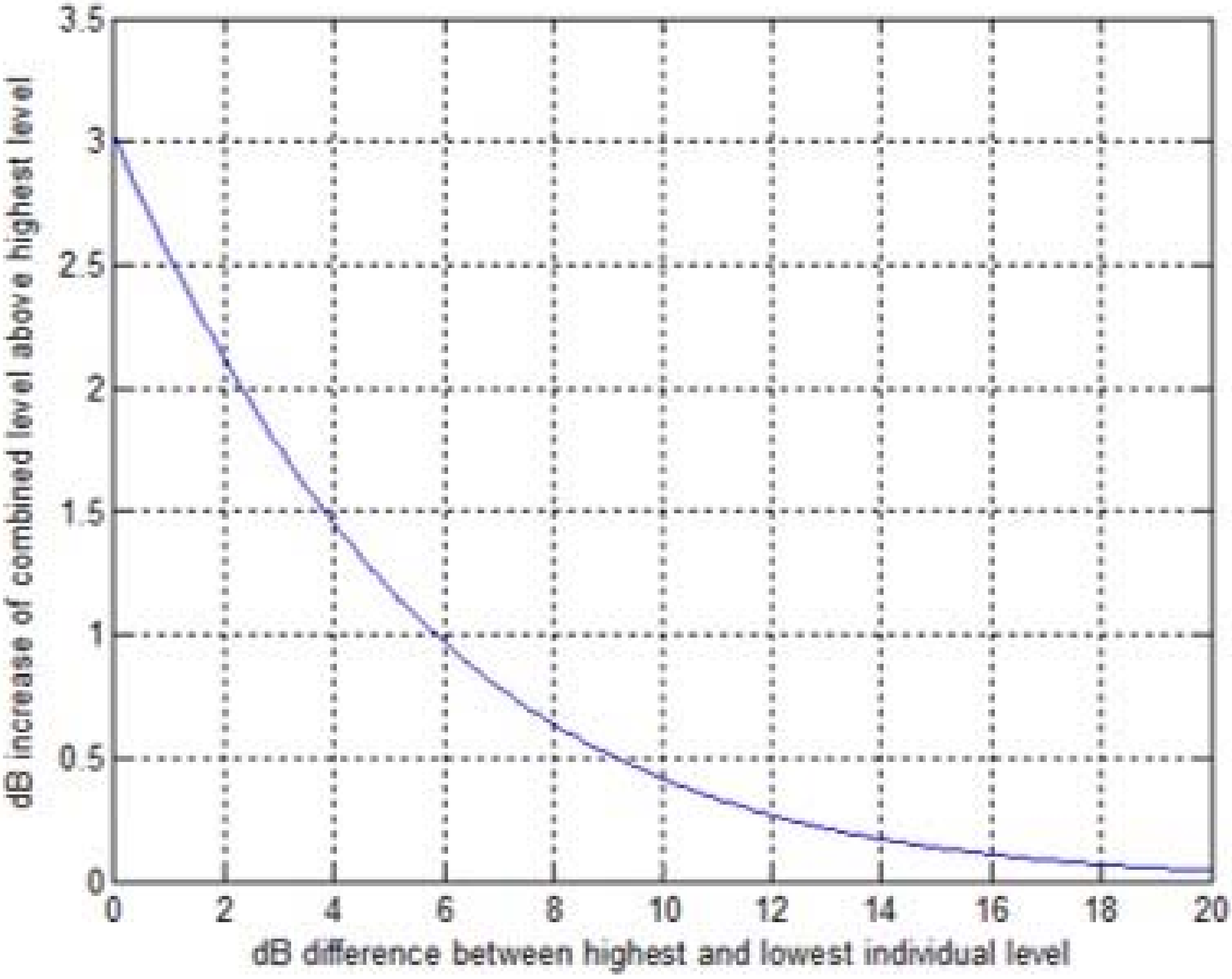
Source: https://www.nopsema.gov.au/environmental-management/activity-status-and-summaries/details/446

Because low frequency acoustic energy from seismic surveys travels large distances underwater, the overall acoustic footprint associated with an MSS can be extensive (**Section 7.2.1.3.3**). Cumulative impacts are much more likely to occur when two surveys are operating close together in time or space (or both). It is considered that a cetacean may be able to reorient and cope with a single sound source emitted from a seismic survey but may be less able to cope with multiple sources; however, this is still unproven. From the STLM results, the distances of the PGS and CGG Operational Areas (300 and 400 km respectively), the emitted SELs will be at ambient levels well before this distance (i.e. 200 km – depending on bathymetry) (**Figure 65**).

With regard to the potential temporal and spatial overlap of SLB's Otway Basin 2DMC MSS and the other MSS that may potentially occur at a similar time listed in **Table 103**, it is important to consider how multiple acoustic footprints from seismic surveys combine.

When acoustic outputs from two different seismic surveys combine the outcome is counter-intuitive; whereby the largest difference between the combined and individual SELs will be 3 dB re 1µP^{2}s, and this will only occur at locations where both surveys produce the same SEL's. In other words, if at a given location, Survey A by itself would produce a SEL of 160 dB re 1µP^{2}s, and Survey B by itself would also produce an SEL of 160 dB re 1µP^{2}s, then the two surveys combined will produce an SEL at the same location of 163 dB re 1µP^{2}s (*Expert 5 – Sensitive Information*). However, if one survey produces a higher SEL, then the higher SEL will dominate to the point where if Survey A produces an SEL of 6 dB re 1µP^{2}s higher than Survey B, then the combined level is 1 dB re 1µP^{2}s higher than the higher of the individual SELs (i.e. Survey A) (**Figure 78**).

Figure 78 Combined Sound Exposure from two Seismic Sources



Source: *Expert 5 – Sensitive Information*.

To reduce the risk of cumulative impacts from concurrent MSS, recent best practice is to maintain a spatial separation of at least 40 km between the active seismic sources (BOEM, 2014). SLB will manage seismic data acquisition during the Otway Basin 2DMC MSS to maintain a minimum separation distance of 40 km from any other MSS being undertaken in the region. Maintaining a separation distance of this magnitude will ensure multiple active sound sources do not overlap and therefore will not cause higher SEL for marine species. This approach reduces the risk from cumulative noise effects to **ALARP**.

9.2 Consecutive Marine Seismic Surveys

In addition to assessing potential risks from concurrent MSS, a search was undertaken of NOPSEMA's website for MSS that have been recently undertaken in the vicinity of the Otway Basin 2DMC MSS Operational Area. Only one recent MSS was identified.

The Crowes Foot 3D Seismic Survey was acquired in the Otway Basin in Q4 2016 in the Otway Basin, where it was located 15 km southwest of Cape Otway and 67 km northwest of King Island, northeast of the existing Thylacine production platform (**Figure 55**). This survey area was located inshore of the Otway Basin 2DMC Operational Area and was acquired three years prior to the proposed commencement data of the Otway Basin 2DMC MSS. As a result, there is not expected to be any potential for cumulative impacts on marine receptors from seismic energy released from the Crowes Foot survey within the general Otway Basin area.

In addition, recent research indicates that short-term (acute) noise exposures (like those associated with seismic surveys) are less likely to affect marine species at a population level compared to long-term (chronic) noise exposures (Ellison *et al*., 2016).

A recent study by CSIRO (Richardson *et al*., 2017) concluded that zooplankton biomass recovered to a pre-seismic survey inside the seismic area and within 15 km in only three days following the completion of the survey. The rapid recovery was attributed to zooplankton's fast growth rates and the dispersal and mixing of zooplankton from both inside and outside of the impacted region. These authors state that MSSs conducted in areas of high energy ocean circulation (such as the Otway Basin) are likely to have less net impact on zooplankton due to the continual movement of the water mass, and that seismic lines conducted perpendicular to the prevailing current flow (as proposed for the Otway Basin 2DMC MSS) reduce the chance of zooplankton being exposed multiple times because the zooplankton are moving across the line of seismic travel. The authors also indicated that surveys off the shelf edge are likely to have less absolute impact due to lower biomass in the water column offshore.

For these reasons, undertaking two successive seismic surveys across the same general area is not expected to affect populations of marine species residing in, or passing through the Otway Basin 2DMC MSS Operational Area.

SLB are not aware of any additional proposed MSSs for the Otway Basin, and given the timeframe for gaining regulatory approval for an EP, it is unlikely that any new projects that commence now would contribute to potential cumulative effects within the Otway Basin 2DMC MSS Operational Area. However, during the approval process if SLB became aware of another MSS being approved for the Otway Basin, the potential for cumulative effects from spatially and/or temporally overlapping surveys would be reassessed.

9.3 Multiple Exposures – Infilling

The acquisition of seismic data during an MSS is pre-planned along parallel seismic lines that are spaced apart to provide sufficient coverage of the subsea geology. During the acquisition of seismic data, occasional gaps in the data coverage occur, due to a variety of possible causes, such as malfunction of seismic equipment, minor navigation errors causing the vessel to move off-track, data errors, or enforced periods of non-acquisition due to interactions with marine species, weather constraints or vessel issues. These data gaps may negatively impact on the overall integrity and usefulness of the seismic data and prevent the objectives of the survey being achieved. Critical gaps in the seismic data coverage require 'infilling' with new data and the seismic vessel is required to re-run data acquisition across each area of data gap.

Infilling has the potential to expose resident marine species, such as site-attached benthic species, to a second dose of seismic energy within a relatively short period of time. The time interval between initial data acquisition and infilling depends on a variety of factors, including data processing, vessel scheduling, local conditions and competing data priorities. Re-acquisition time intervals typically vary from a few hours to a few days, with longer intervals expected to reduce the seismic exposure risk to site-attached species. Note however that Przeslawski *et al.* (2016) concluded that none of the most recent studies (i.e. Parry *et al.*, 2002; Harrington *et al*., 2010; Aguilar de Soto *et al.,* 2013; Day *et al.*, 2016a) indicate that MSSs cause catastrophic or short-term mortality on benthic shellfish (scallops) under realistic exposure scenarios. Furthermore, Przeslawski *et al.* (2016) state that effects on the catch rates or abundances have not been detected for cephalopods, bivalves, gastropods, decapods, stomatopods, or ophiuroids (Wardle *et al.,* 2001; Parry *et al.*, 2002; Christian *et al.,* 2003; Parry & Gason 2006). These scientific results indicate that MSSs, especially in the deep-water areas proposed for the Otway Basin 2DMC MSS, are unlikely to impact site-attached benthic species, and therefore infilling is equally unlikely to affect the benthic species.

As a result of the calculations determined from the survey parameters and the STLM results (**Section 7.2.1.3.4**), SLB will undertake infilling with a minimum interval of 5 hours between initial data acquisition and the infill run. In many cases a longer time period than this is likely, but any repeated noise exposure at a location within 24 hours would contribute to cumulative noise exposure for assessment to the noise thresholds and to determine zones of impact. The noise impacts of infill lines occurring within a minimum up 5 hours and up to 24 hours and the resulting increase in zones of impact for particular species have been identified throughout **Section 7.2**.

9.4 Multiple Sound Sources

Cumulative noise impacts can also occur due to seismic activities overlapping with existing background noise in and around the Operational Area, such as from commercial vessels. **Section 5.5.3** provides details on the commercial shipping activity that occurs off southern Australia. High level vessel traffic occurs in this area due to commercial vessels moving between Australia's east and west coasts, and vessel noise is an ongoing and currently unquantified component of the soundscape within the Operational Area.

The Otway Basin 2DMC MSS will comprise of one seismic vessel and one smaller support vessel therefore the increase in vessel noise will be small compared to the regular movement of commercial vessels within the Operational Area and wider area. The 'background' noise levels associated with busy shipping areas is known to affect the communication calls between marine mammals due to 'masking', whereby calls are not as easily heard above the noisy background. Masking is a complex phenomenon and masking levels are difficult to predict for any particular combination of sender, environment, and receiver characteristics (Erbe *et al*., 2016).

The Otway Basin is frequently transited by large commercial vessels and hence shipping noise is an existing feature of these waters and marine mammals that are resident within the area are likely to have adapted to the persistent background noise. In the presence of constant noise, marine mammals sometimes adapt their vocalisations in order to overcome the effects of masking (e.g. McGregor *et al*., 2013) (also see **Section 7.2.2**). In contrast to marine mammals that are resident within the Operational Area, marine mammals that seasonally migrate through the Operational Area are more likely to experience masking effects from vessel noise and noise generated during the Otway Basin 2DMC MSS.

The cumulative effects of exposure to multiple sound sources may be more relevant at the population level on a chronic basis than at the individual level on an acute basis (Ellison *et al*., 2016), and therefore introducing short-term (acute) seismic-based noise to an area that has an existing high background of vessel noise, such as the Otway Basin, is unlikely to impact marine species at the population level.

Marine environments differ in their resilience to anthropogenic stressors (Ban *et al*., 2010), and the potential for cumulative effects is likely to be related to physical features such as water depth, seabed characteristics and coastline shape. A higher risk from noise is evident in shallow waters and enclosed bays where the attenuation potential is lower, whereas open coastlines allow sound to dissipate more rapidly and therefore the risk is lower.

9.5 Conclusions

The potential for cumulative noise impacts associated with the Otway Basin 2DMC MSS is low considering that:

- There are two recently approved EPs for MSSs in the Gippsland Basin and Great Australian Bight; however, these MSS have Operational Areas which are located 400 km and 300 km from the Otway Basin 2DMC MSS Operational Area respectively. Spectrum Geo's currently have an EP under consideration by NOPSEMA which is currently on hold as NOPSEMA were not reasonably satisfied and provided Spectrum Geo with the opportunity to modify the EP. If the Otway Deep MSS is approved and overlaps in space and time with the Otway Basin 2DMC MSS, SLB will implement a 40 km separation zone between the two active seismic sources to reduce impacts to **ALARP** and given the large separation distances between the CGG and PGS MSSs, no separation distances will have to be maintained, as the survey locations do that already;
- Recent modelling by CSIRO (Richardson *et al.,* 2017) indicates that zooplankton recovers within three days following a MSS. So, any potential for spatial overlap, albeit very remote, is unlikely to have any impact on zooplankton populations with the separation zones in place. There is no scientific evidence that site-associated benthos is impacted by seismic energy (Przeslawski *et al*., 2016). Population effects are only associated with chronic exposure to noise (Ellison *et al*., 2016), not short-term exposures like those associated with an MSS;
- The necessity of infilling critical gaps in the seismic data is not expected to significantly increase sound exposure impacts on marine species, especially since the open ocean environment of the Otway Basin 2DMC MSS Operational Area will ensure continual movement and mixing of the water mass, moving planktonic species away from the seismic lines during the period between initial data acquisition and infilling. As indicated above, there is no scientific evidence that site-associated benthos is impacted by seismic energy (Przeslawski *et al*., 2016). The zones of impact to various species exposed to SELs during infill lines are identified throughout this EP; and
- The Otway Basin 2DMC MSS Operational Area has a high commercial vessel activity, with a high-level of background noise to which resident marine species are likely to be acclimated. Additional vessel noise associated with the seismic vessel and support vessel will be small compared to the background. The introduction of short-term (acute) seismic-based noise to this area that has an existing high background of vessel noise is unlikely to impact marine species at a population level.

10 Implementation Strategy

Regulation 14 of the Environment Regulations requires an EP to contain an implementation strategy. As outlined within NOPSEMA (2016), the implementation strategy must describe the specific measures and arrangements that will be implemented for the duration of the MSS to ensure that:

- All of the environmental impacts and risks of the activity will be continually identified and reduced to a level that is **ALARP**;
- Control measures detailed in the EP are effective in reducing the environmental impacts and risks of the activity to **ALARP** and **Acceptable Levels**;
- Environmental performance outcomes and standards set out in the EP are met;
- Arrangements are in place to respond to, and monitor impacts of, oil pollution emergencies; and
- Stakeholder consultation is maintained through the activity as appropriate.

The following sections outline the methods in which SLB will conform to the requirements of Regulation 14.

10.1 Schlumberger Environmental Management System

As defined within Regulation 4 of the Environment Regulations, an Environmental Management System includes the responsibilities, practices, processes and resources used to manage the environmental aspects of an activity. The design and implementation of the Otway Basin 2DMC MSS will be conducted within the framework of SLBs HSE Management System.

The underlying approach for the Environmental Management System and the EP in general, is based on the Plan-Do-Check-Act concept outlined within AS/NZS ISO 14001:2016. This is followed through the EP by planning various control measures to reduce impacts and risks to **ALARP** and **Acceptable Levels**, implementing these controls during the Otway Basin 2DMC MSS, checking these controls are operating effectively utilising appropriate monitoring, recording and auditing, then ensuring any changes required are done through a Management of Change (**MoC**) process.

The key components of the HSE Management System include:

- Undertaking the Otway Basin 2DMC MSS in accordance with the QHSE Policy (**Figure 1**) and this EP;
- Ensuring any change to operations are managed through a MoC procedure (**Section 10.4.6**);
- The implementation, management and review of the EP (including during emergencies or potential emergencies) follows the chain of command outlined within the Roles and Responsibilities (**Section 10.2**). This includes appropriate communication establishing the flow of information in order to achieve the relevant operational tasks and states environmental performance (**Section 10.2.1**);
- Applicable training and competency are managed through SLBs Training Management System (**Section 10.3**) to ensure critical control measures that are in place can be effectively implemented;
- Undertaking inspections, audits and management of compliance in accordance with **Section 10.4**, including the review of the EP to ensure ongoing reduction of risks and impacts to **ALARP** and **Acceptable Levels** for the duration of the Otway Basin 2DMC MSS; and
- Relevant reporting procedures described in **Section 10.6** are followed. These include environmental performance reporting, environmental incident reporting, marine mammal observation reporting, marine mammal collision reporting and marine pest/disease reporting.

As part of SLBs Environmental Management System, SLB has undertaken comprehensive consultation during the development of this EP (**Appendix B**, **C**, **D** & **F**) and are committed with ongoing consultation with relevant authorities of the Commonwealth, State and all other relevant interested persons and organisations. The ongoing stakeholder engagement strategy is outlined in detail within **Section 4.5.8**.

Various management plans and operational procedures will be implemented for the duration of the Otway Basin 2DMC MSS to ensure that environmental performance measures stated throughout the EP are achieved. Primarily, the Otway Basin 2DMC MSS will be undertaken in accordance with a project-specific HSE Plan. In addition, the vessel contractor will have their own suite of operational procedures and management plans that will apply to the vessels utilised for the MSS. The key safety and environmental policies, operational procedures and management plans that are relevant to the Otway Basin 2DMC MSS include:

- The contents of this EP;
- SLB QHSE Policy (**Figure 1**);
- Vessel specific SOPEP;
- Vessel specific Ballast Water Management Plan;
- Vessel specific Garbage Management Plan; and
- Vessel specific SEEMP.

In addition to the above, a project-specific HSE Plan will be developed that SLB and the vessel operator will abide for the duration of the Otway Basin 2DMC MSS. This Otway Basin HSE Plan will be tailored to capture all of the environmental management measures proposed for implementation during the Otway Basin 2DMC MSS, including meeting the various environmental performance outcomes and environmental performance standards, in order to reduce the potential impacts and risks from the MSS on the receiving environment to **ALARP** and an **Acceptable Level**.

10.2 Roles and Responsibilities

As stated in the NOPSEMA Guidance Note (NOPSEMA, 2016), a clear definition of the roles and responsibilities of all personnel involved in the Otway Basin 2DMC MSS ensures effective and consistent implementation of SLB's commitments to reducing potential impacts to the receiving environment to **ALARP** and an **Acceptable Level** as outlined in this EP.

While the Vessel Master has the overall responsibility to maintain health and safety standards for everyone on-board the seismic vessels, it is the responsibility of all SLB employees and contractors to apply the requirements of any HSE Policy and to ensure that their work is carried out in a safe manner and in a way that minimises any further potential risk to the receiving environment.

Table 104 outlines the roles of SLB employees and contractors that will be involved in the proposed Otway Basin 2DMC MSS and their responsibilities for the duration of the survey.

The organisation structure of the SLB management team and HSE representatives is provided in **Figure 79**. This is the management structure that will be in place for the duration of the Otway Basin 2DMC MSS.

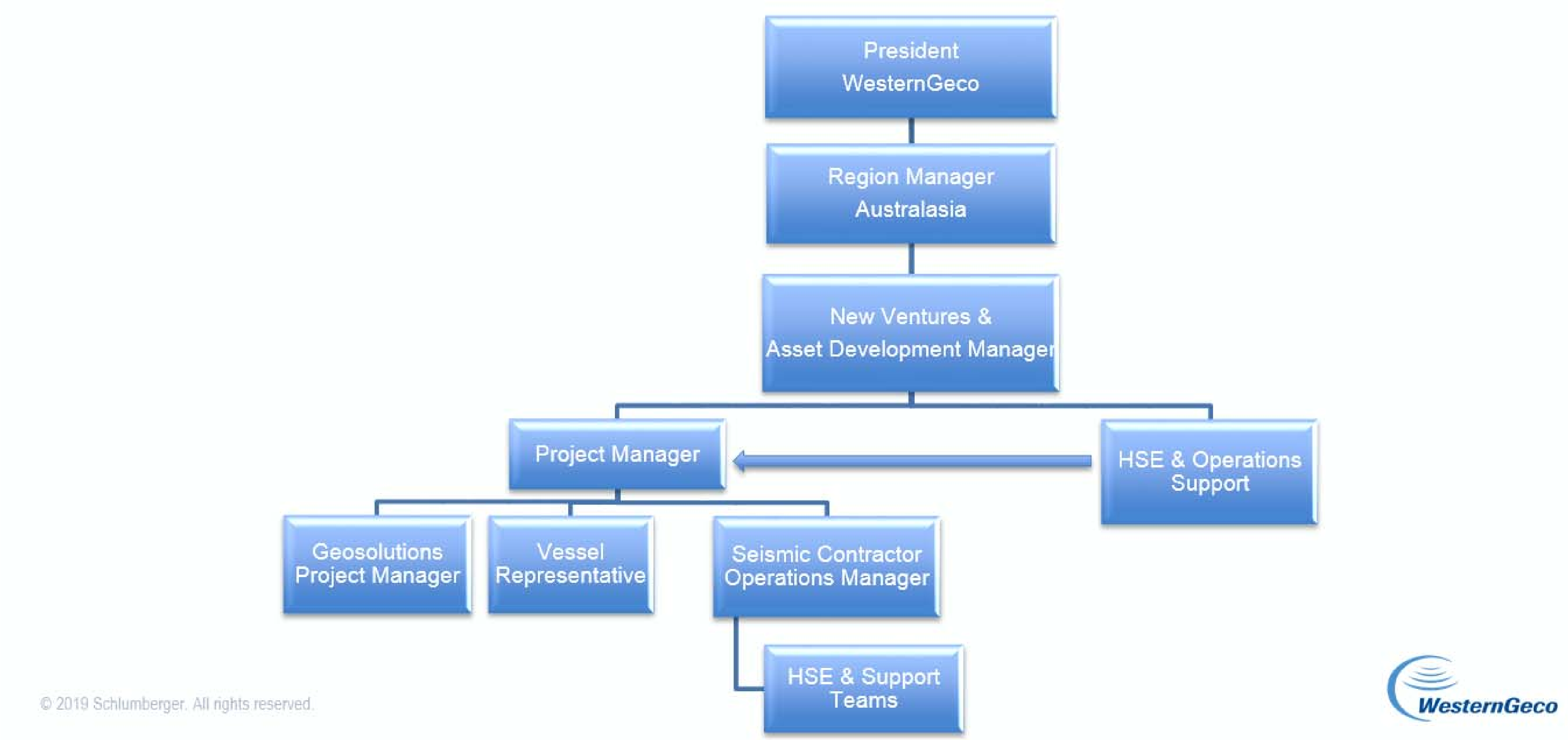
Table 104 Roles and Responsibilities during the Otway Basin 2DMC MSS

Role	Responsibility
SLB Director	• Overall accountability for the Otway Basin 2DMC MSS; • Overall accountability for compliance with the SLB HSE Management System; and • Ensures staff members are provided with sufficient resources to ensure compliance with regulatory requirements and that all statutory approvals are obtained prior to the commencement of MSS activities.
SLB Project Manager	• Coordinates all regulatory approvals required for the Otway Basin 2DMC MSS; • Responsible for hiring qualified and experienced MMOs and PAM Operators; • Ensures all reporting required under **Section 10.6** occurs in accordance with the relevant requirements; • Responsible for all consultation activities and ensures that ongoing consultation is carried out in a manner that is consistent with SLB's stakeholder strategy (**Section 4.5.8**); • Ensures all records are kept and maintained, and made available to relevant authorities on request; and • Ensure that any review of, and change to, the EP is undertaken in accordance with SLB's MoC process (**Section 10.4.6**).
SLB Onboard Representative	• Reports to SLB Project Manager; • Responsible for notifying SLB Project Manager of any incidents and maintains the collection of records; • Responsible for the internal recording and reporting of any HSE incidents and leads the investigation on such incidents; • Ensures that the relevant records and monitoring data is undertaken; • Ensures that all vessel crew are adhering to the requirements stipulated within the EP; • Responsible for carrying out any HSE inductions with regard to requirements of the EP and any internal SLB policies; • Conducts environmental inspections/audits of the survey activities against the EP; and • Prepares and submits daily status reports to SLB Project Manager.

Role	Responsibility
Vessel Master (seismic and support vessels)	• Overall control of vessel and operates vessel in a safe and responsible manner, and is responsible for the management of health and safety of all crew; • Ensure vessel complies with all relevant legislation such as the Navigation Act 2012, COLREGs, UNCLOS, MARPOL and the EPBC Regulations 2000 (with regard to interactions between the vessel and cetaceans); • Ensure compliance with the approved EP and associated control measures are enforced; • Provide schedule updates for Notice to Mariners to the AHO; • Maintain clear communication with vessel crew; • Ensure all crew members go through a vessel induction when first board the vessel, and on each crew change so that they are aware of their roles and responsibilities and any work place health and safety requirements/hazards while on-board the vessel; • Ensure all maintenance, emergency drills, and training are undertaken to schedule and all records are maintained; • Liaise with all SLB representatives including SLB On-board Representative and SLB Project Manager; and • Notify the appropriate authorities of any incidents at sea (e.g. collision, near-miss, hydrocarbon spill, etc.) and follow-up with any required actions.
Watch keeper	• Maintenance of bridge watch in compliance with the International Convention of Standards of Training, Certification and Watch keeping for Seafarers, including visual scanning, and monitoring of AIS and radar systems.
Party Chief	• The ultimate leader of the seismic operators and survey crew; • Ensures the quality of work the crew is performing in the field is high; • Ensures the job is progressing according to the plan agreed by the client and seismic crew; • Ensures all the survey crew are aware of the HSE Management Systems and Policies onboard; • Produce reports as necessary, including the final project report, regular operations, HSE reports and technical performance reports.
Seismic operators	• Deployment and maintenance of acoustic source and streamer; • Operation of acoustic source, including initiation of soft-start and shut-down procedures; and • Communicate with Vessel Master, MMOs and PAM Operators to implement soft-start and shut-down procedures, and to ensure acquisition/activation of the acoustic source only occurs within the Operational Area.

Role	Responsibility
General vessel crew (seismic and support vessels)	• Undertake work in a manner that is in accordance with all health and safety procedures and to ensure there are no adverse effects on the marine environment; • Keep a watching brief on any potential increases or changes to the activity which have the potential for changing the impact and/or risk profile, or which may cause deviation from the EP; • Report all hazards, near-misses and incidents to supervisor as soon as possible; • Maintain a high standard of housekeeping; and • Participate in vessel inspections, inductions, safety drills, and health and safety meetings when required.
Onshore Liaison Officer	• Be a local point of contact for fishermen and recreational divers to raise issues; and • Liaise with fishermen should fishing equipment along sail lines be required to be moved.
MMO	• Maintenance of constant day light visual observations for marine mammals and marine fauna; • Maintenance of communication with Vessel Master, PAM Operators and acoustic control room to initiate EPCA Act Policy Statement 2.1. Part A and additional Part B mitigation measures described in **Section 2** and **Section 3.4.7** such as, implementation of soft-start and shut-down procedures of the acoustic source as appropriate, Shut-down Zones and extended Shut-down Zones; and • Preparation of cetacean survey reports (in collaboration with PAM Operator) that outline any marine mammal observations, interactions, and mitigation actions taken.
PAM Operator	• Deployment and maintenance of PAM equipment; • Maintenance of 24-hour monitoring (daylight and night) of PAM equipment for acoustic detections of cetacean presence; • Maintenance of communication with Vessel Master, MMOs and acoustic control room to initiate mitigation measures described in **Table 66** and **Section 3.4.7** such as shut-downs of acoustic source; and • Preparation of cetacean survey reports (in collaboration with MMO) that detail any cetacean detections, interactions, and mitigation actions taken.

Figure 79 Organisation Chart



10.2.1 Communications

The Vessel Master and SLB Onboard Representative are jointly responsible for keeping the vessel crew informed about environmental issues, acting as a focal point for personnel to raise environmental issues, and consulting and involving all personnel in the following areas:

- Issues associated with the implementation of the EP;
- Any proposed changes to equipment, systems, or methods of operation of plant, where these may have potential environmental implications; and
- Any proposals for the continuous improvement of environmental protection, including the setting of environmental outcomes and training schemes.

Weekly HSE meetings will be held onboard each vessel used for the duration of the Otway Basin 2DMC MSS with minutes recorded for all items and issues discussed and what the action items are. The minutes of each meeting, including action items from the meetings, will be made available to all personnel following the meeting.

Other forms of internal communication include daily toolbox meetings, which are undertaken at the start of each day, at the start of each shift or before every critical or unfamiliar job. This toolbox meeting includes all personnel involved in the task and includes aspects such as housekeeping, health and safety, and spill prevention requirements.

Any concerns or issues that arise in relation to environment performance/requirements of the EP will be recorded and communicated through:

- Personnel related issues/concerns raised are to be communicated with the Vessel Master or SLB Onboard Representative, and are communicated/recorded in daily meetings if required; and
- Infield stakeholder engagement with fishing and shipping activities is managed by the vessel master/crew and recorded on the vessel log (i.e. stakeholders in field must follow mariners' warnings and navigational requirements and/or agreed controls under this EP).

Consultation with relevant stakeholders identified in this EP will be managed and maintained and all records of communications with external stakeholders (i.e. calls, emails, meetings etc.) will be recorded.

10.3 Training, Competencies and Awareness

The correct selection, placement, training and ongoing assessment of employees and contractors is a key component of any offshore activity in order to ensure that operations meet all business, statutory and environmental requirements.

This process is guided by SLB internal standards including Training and Competency (*SLB-QHSE-S005*), Contracting (*SLB-QHSE-S012)* and Newcomer Employee (*Green Hat*) Program Guideline (*SLB-QHSE- S017-G001*). The basis of recruitment relies on a position description that details the necessary qualifications, experience and skill levels required to undertake the defined and the HSEQ responsibilities of that position.

10.3.1 Environmental Inductions

All vessel-based SLB employees and contractors will be required to attend a survey-specific environmental induction prior to the commencement of operations in line with SLBs Marine Induction Procedure (*M3MAQ/P007*). This environmental induction will include awareness and compliance aspects of the approved EP, including:

- Environmental regulatory requirements;
- Environmental sensitivities within the Otway Basin, and the key impacts/risks associated with the Otway Basin 2DMC MSS;
- The key control measures and relevant environmental performance standards, environmental performance outcome and measurement criteria, including but not limited to:
  - The relevant requirements of the EPBC Policy Statement 2.1;
  - Megafauna sighting procedures;
  - Environmental incident reporting;
  - Waste segregation, containment and disposal;
  - Housekeeping and spill prevention; and
  - Spill preparedness and response.

Responsibilities under the MoC process will also be communicated to all personnel involved in the survey and SLB staff managing the survey (either shore-based or onboard the vessel). This will include reiterating the requirements for individuals being vigilant of potential changes to the activity with the potential for affecting the risk and impact profile, or which may cause deviation from the accepted EP.

Induction attendance records will be retained; made available on request (i.e. SLB internal audits and inspections). The SLB Onboard Representative is responsible for ensuring personnel receive this induction with all personnel being required to sign an attendance sheet to confirm their participation in and understanding of the induction.

10.3.2 MMOs and PAM Operators

The EPBC Act Policy Statement 2.1 requires MMOs to have '*proven experience in whale observation, distance estimation and reporting*'. SLB will employ experienced trained MMOs, as identified by their professional CVs and records of relevant past experience. In particular, given the sensitivity towards whales in the Operational Area and the extended 4 km Shut-down Zones that will be implemented in the BIAs and the Bonney Upwelling (**Section 3.4.7**), SLB will require the following minimum level of experience or the MMOs.

- MMO's must have logged a minimum of 20 weeks' relevant sea-time engaged in marine seismic survey operations in Australian waters as an MMO or MFO. In particular MMOs will need to be able to demonstrate competency in identifying the species that have been identified as likely to be present during the Otway Basin 2DMC MSS (as stated in this EP). Competency will also need to be demonstrated in assessing behaviour and estimating distance.

Likewise, PAM Operators employed during the Otway Basin 2DMC MSS will need to be experienced in the use of PAM for the detection and monitoring of cetacean vocalisations. This experience will be identified by their professional CVs and records of relevant past experience. In particular, SLB will require that the following minimum level of experience is required for the PAM Operators:

- PAM Operators must have logged a minimum of 20 weeks' relevant sea-time engaged in marine seismic survey operations in Australian waters as a PAM Operator (following the recommendation of the Marine Mammal Observer Association (MMOA, 2019)). In particular PAM Operators will need to be able to demonstrate competency in the acoustic identification of the species that are likely to be present during the Otway Basin 2DMC MSS (as stated in this EP). PAM Operators will also need to demonstrate competency in interpreting acoustic software and estimating distance to any whale calls detected.

All contracted MMOs and PAM Operators will be aware of the requirements of the EPBC Act Policy Statement 2.1 Part A procedures and adopted Part B procedures. MMOs and PAM Operators will also have experience with the preparation of compliance and sighting reports (see **Section 10.6.3**).

10.4 Review of Environmental Performance

The development of this EP resulted in a number of control measures, environmental performance outcomes, environmental performance standards and relevant measurement criteria to ensure the control measures are operating to reduce the impacts and risks to **ALARP** and **Acceptable Levels**. These provisions have been based on a number of pieces of legislation (outlined throughout **Section 2**) to provide a suite of control measures to ensure that levels of environmental performance specifically defined in the EP are being met. This suite of control measures is detailed throughout **Section 7** and **8** for the planned and unplanned activities respectively.

Regulation 14(6) requires the implementation strategy to provide for sufficient monitoring, recording, audit, management of non-conformance and review of the environmental performance and the implementation strategy to ensure that the environmental performance outcomes and standards in the EP are being met. SLB will continue to monitor the environmental performance of the control measures during the Otway Basin 2DMC MSS in line with the Otway Basin HSE Plan and as per Regulation 14(6) of the Environment Regulations to ensure that:

- The environmental performance outcomes and the associated environmental performance standards are being met through a review process to ensure that where necessary they can be amended to maintain the management of impacts and risks to the receiving environment to **ALARP** and an **Acceptable Level**;
- Any opportunities for improvement are identified promptly to further reduce potential impacts and risks, and any non-conformances are identified to allow appropriate corrective action is undertaken; and
- All required monitoring requirements have been undertaken prior to the completion of the Otway Basin 2DMC MSS.

The suite of control measures will be incorporated into the key requirements to review SLBs environmental performance during the Otway Basin 2DMC MSS, including:

- Ensuring sufficient monitoring and recording is undertaken (discussed in **Section 10.4.1**);
- Maintenance of accurate records as required within the Environment Regulations (discussed within **Section 10.4.2**);
- Undertaking auditing to ensure the processes and systems adopted are effective (discussed in **Section 10.4.3**);
- The management of non-conformances (discussed in **Section 10.4.4**); and
- The review of the EP to continuously look for ways to improve operations during the Otway Basin 2DMC MSS (discussed in **Section 10.4.5**).

10.4.1 Monitoring and Recording

Regulation 14(7) of the Environment Regulations requires SLB to provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether these discharges occur as part of normal operations or otherwise) such that the record can be used to assess whether the Environmental Performance Outcomes and standards in the EP are being met.

Each vessel operating as part of the Otway Basin 2DMC MSS will prepare a daily report and carry out a weekly inspection. The weekly inspection checklist will be included within the end-of-week daily report. This daily report and weekly inspection will ensure:

- Environmental issues and/or concerns raised through the MoC (**Section 10.4.6**) process are communicated to SLB management and recorded for future learnings;
- Any issues arising from SOPEP testing (**Section 10.9.1**) are reported;
- Monitoring of key parameters (**Table 105**) are recorded for when a review of the EP is undertaken including an evaluation of environment performance based on the potential impacts and risks associated with the Otway Basin 2DMC MSS; and
- The performance of key equipment as described in this EP is checked at least weekly to ensure ongoing reduction of risks and impacts to **ALARP** and **Acceptable Levels**, and any potential issues (i.e. observations of poor operating condition/performance or non-conformances) are continually monitored and raised as soon as practicable.

The results will be reported in the end-of-survey EP performance report submitted to NOPSEMA (**Section 10.6.2**).

Table 105 Summary of Routine Environmental Monitoring

Environment Aspect/Activity	Parameter Measured	Reporting to be Maintained
Physical presence of seismic vessel and towed equipment		
Negative interactions with marine fauna	Marine fauna ship strike or entanglement incidents	Incident records of location, time, type of marine fauna, expected injury. DoEE Ship Strike Database.
Negative interactions with other marine users	Incident or near miss involving the seismic vessel and other marine users	Report provided to AMSA on any incidents or near misses that threaten the safety of the seismic vessel and/or requires remedial action by the support vessel. Bridge logs.
Acoustic disturbance to the marine environment		
Impacts on whales through acoustic disturbance	Whales	Daily report summaries any adaptive measures required to be applied due to whales. Weekly checklist confirms that whales sighting datasheets are correctly filled out and maintained.
	Adherence to EPBC Policy Statement 2.1	Bridge Logs. MMO Report. PAM Logs. Whale Observation Report.
	Application of defined Shut-down Zone	MMO Report.
	Restrictions of acoustic release outside of Operational Area	Bridge Logs and digital records such as AIS.
	Crew training	Induction and training records for crew, MMOs and PAM Operators.
Routine permissible waste discharges		
Grey water and sewage discharge	Liquid waste discharges	Weekly inspection record confirms that recordable discharge records are maintained. Discharge logs confirm discharges occurred outside of Australian Marine Parks. Maintenance records confirm equipment/machinery functioned correctly.
Atmospheric emissions		
Refuelling	MGO volume	The daily record will record the day of bunkering and provide sufficient detail to confirm the bunker notes/records are maintained, the refuelling checklist is completed, and no incidents occurred.
Minimisation of atmospheric emissions	MGO usage	Weekly inspection records the volume of MGO used.
No deliberate discharge of ODS	ODS discharges	ODS Record Book confirms no deliberate discharge of ODS.
Incineration of approved substances	Substances incinerated	Incineration Log confirm only wastes approved by the Garbage Management Plan is incinerated and at a distance greater than 12 NM from shore.

Environment Aspect/Activity	Parameter Measured	Reporting to be Maintained
Artificial light emissions		
Light generation from survey vessel	Directional lighting and minimisation of unnecessary lighting	Pre-mobilisation audit and inductions. Bridge logs.
	Separation distances from shore maintained	Digital records, such as AIS tracking, showing separation distance of at least 3 NM from shore maintained.
Invasive marine species		
Introduction of invasive marine species	Ballast water exchange	Weekly checklist confirms that ballast records maintained in accordance with the Ballast Water Management Plan. Ballast Water Logbook detailing all ballast water exchanges. Certification of approved ballast water treatment system. Biosecurity clearance using the Maritime Arrivals Reporting system.
	Vessel hull biofouling	Inspection certificate and dry-dock and/or anti-fouling application certification. Biofouling Risk Assessment Report. Incident reporting form for any sighting or suspicion of any IMS on vessel(s), in niche areas, and in ports/harbours.
Streamer Loss		
Physical damage to benthic environment from loss of streamer	Location, equipment type, duration of incident and response option taken	Vessel incident report outlining details of equipment loss.
Vessel Collision and Associated Hydrocarbon Spill		
Vessel collision	Location, volume, duration, type of spill and response option taken	Vessel incident report outlining details of incident. AMSA Report Notification. NOPSEMA Reports. POLREP.
Vessel refuelling	Refuelling operations	Bunker documentation showing refuelling operations undertaken at port.
Hydrocarbon Spill Response		
Secondary impacts from response options	Implementation of response options	Vessel incident report outlining 'first-strike' response options undertaken. NEBA Report.
Accidental Release of Hazardous and Non-Hazardous Materials		
Hazardous and non-hazardous solid waste management	Solid waste generation	Weekly inspection records confirm waste tracking certificates or garbage record books are up to date. Waste Transfer Certificate issued by licensed facility of carrier for onshore transfers.
Accidental release of hazardous and/or non-hazardous material	Location, volume, and duration of incident, and response option taken	Vessel incident report detailing the release. Notice to Mariners lodged for objects unable to be found/retrieved.

10.4.2 Record Management

Regulations 27 and 28 of the Environment Regulations outline the requirements for storage of records and availability of records, respectively. SLB will maintain all documents and reports relevant to the Otway Basin 2DMC MSS for a minimum of five years following the completion of the survey. These records will be made available upon request.

Documents and reports to be kept by SLB include:

- The Otway Basin 2DMC MSS EP and associated documents, including any reviews or revisions;
- Records of emissions and discharges into the environment made in accordance with the EP;
- End-of-survey EP performance report;
- Stakeholder consultation records;
- Daily vessel operation reports;
- Personnel training and induction records; and
- Records of reportable and recordable incidents.

In addition to the above, the Vessel Master will keep copies of all operation records as required, such as fuel consumption records, oil record book, IOPP/IAPP/ISPP Certificates etc.

10.4.3 Auditing

A pre-survey audit and inspection of the survey vessels will be carried out prior to the commencement of the Otway Basin 2DMC MSS to ensure that the vessels are fit for purpose and to ensure that all procedures are in place in order to ensure compliance with the measures outlined in the EP.

This pre-survey audit/inspection will also ensure that the vessel HSE management systems are in accordance with SLB's internal HSE management systems and policies. This audit will review the risk of the establishment of an IMS, including for IMS inspection certification and dry-dock and/or anti-fouling application certification, to ensure that the vessel does not pose an unacceptable risk for the establishment of an IMS. In addition to the above, the on-board spill response capability of the vessel will be audited against its SOPEP and the respective control measures outlined within this EP to ensure appropriate preparedness for the unlikely event of a spill occurring.

SLB's Auditing Standard (*SLB-QHSE-S007*) outlines audit scheduling and the measurements that must be taken during each audit.

An audit will be carried out within two months of the commencement of seismic operations, with the purpose of assessing the implementation of requirements under the EP. Compliance with the EP will also be continuously audited by the Onboard SLB Representative as part of daily activities.

These audits will include ensuring the environmental performance standards, environmental performance outcomes and the measurement criteria are being appropriately implemented and reviewed to keep impacts and risks to **ALARP** and **Acceptable Levels**. Any non-compliance identified through this auditing process will follow the process outlined within **Section 10.4.4**.

Any findings and recommendations obtained through the auditing process will be distributed to the relevant parties in order to undertake the appropriate actions.

10.4.4 Management of Non-Conformances

For the purpose of the Otway Basin 2DMC MSS, a breach of the any of the Environmental Performance Standards detailed in the EP will be considered a 'non-conformance'. Non-conformances may be identified by any crew member during routine observations, during an inspection or audit, or as a consequence of an unplanned activity. All crew are required to report any non-conformance they observe.

Following identification of a non-conformance, remedial actions will be required in order to resolve the issue and to prevent recurrence. Affected parties will be notified and follow-up actions will be communicated to all relevant crew and affected parties. Follow-up actions will be tracked to closure in accordance with the Reports of Non-Conformities, Accidents, Incidents and Hazardous Occurrences Procedure (*M3MISM/P015*).

An internal risk assessment will be undertaken when any non-conformances are identified to determine whether any changes are required to operational procedures ensure the impacts and risks are maintained or reduced to **ALARP** and **Acceptable Levels**. Should a change be identified during this risk assessment process, a MoC process will be undertaken as per **Section 10.4.6**.

All non-compliances and remedial actions taken will be recorded by the Onboard SLB Representative and included in the Post-Survey Review Report (**Section 10.6.2**).

10.4.5 Environment Plan Revision

Following submission of the EP, SLB will continuously look for ways to improve operations during the Otway Basin 2DMC MSS. Regulation 17 of the Environment Regulations requires the resubmission of the EP to NOPSEMA due to a change or proposed change to circumstances or operations. The following criteria will trigger the requirement for a review/resubmission of the EP:

- Any significant modification or new stage of the activity that is not provided for in the EP currently in force;
- The occurrence of any significant new environmental impact or risk, or significant increase in an existing environmental impact or risk that is not provided for in the EP;
- The occurrence of a series of new environmental impacts or risks, or a series of increases in existing environmental impacts or risks, which, taken together, amount to the occurrence of a significant new environmental impact or risk, or a significant increase in an existing environmental impact or risk that is not provided for in the EP;
- Identification of recent scientific publications that may have an influence on the risk assessment and increase the environmental risk of the survey;
- Identification of any changes to the biological (including the presence of threatened species not already considered under the EP), physical, and socio-economic environment which may have an influence on the risk assessment and increase the environmental risk of the survey;
- The existing suite of control measures are no longer considered suitable to reduce the environmental risk of the survey to **ALARP** and **Acceptable Levels**;
- During operations the number of sightings and/or power-downs of whales are higher than anticipated during the planning of the survey; and/or
- As requested by NOPSEMA.

Following any non-compliance incident, SLB will review the EP and implemented control measures to identify any potential short-falls in the EP, any additional mitigation/control measures that could be implemented to prevent such an occurrence from arising again, and to further investigate the cause of the non-compliance.

10.4.6 Management of Change

The MoC process is utilised when there is a change to the proposed activity, or in the circumstances under which it is being undertaken, which may have the potential to increase or change the level of impact or risk of the activity that is not currently detailed within an accepted EP. MoC is a transparent process used for the identification, assessment, control and documentation of any such change.

On 23 March 2016, NOPSEMA issued an Environment Alert regarding the proper application of the MoC process. This alert was a result of inspections undertaken by NOPSEMA which found that titleholders manage change through partial or simplistic environmental assessments which differ to the assessments undertaken during the EP process. This alert requested better consideration of changes and a more robust MoC procedure that is in accordance with the procedures for impact and risk assessment within an accepted EP to confirm that these impacts and risks are **ALARP** and at an **Acceptable Level** throughout the life of the EP.

The MoC procedure that would be implemented by SLB for the proposed activity is consistent with this Environment Alert and is further detailed in the sub-sections below. SLBs comprehensive MoC procedure is also consistent with its own internal risk assessment procedure (*SLB-QHSE-S020* a *Hazard Analysis and Risk Control Standard*). This MoC procedure will implement a sound process of change identification, risk and impact assessment, establishment of modified or new controls if required, re-assessment of the risk and impact profile following the same risk assessment procedures as used in this EP, and documentation of the process, rationale and outcomes of the assessment.

10.4.6.1 Triggers for Management of Change

Three regulations under the Environment Regulations require changes to be assessed and managed; these include:

- Regulation 7 – Operations must comply with the accepted EP. This requires that titleholders do not undertake an activity in a way that is contrary to the EP that is in force for that activity. This means that any changes to the activity, or the conditions under which it is being enacted, must be assessed for potential divergence from the accepted EP and possible increase in the environmental impact or risk profile;
- Regulation 8 – Operations must not continue if new or increased environmental risk is identified. This makes it an offence for the titleholder to undertake an activity after the occurrence of any significant new environmental impact or risk arising from the activity; or any significant increase in an existing environmental impact or risk arising from the activity; and the new impact or risk, or increase in the impact or risk, is not provided for in the EP in force for the activity; and
- Regulation 17 – Revision because of a change, or proposed change, of circumstances or operations. This requires a titleholder to submit a proposed revision of the EP for an activity before, or as soon as practicable after:
    - The occurrence of any significant new environmental impact or risk, or significant increase in an existing environmental impact or risk, not provided for in the EP in force for the activity; or

- The occurrence of a series of new environmental impacts or risks, or a series of increases in existing environmental impacts or risks, which, taken together, amount to the occurrence of a significant new environmental impact or risk, or a significant increase in an existing environmental impact or risk, that is not provided for in the approved EP for the activity.

The Environment Alert issued by NOPSEMA contained a number of deficiencies that were identified in managing change through the implementation of EPs. Specifically, the following points are relevant to the proposed Otway Basin 2DMC MSS which will be regularly considered under this MoC process prior to, and during, the MSS:

- Extending the duration of an MSS;
- Consideration of a series of increases, or new, impacts and/or risks, arising from changes to the activity over time which additively creates a significant increase in impacts or risk;
- Alteration or removal of an environmental performance standard in the accepted EP, including changes to the wording which may materially degrade or diminish the level of performance;
- Reporting of breaches to environmental performance standards after realising that the standard does not, or cannot, monitor the level of performance set in the EP; and
- Greater discharge to the marine environment than predicted in the EP.

If any of the following types of changes are identified, the MoC process will be implemented:

- Identification of new impacts or risks, such as a stakeholder raises a new issue or concern prior to, or during, the implementation of the EP;
- Increase in impact or risk, such as if the seismic source volume is required to be increased to improve quality of imagery;
- A new stage of the activity is required, e.g. if a significant extension of timeline is required to complete the acquisition;
- Reduced ability to effectively implement the EP to meet its stated environmental performance standards, such as if an MMO is taken ill and demobilised; and
- Any incremental change in the activity increasing the risk of significant impact.

SLB will undertake regular reviews of the currency of the list of relevant stakeholders and may need to initiate MoC if new stakeholders raise new issues which have potential to significantly increase the risk of interference with the stakeholders’ interests.

10.4.6.2 Originator of Management of Change

Throughout the Otway Basin 2DMC MSS all personnel involved with the survey, including the seismic vessel operator’s staff, along with SLB staff managing the survey, are required to keep a lookout for any potential changes to the activity which have the potential for changing the impact and/or risk profile, or which may cause deviation from the EP. Any personnel in charge of work functions will be required to report any changes within their area of work, e.g. the Vessel Master will be required to report changes to the functionality of pollution control equipment on the vessel as they become aware of such changes. Similarly, the SLB Onboard Representative will be required to report any potential changes to the seismic activity before they are implemented. Potential MoC triggers shall be reported immediately to the SLB Project Manager. These responsibilities will be reinforced to all personnel during the induction process.

This EP will be reviewed as per the discussion in **Section 10.4.5** so that any changes to the activity, occurrence of a new environmental impact or risk, scientific publications or changes to the existing environment are taken into account during the Otway Basin 2DMC MSS. This review will ensure that the impacts and risks of the MSS remain **ALARP** and at an **Acceptable Level**.

10.4.6.3 Management of Change Process

If potential changes to the MSS activity are identified which trigger a MoC as identified above, the following steps will be initiated and documented:

- Stop work if the survey has started, or delay commencement of new activity;
- Establish a risk assessment team and advise the SLB Project Manager;
- Assess the need for SLB MoC (*SLB-QHSE-S010 Management of Change and Exemption Standard*);
- Initiate a risk and impact assessment by the risk assessment team, using the same procedures as outlined in **Section 6** of this EP. This process will determine if the increase in risk is significant and would therefore trigger a requirement to revise and resubmit the EP under Regulation 17 of the Environment Regulations;
- If resubmission of the EP is required, the work or the new activity is to be suspended until revised EP is accepted by NOPSEMA;
- If resubmission is not required, conduct and document detailed risk and impact assessment;
- Consultation with stakeholders if changes may affect their activities or interests (based on previous feedback discussed throughout **Section 4** and **Appendix F**);
- Develop any additional controls required to reduce risks and impacts to **ALARP** and to an **Acceptable Level**;
- Develop an EP Addendum which documents the following:
  - The MoC process followed;
  - Risk and impact assessment process undertaken;
  - Rationale for conclusions on residual risk;
  - Stakeholder feedback;
  - Additional controls to be implemented;
  - Demonstration of **ALARP** and justification for acceptability;
  - Revised performance standards, measurement criteria, responsibilities for each revised or new control; and
  - Confirmation that all sections of EP have been checked to ensure any potential deviations from the accepted plan have been captured and addressed.

10.4.6.4 Approver of Management of Change Outcomes

Should the MoC procedure not trigger Regulation 17 resubmission (and hence approval from NOPSEMA), any work on new or modified activities will only commence on the authority of the SLB Project Manager.

10.5 Support Vessel MMO Management Plan

At least one support vessel will be present in close proximity to the survey vessel for the duration of the Otway Basin 2DMC MSS. The primary role of the support vessel is to manage any possible interactions between the seismic vessel and the seismic array (i.e. acoustic source and streamer) with any other vessels or maritime activities occurring in the area. The support vessel will assist with informing any other vessels in the path of the approaching seismic vessel that cannot be raised on VHF radio or any other means. In addition, the support vessel will also be utilised as an additional platform for whale observations by an experienced MMO when seismic activities take place within the blue whale BIA, southern right whale BIA, the 4 km BIA buffer zone and the Bonney Upwelling Zone (**Figure 8** and **Figure 9**).

An additional vessel such as the support vessel does pose additional risk to whales in the area; however, the master of the support vessel will be operating in accordance with the EPBC Regulations Part 8, Division 8.1 in regards to the minimum approach distances and vessel speed for "other craft and follow the prescribed actions when adult cetaceans and/or calves are present within the caution zone (**Section 7.1.2.2**).

The following procedures will be implemented whilst the additional MMO is onboard the support vessel:

- Communications:
  - The support vessel will be in close contact with the seismic vessel on VHF radio at all times to ensure clear communications are maintained;
  - The support vessel will be able to receive and transmit communications via VHF radio at all times with all maritime traffic in the area; and
  - The MMO on the support vessel will maintain direct communication with the MMOs and PAM Operator onboard the survey vessel at all times throughout their observational shift.
- Maintenance of distance to survey vessel:
  - The support vessel will be present around the survey vessel at all times unless an intervention is required to be carried out by the support vessel;
  - While the survey vessel is within the BIAs, the 4 km buffer zone and the Bonney Upwelling Zone, the support vessel will maintain a distance of 2-4 km from the survey vessel for monitoring of the Shut-down Zone for whales;
  - The survey vessel will be either positioned directly abeam or ahead of the survey vessel, but not behind the survey vessel;
  - Both support and survey vessels will be equipped with radar and AIS, allowing the exact position and distance between each vessel to be continuously monitored; and
  - In the case that the support vessel is unable to maintain the above distance to the seismic vessel (e.g. it is undertaking intervention actions), the Masters of the support vessel and seismic vessel will maintain radio contact.
- Use of support vessel as a secondary MMO platform:
  - An experienced MMO will be on the support vessel when the survey vessel is operating in the blue whale BIA, southern right whale BIA, Bonney Upwelling Zone or the 4km BIA buffer zone;
  - The support vessel will be used as a secondary platform for whale observations and monitoring the Shut-down Zone;

- The MMO will be stationed on the bridge of the support vessel during day light hours to assist the survey vessel in detection of whales and observation of the 4 km Shut-down Zone;
- If the MMO on the support vessel observers a whale, the MMO on the survey vessel will be immediately notified;
- The MMO on the support vessel will have the same roles and responsibilities as those on the survey vessel, including the full authority to direct mitigation actions such as shut-down procedures of the acoustic source if a whale is observed within the relevant Shut-down Zone; and
- Upon detection of a marine mammal, the support vessel MMO will immediately relay the observation to the MMOs and PAM Operator onboard the survey vessel. The implementation of mitigation actions will be carried out upon discussion between the MMO onboard the support and seismic vessels.

10.6 Reporting

SLB has internal requirements for the recording and reporting of incidents, as outlined in the Reports of Non-Conformities, Accidents, Incidents and Hazardous Occurrences Procedure (*M3ISM/P015*). There are legal obligations under the Environment Regulations to report incidents to NOPSEMA within a specified time period. The legislative requirements for recording and reporting are described in further detail below.

10.6.1 Notification of Start and End of Activity

The Environment Regulations requires a number of notifications for starting and ending an activity, and ending of an EP. SLB will comply with these notification requirements, as per the below:

- Start of Activity Notification – At least 10 days before the commencement of the activity, SLB must provide written notification to NOPSEMA of the date of intention to commence the activities approved under the EP;
- End of Activity Notification - At least 10 days following the completion of the activity, SLB must provide written notification to NOPSEMA of the date of the completion of the activities approved under the EP; and
- End of EP Notification – As soon as practicable on the completion of the last activity covered under the survey, SLB must provide written notification to NOPSEMA informing that all of the activities and obligations covered under the EP have been completed. Following acceptance of the notification by NOPSEMA, the EP is no longer in force.

In addition to the above notifications, further pre-survey and post-survey notifications will be undertaken to the relevant parties outlined within **Section 4.5.10** and **4.5.11**.

10.6.2 Environmental Performance Reporting

Under Regulation 14(2) of the Environment Regulations, SLB are required to submit an Annual Report that provides a review of compliance with the EP's Environmental Performance Objectives and Environmental Performance Standards. Regulation 26(c) also requires submission of a review report following the completion of the activity. Due to the proposed timing of the Otway Basin 2DMC MSS, the Annual Report and post-survey review report will be combined and submitted together.

The Post-Survey Review Report/Annual Report will be submitted to NOPSEMA within two months of the completion of the survey. The content of this report will include the following:

- A review of routine activities an incident records, including:
  - Whale sighting records, and any other interactions with whales requiring start-up delays;
  - Records of any interaction between marine fauna and vessels of towed equipment used during the survey;
  - Records of any unplanned activities, such as accidental discharges of hazardous and non-hazardous substances, vessel collisions or negative interactions with commercial operators in the Otway Basin (fishing, shipping etc.);
- An assessment of compliance with requirements set out in the EP (i.e. compliance with the Environmental Performance Objectives and Environmental Performance Standards);
- An assessment of compliance with the SLB HSE Management Systems and Policies; and

- A review of all recordable and reportable incidents.

10.6.3 Marine Mammal Reporting

As required by the EPBC Policy Statement 2.1, a report on all whale interactions will be provided to the DoEE within two months of survey completion. The report will contain the following information as a minimum:

- The location, date and start time of the survey;
- Name, qualifications and experience of any MMOs (or research scientists) involved in the survey;
- The location, times and reasons when observations were hampered by poor visibility or high winds;
- The location and time of any start-up delays, power downs or stop work procedures instigated as a result of whale sightings;
- The location, time and distance of any whale sighting including species where possible; and
- The date and time of survey completion.

This information will be recorded using the 'Cetacean Sightings Application' software as outlined in the EPBC Act Policy Statement 2.1. Upon completion of the survey the information entered into this application will be exported as a text file and emailed to sightingsdata@aad.gov.au.

The following additional information may also be collected during the Otway Basin MC2D MSS. Note that this additional information includes sightings of all marine mammals (i.e. dolphins and pinnipeds, as well as whales):

- The location, time and distance of any marine mammal sighting including species where possible;
- Method of detection (visual or PAM);
- Observation platform (seismic vessel or fixed wing plane);
- Water depth at time of each whale sighting;
- Sea condition (Beaufort scale) at time of each marine mammal sighting;
- Number of animals involved in each marine mammal sighting (total);
- Number of juveniles involved in each marine mammal sighting (if present);
- Description of behaviour for each marine mammal sighting;
- Description of any injuries, mortality, entanglement or other interactions;
- Distance from seismic source at first sighting;
- Closest subsequent distance to seismic source;
- Behaviour at first sighting (travelling, feeding, milling etc.); and
- Subsequent behaviours (avoidance, attraction and other changes in behaviour).

10.6.4 Reportable and Recordable Incident reporting

10.6.4.1 Reportable Incidents

Regulation 26 of the Environment Regulations requires SLB to report all 'reportable incidents' that occur in relation to the Otway Basin 2DMC MSS. Under the Environment Regulations, a reportable incident is defined as '*an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage*'.

NOPSEMA must be provided with an oral notification (phone (08) 6461 7090) of any reportable incident as soon as practicable, but no later than two hours after the occurrence of the incident. Following oral notification, a written notification (via submissions@nopsema.gov.au) must be provided to NOPSEMA as soon as practicable, but not later than three days following the first occurrence of the reportable incident. A written record must then be submitted to NOPSEMA as soon as practicable after the oral notification, with a copy of this report provided to the National Offshore Petroleum Titles Administrator (via resources@nopta.gov.au) and the Department of the responsible State or Territory Minister within seven days of providing the report to NOPSEMA. The Reportable Incident Report must include the following:

- All facts and circumstances concerning the incident that SLB knows, or is able find out with reasonable effort;
- Actions taken to avoid, or mitigate impacts arising from the reportable incident; and
- Any actions that were taken, or have been proposed to be taken to stop, control, or remedy the reportable incident.

For the purpose of the Otway Basin 2DMC MSS, reportable incidents have been identified as:

- Any incident involving a collision between the survey vessels and marine megafauna;
- Any incident involving the entanglement of megafauna in towed equipment;
- Any incident involving a negative interaction between other marine users (i.e. those identified in the EP) such as a collision or whereby intervention by the support vessel is required; and
- Any incident that results in a hydrocarbon spill of > 80 L into the surrounding marine environment.

10.6.4.2 Recordable Incidents

Recordable incidents are breaches of Environmental Performance Outcomes or Environmental Performance Standards (as outlined in this EP) that do not meet the definition of a reportable incident. A written report must be provided to NOPSEMA as soon as practicable, but not later than 15 days, after the end of the calendar month. If no recordable incidents occur, a monthly 'nil incident' report is required to be submitted to NOPSEMA (via submissions@nopsema.gov.au). The monthly Recordable Incident Report must include the following:

- A record of all recordable incidents that occurred during the calendar month;
- All facts and circumstances concerning the incident that SLB knows, or is able find out with reasonable effort;
- Actions taken to avoid, or mitigate impacts arising from the recordable incident;
- Any actions that were taken, or have been proposed to be taken to stop, control, or remedy the recordable incident; and

- Any actions that were taken, or have been proposed to be taken, to avoid a similar incident occurring in the future.

10.7 Emergency Response

Health and safety to all personnel on the seismic vessels and all aspects of the marine environment are of the highest importance to SLB and have been considered very seriously throughout the planning and development phase of the Otway Basin 2DMC MSS EP. Safety plans, control measures, operational procedures and management plans have been developed by SLB to minimise the potential risk of any emergency that could result in any injury to personnel onboard the seismic vessels or lead to the loss of hydrocarbons exposing marine life within the Otway basin to hazardous substances. All of these control measures, operational procedures and management plans have been detailed throughout this EP.

As identified in **Section 8.3**, vessel collision or rupture of the hull of the seismic vessel is considered to be the highest risk for a release of MGO into the marine environment; however, with the extensive control measures in place and operational procedures, the risks associated with this have been reduced to **ALARP** and an **Acceptable Level**. This is also further supported by the fact that there have been no vessel collisions or groundings with seismic vessels recorded in Australian waters in over the last 30 years.

The emergency response procedures that SLB require the active commitment to, and accountability for from all employees and contractors during the Otway Basin 2DMC MSS are included in the QHSE Policy (**Figure 1**). The QHSE Policy is regularly reviewed and will be incorporated as part of the crew induction process. Of relevance to the emergency response procedures, the QHSE Policy contains SLBs commitment to:

- Protect and strive for improvement of the health, safety and security of personnel at all times;
- Eliminate any HSE accidents;
- Plan for, respond to and recover from any emergency, crisis and business disruption; and
- Minimise disruption on the environment through pollution prevention.

The following sub-sections provide further details of how SLB are prepared for emergency response, primarily in regard to approaching adverse weather conditions or hydrocarbon spill through the Oil Pollution Emergency Plan.

These procedures and plans detail the processes SLB will undertake in the event of an approaching adverse weather system or a hydrocarbon spill. A release of hydrocarbons to the marine environment has been assessed as the highest risk to the marine environment within this EP, and as such SLB has developed a detailed Oil Pollution Emergency Plan which is aligned with the statutory plans of both Commonwealth and State agencies for oil spill response. The roles and responsibilities are clearly defined, in particular who will be the Control Agency in the event of a hydrocarbon release, and likewise, the role of SLB in supporting the relevant Control Agency to achieving the best environmental outcome.

In the event of any emergency occurring during the Otway Basin 2DMC MSS, the Master of the seismic vessel will assume overall onsite command of all vessels and crew and will take on the role as the Emergency Response Coordinator. The seismic vessel will have suitable equipment onboard to respond to any emergencies should they arise, and suitably trained crew will be sufficient in the use of such equipment, they will be familiar with where the equipment is stored, and all crew will undertake regular exercises, which will be documented and recorded.

The emergency response equipment onboard the seismic vessels is for first response and will include medical equipment/supplies, firefighting equipment and oil spill response equipment. However, as mentioned some of these items will be limited, such as any serious medical injury or illness would require a medivac to the nearest hospital. In addition, the intention of the oil spill response equipment on the seismic vessel is for the purpose of containing and cleaning any spills onboard the vessel, and preventing discharges of hydrocarbons into the ocean, the equipment will not be carried for spill response of hydrocarbons in the ocean.

10.8 Adverse Weather Procedures

Damage to survey equipment, risks to health and safety of survey personnel and increased risks of hazardous material spills can all occur during severe weather events. To mitigate these potential risks, SLB will operate in accordance with the seismic vessel contractor's marine *Adverse Weather Procedures*, which will define a set of controls for managing risks of adverse weather whilst undertaking marine offshore operations, as well as the roles and responsibilities of the key personnel onboard the seismic vessel. However, SLB has not finalised the selection of a seismic contractor for the Otway Basin 2DMC MSS and consequently the *Adverse Weather Procedures* document is not currently available for submission with this EP. SLB will ensure that a suitable *Adverse Weather Procedures* document of the successful seismic contractor is in place and that it is aligned with SLBs QHSE Policy (**Figure 1**) as part of contract negotiations and prior to commencing the Otway Basin 2DMC MSS.

In addition to the *Adverse Weather Procedures* that will be in place, SLB will subscribe to a weather monitoring service that will provide forecasts that update regularly throughout the day. This monitoring service will provide information on wind, waves/seas and currents, primarily to plan the movements and operations to occur when and where in the Operational Area the weather is safest and operationally feasible to acquire the survey safely. The benefit of this service will provide SLB prior warning of any severe weather event forming within, or approaching, the Operational Area. If this were the case, the Vessel Master on-board the survey vessel will make decisions relevant to their authority to ensure safety of the vessel, personnel and the environment. In a worst-case scenario, and a large storm event approaches, the survey vessel may retrieve the seismic equipment, and retreat from the area to more sheltered waters.

10.9 Oil Pollution Emergency Plan

The following OPEP provides an overview of SLB's arrangements for responding to a hydrocarbon spill event during the Otway Basin 2DMC MSS. It is important to note that SLB's response arrangements do not negate the requirements for a SOPEP. Once contracting has been completed with the successful seismic vessel, the SOPEP for this vessel will be reviewed, tested, and incorporated into the OPEP arrangements as part of this EP.

This OPEP does not describe spills for petroleum operator infrastructure as it is not considered credible that the Otway Basin 2DMC MSS can cause a spill from infrastructure during the activities described in this EP.

10.9.1 Vessel Shipboard Oil Pollution Emergency Plan

MARPOL Annex I requires a SOPEP to be carried on all vessels greater than 400 gross tonnes. In general, a SOPEP describes the steps to be taken:

- In the event that a hydrocarbon spill has occurred;
- If a vessel is at risk of a hydrocarbon spill occurring, and
- For notification procedures in the event of a hydrocarbon spill occurring and provides all important contact details.

The Vessel Master is the overall in charge of the SOPEP and ensuring that all crew comply with the plan.

Although support vessels are not required under MARPOL Annex I to have a SOPEP, SLB will require both the survey and support vessel hold a SOPEP.

Each SOPEP will be specific to the vessel that holds it (i.e. separate SOPEPs will be held by the support and seismic vessel and will contain vessel-specific details). The SOPEP will provide the following:

- A description of all actions to be taken by onboard personnel to reduce or control the discharge following a hydrocarbon spill incident;
- A detailed description of all spill response equipment held onboard the vessel including what equipment is available and its stored location;
- Detailed diagrams of the vessel, including locations of drainage systems, location of spill response equipment, and general layout of the vessel;
- An outline of the roles and responsibilities of all onboard personnel with regard to hydrocarbon spill incidents;
- A description of the procedures and contacts required for the co-ordination of hydrocarbon spill response activities with the relevant National and Local Authorities; and
- Requirements for testing of the SOPEP and associated drills.

The SOPEP also includes specific emergency procedures including steps to control discharges for bunkering spills, hull damage, grounding and stranding, fire and explosions, collisions, tank failure, sinking and vapour release.

In accordance with the control measures that will be implemented during the Otway Basin 2DMC MSS (**Section 8.3.4**), each vessel involved in the Otway Basin 2DMC MSS will have:

- An IMO certified SOPEP;

- A SOPEP drill conducted prior to the Otway Basin 2DMC MSS commencing (i.e. within 3 months). A SOPEPE drill is normally every three months; however, due to the proposed duration of the MSS, with this measure in place a SOPEP drill will be performed at least once during the Otway Basin 2DMC MSS;
- The spill kits will be kept fully stocked (to vessel class requirements) and any items will be replaced if they are used; and
- In the event of a hydrocarbon spill, the Vessel Master will implement available controls and resources of the SOPEP.

10.9.2 Statutory Plans

10.9.2.1 Commonwealth Waters

If a spill occurs within Commonwealth waters the National Plan will apply and integrates with the relevant State response plans (discussed in **Section 10.9.2.2**). Initial actions would be undertaken immediately by the Vessel Master, with any further actions determined following immediate contact with AMSA.

The National Plan integrates the response from both the Commonwealth and relevant State Governments to ensure an effective response to marine pollution incidents. The National Plan provides for AMSA to be the Control Agency when responding to a spill event who works closely with the relevant State Governments, emergency services and industry to ensure a robust response capability.

10.9.2.2 State Waters

Should a spill occur during the Otway Basin 2DMC MSS which originates within, or is likely to move into, State waters, the relevant statutory plans are as follows (depending on the location of the spill):

- The Victoria state plan is the State Maritime Emergencies (Non-search and Rescue) Plan. Under this plan, the Department of Economic Development, Jobs, Transport and Resources (**DEDJTR**) is the Control Agency;
- The South Australian state plan is the SA Marine Spill Contingency Action Plan. Under this plan, the Department of Planning, Transport and Infrastructure (**DPTI**) is the Control Agency; and
- The Tasmania state plan is the Tasmanian Marine Oil Spill Contingency Plan. Under this plan, the Tasmanian Environment Protection Authority is the Control Agency.

10.9.3 Hydrocarbon Spill Response Framework

SLB utilise the incident classification as outlined in the National Plan (AMSA, 2017) for hydrocarbon spills to provide direction on the potential consequence and impact of the incident and to provide guidance for preparedness, incident notifications and response actions.

Two levels of incident are possible for the Otway Basin 2DMC MSS:

- **Level 1:** Incidents are generally able to be resolved through the application of local or initial resources only (e.g. first-strike capacity); and
- **Level 2:** Incidents are more complex in size, duration, resource management and risk and may require deployment of jurisdiction resources beyond the initial response.

The division of the responsibilities in the event of a hydrocarbon spill that affects State and Commonwealth Waters is provided in **Table 106**.

Table 106 State and Commonwealth Hydrocarbon Spill Responsibilities

Location	Spill Source	Statutory Authority	Control Agency	
			Level 1	Level 2
Commonwealth waters	Shipping sourced spill	NOPSEMA	AMSA	AMSA
Victorian State waters		DEDJTR	DEDJTR	AMSA
South Australia State waters		DPTI	DPTI	AMSA
Tasmanian State waters		Environmental Protection Authority Tasmania (**EPA Tasmania**)	EPA Tasmania	AMSA

10.9.3.1 Control Agency

AMSA is the designated Control Agency if a hydrocarbon spill occurs from a ship associated with the Otway Basin 2DMC MSS within Commonwealth waters. AMSA will assume control of the incident and respond in accordance with the National Plan. SLB will assume a Support Agency role and provide all available assistance to AMSA during their Control Agency responsibilities.

10.9.3.2 Cross Jurisdictional Coordination

As stated in the National Plan, maritime environmental emergencies have the potential to impact upon the interests of two or more Australian jurisdictions, where both jurisdictions have legitimate administrative and regulatory interests in the incident. In this case, the National Plan addresses these complexities through the *Guidance on the Coordination of Cross Border Incidents* which provides for the establishment of an incident coordination process and the determination of a 'lead' jurisdiction, if appropriate.

10.9.4 Nature and Scale of Preparedness

10.9.4.1 Maximum Credible Scenario

As described in **Section 8.3** it is considered that a vessel collision is the only credible scenario in which a hydrocarbon spill will occur during the Otway Basin 2DMC MSS. Based on AMSAs "*Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities*" (AMSA, 2015), the largest fuel tank is adopted as the worst-case Maximum Credible Scenario (**MCS**) that may result from a vessel collision. Therefore, for the Otway Basin 2DMC MSS, a spill of 572 m^3 of MGO from the complete rupture of the largest fuel tank on the seismic vessel (through vessel collision) is considered to be the MCS. This MCS is considered to be very conservative as while the survey is underway it is likely that the tank will not be 100% full and the fact that there are a number of controls in place to avoid this situation from occurring.

10.9.4.2 Hydrocarbon Characteristics and Behaviour

The fuel to be used during the Otway Basin 2DMC MSS is MGO which is a light petroleum distillate. This would undergo rapid dispersion and evaporation if it was released into the high energy offshore marine environment of the Otway Basin. DNV 2011 estimates that the half-life of MGO is 2.5 hours in wind speeds of 10 m/s, 1 hour at 20 m/s and approximately 12 minutes in storm conditions with wind speeds over 30 m/s.

Based on an average wind speed of approximately 6 m/s (in March) for the Otway Basin (**Section 5.1.1**) the MGO may be present longer on the surface; however, this will aid in a larger proportion of MGO being evaporated compared to dispersal.

10.9.4.3 Spatial Extent of MCS

Hydrocarbon spill modelling has not been undertaken during the development of this EP as discussed within **Section 8.3.4** where it is considered more appropriate to undertake real-time modelling in case the unlikely event that a vessel collision occurs. However, the extent of the MCS has been based on previous modelling undertaken by SLB in previous MSS operations for a spill of MGO (MSL, 2012).

This previous modelling has shown that the extent of a spill varies with average wind speed and current speed; however, the volume percentage of a spill remaining on the surface after three hours did not differ between 13 and 21°C, indicating water temperature does not play an important role in the dispersion or evaporation of MGO. Based on previous modelling, a conservative extent would be 50 km from the spill location. This estimate is considered highly conservative due to the risks of a spill actually occurring (based on the control measures in place), the amount of MGO left in/on the water reducing over time and the quantity of MGO potentially spilt. This is further mitigated by the trend in current wind direction within the Operational Area which is generally trending from the northwest to southeast (i.e. away from the coastline).

The closest point of the Operational Area from the shoreline is over 6.2 km; however, the actual survey line is located over 11 km offshore. Therefore, the worst-case scenario would be if the spill occurs at the inshore boundary of the Operational Area and the spill is directed straight towards the shoreline. However, given the location of most of the survey lines and the distance they are located offshore (excluding the inshore portion of the tie lines), the potential for this situation to occur is very remote.

10.9.5 Hydrocarbon Spill Response Arrangements

10.9.5.1 Hydrocarbon Spill Resources

SLB will ensure that the vessels used for the Otway Basin 2DMC MSS will have on-site response equipment for the prevention and minimisation of loss of oil to the sea. This equipment will include the on-board spill containment and recovery kits which includes absorbent material to meet the flag state and class requirements. All crew onboard will be trained in the use of this spill response equipment and know the location of the response kits. However, this response equipment that will be onboard will not be suitable for deployment to sea for any spills.

For Level 2 spills, the equipment needed (such as booms – although this is not likely needed for MGO) will come from AMSA stockpiles (either from the Adelaide, Melbourne or Devonport stockpile dependant on location of the spill) deployed through the National Plan arrangements. AMSA also has access to stockpiles in Geelong, Victoria which are managed by the Australian Marine Oil Spill Centre (**AMOSC**).

10.9.5.2 Spill Response Options

An assessment of the hydrocarbon spill response options was undertaken within **Section 8.4**. These options include:

- Source control including securing cargo and trimming;
- Natural weathering relating to monitoring and evaluating the spill via vessel/aerial surveillance and trajectory modelling;
- Physical break-up via vessel prop-washing;
- Application of dispersants;
- Containment and recovery through booms and skimmers;

- Protection and deflection utilising booms in the intertidal area;
- Shoreline clean-up through physical removal, surf washing, flushing and natural dispersion; and
- Oiled wildlife response via capture and rehabilitation.

This assessment concluded that source control and natural weathering are the preferred options when dealing with a hydrocarbon spill during the Otway Basin 2DMC MSS due to the location of the Operational Area and the likely break-up of MGO.

Source control will be undertaken as part of a Level 1 response in accordance with the vessels SOPEP. For Level 2 responses, SLB will assist where required by the Control Agency, including provision of up-to-date monitoring information from visuals from the available vessels, and trajectory modelling.

10.9.5.3 Notifications

The Vessel Master has the responsibility for notification and reporting of any spills into the marine environment (via POLREP Form contained in the vessel's SOPEP) to the AMSA Response Coordination Centre. Once this initial report has been undertaken, further reports will be sent at regular intervals to keep relevant parties (such as AMSA, SLB, NOPSEMA, etc.) informed.

The SLB On-board Representative is responsible for advising the SLB Project Manager of the spill incident. The SLB Project Manager is then responsible for notifying NOPSEMA.

The Notification and associated timeframes for both Level 1 and 2 responses are outlined in **Table 107**.

Table 107 Hydrocarbon Spill Response Notifications and Timeframes

Incident Classification	Notification Timing	Authority/Company	Contact Number	Instructions
Level 1 and Level 2	Immediately	SLB Project Manager	(08) 9420 4801	Verbally notify SLB of event and estimated volume and hydrocarbon type.
	Within 2 hours	NOPSEMA	(08) 6461 7090	Verbally notify NOPSEMA for spills > 80 L Record notification using Initial Verbal Notification Form or equivalent and send to NOPSEMA as soon as practicable
	Within 3 days			Provide a written NOPSEMA Incident Report Form as soon as practicable (no later than 3 days after notification)
	Within 1 day	National Offshore Petroleum Titles Administrator	(08) 6424 5317	Provide a verbal or written incident summary

Incident Classification	Notification Timing	Authority/Company	Contact Number	Instructions
	As soon as possible	Director of National Parks	(04) 19 293 465	Provide titleholder details, time and location of incident, name of marine park likely to be effected, proposed response arrangements (as per OPEP), confirmation of providing access to relevant monitoring and evaluation reports when available, and contact details for the response coordinator.
Level 2	Within 2 hours	AMSA	1800 641 792	Verbally notify AMSA Response Coordination Centre of the hydrocarbon spill. Follow up with a written POLREP as soon as practicable following verbal notification.
	As soon as possible if spill affects Victorian state waters	DEDJTR	(03) 8392 6934	Verbally notify DEDJTR. Follow up with a written POLREP as soon as practicable following verbal notification.
	As soon as possible if spill affects South Australian state waters	DPTI	(08) 8248 3505	Verbally notify DPTI. Follow up with a written POLREP as soon as practicable following verbal notification.
	As soon as possible if spill affects Tasmanian state waters	EPA Tasmania	(03) 6165 4599	Verbally notify EPA Tasmania. Follow up with a written POLREP as soon as practicable following verbal notification.
	Within 2 hours	Type II Monitoring Service Provider	To be confirmed prior to commencement	Verbally notify the nominated emergency contact person for the Type II Monitoring service provider (see **Section 10.9.6.2**). Note that the initial notification may not be able to provide key details (i.e. meeting the scientific monitoring program initiation criteria); however, will allow the service provider to commence planning activities to be at the ready. Follow up with more formal notification (includes written documentation), if and when a scientific monitoring program initiation criterion is met (see **Section 10.4.3**)

10.9.5.4 Control Measures for Hydrocarbon Spill Response

SLB has developed a number of control measures that are necessary to ensure timely response to an emergency that result, or may result, in hydrocarbon pollution. These control measures are described within **Table 90** in **Section 8.3**.

10.9.5.5 Capability and Training Requirements

As part of the basic introductory and technical training, all staff will also receive environmental awareness training. As stated within the SLB Environmental Standard (*SLB-QHSE-S008*), SLBs environmental training programme also provides addition training where required, such as for site-specific environmental exposures etc. as all employees are responsible for environmental protection and to minimise the potential impacts on the environment.

10.9.5.6 Arrangements for Testing the OPEP

Prior to the commencement of the Otway Basin 2DMC MSS the OPEP will be tested. A summary of arrangements for testing the response arrangements is provided in **Table 108**.

Table 108 Testing Requirements of the Response Arrangements

Environment Regulations	Description
Regulation 14(8B) of the Environment Regulations requires the arrangements for testing the response arrangements to include:	
A statement of the objectives of testing:	The objectives of testing are to provide an opportunity for crew to gain confidence in using the onboard spill equipment and implementing the incident response procedures. The result of this will increase efficiency in the event of an emergency, review the efficiency of procedures and detect any failures in equipment.
A proposed schedule of tests:	Three-monthly drills and exercise will be carried out on all vessels associated with the Otway Basin 2DMC MSS in line with IMO/SOPEP. The timing of the drills will be scheduled to coincide at the start of the MSS. These drills will include, but not be limited to: • Spill response; • Collision and grounding; • Fire and explosion; and • Helicopter emergency.
Mechanisms to examine the effectiveness of response arrangements against the objectives of testing:	Refer to **Section 10.4**, **i**n particular: • Issues raised (if any) will be described in daily report; • Weekly checklists will ensure that spill monitoring equipment is in place and fully stocked; • Requirements described for the review of the EP and OPEP; and • Requirements described for testing below.

Environment Regulations	Description
Mechanisms to address recommendations arising from tests:	As mentioned above, any issues raised resulting from testing will be described in the daily report. Also, the Vessel Master is made aware that any change to this OPEP and EP is managed through MoC described in **Section 10.4.6**.
Regulation 14(8C) of Environment Regulations states that proposed schedule of tests must provide for the following:	
Testing the response arrangements when they are introduced:	As outlined in **Section 10.9.1**, SOPEP drill conducted prior to the activity (within three months) and at least every three months during the activity.
Testing the response arrangements when they are significantly amended:	The MoC process described in **Section 10.4.6** details the process for any changes to be introduced to the OPEP and EP. Where these changes reasonably affect the arrangements in place, the changed arrangements will be tested prior to finalising the MoC.
Testing the response arrangements, no later than 12 months after the most recent test:	As discussed above, and in **Section 10.9.1**, testing will occur every three months during the activity. However, this is longer than the duration of the survey so as mentioned the testing will occur when the survey starts.
If a new location for the activity is added to the EP after the response arrangements have been tested, and before the next test is conducted — testing the response arrangements in relation to the new location as soon as practicable after it is added to the plan:	SLB will not be undertaking work outside of the Operational Area described within **Section 3.2**.
If a facility becomes operational after the response arrangements have been tested and before the next test is conducted—testing the response arrangements in relation to the facility when it becomes operational:	Not applicable to the Otway Basin 2DMC MSS.

10.9.6 Operational and Scientific Monitoring Plan

SLB would develop a specific operational and scientific monitoring program following an oil spill based on the parameters of the spill, including the location, nature and scale of the spill, and any potentially impacted values including sensitive resources.

As part of the initial response, SLB and the seismic vessel operator will provide a first-strike response (i.e. local or initial resources to stop or contain spill) at the direction of the Control Agency and provide ongoing response and monitoring arrangements where requested.

10.9.6.1 Type I Operational Monitoring

As outlined within **Section 8.3**, Type I 'Operational Monitoring' will be implemented where safe to do so and when there is a net benefit in doing so (as agreed with the Control Agency). This monitoring will be implemented to:

- Determine the extent and character of a spill;
- Visual tracking of the movement/ trajectory of surface slicks;
- Identify areas/ resources potentially affected by surface slicks; and

- Determine sea conditions/ other constraints.

This monitoring will enable the Vessel Master to provide the necessary information to the relevant Control Agency, via a POLREP form, to determine and plan appropriate response actions under the National Plan and the relevant State plan. Operational monitoring and observation in the event of a spill will inform an adaptive spill response and scientific monitoring of relevant key sensitive receptors

Ongoing situational awareness information is provided to the Control Agency through the use of a Marine Pollution Situation Report (**SITREP**).

For a Level 2 spill, SLB will undertake real-time spill trajectory modelling to provide assurances that response options can be tailored to the specific spill situation. The modelling will be based on continuous weather monitoring which will be utilised in conjunction with hindcast data to predict any potential beaching locations of the hydrocarbon, if any exist. This real-time spill trajectory modelling will be utilised to focus any potential scientific monitoring if it were to be required (and directed by the Control Agency) in order to monitor the impacts from a spill occurrence. Further discussion on scientific monitoring is detailed within **Section 10.9.6.2**.

Field-based monitoring, including vessel and/or aerial surveillance, will be undertaken immediately following a spill event. This monitoring will enable the Vessel Master to provide up-to-date information to the relevant Control Agency via the POLREP form to appropriate plan any response options. This field-based monitoring will be utilised further in the development of any scientific monitoring of key sensitive receptors if scientific monitoring is required and requested by the Control Agency. Field-based monitoring has its limitations in that it can only be conducted during daylight hours when the surface slick is visible.

SLB will assist with further operational monitoring (including funding if required) as directed by the Control Agency.

10.9.6.2 Type II Scientific Monitoring

In consultation with the Control Agency, SLB will commit to scientific monitoring dependent on the circumstances of the spill, and the sensitivities at risk. It is not considered that detailed Scientific Monitoring Plans are required to be developed or environmental baseline monitoring is required prior to the MSS commencing due to the potential risks associated with the Otway Basin 2DMSS and a hydrocarbon spill through vessel collision are considered very low with all of the associated control measures in place. This potential risk is short term, transient and in the very unlikely even that it did occur, it is unlikely to cause significant impact on the marine environment given the volumes and nature of the MGO. It is considered that this proposed approach is reasonable for the Otway Basin 2DMC MSS as existing control measures, including meeting all of the legislative requirements and industry standards, will reduce the risk or a hydrocarbon spill to the marine environment.

As discussed in **Section 10.9.4**, it is recognised that there is a very remote chance of shoreline contact depending on the location of a hydrocarbon spill. Therefore, SLB commit to having a service agreement with a service provider prior to the commencement of the Otway Basin 2DMC MSS. This agreement will ensure SLB has a capability to undertake Type II monitoring if required and also enable the chosen service provider to act (in a capacity as agreed with all parties), to either assist the Control Agency or to undertake key Type II monitoring activities on SLBs behalf (if initiation criteria are triggered).

10.9.6.2.1 Type II – Scientific Monitoring Services Agreement

As outlined above, prior to the commencement of the Otway Basin 2DMC MSS, SLB will commit to having a service agreement with a service provider who have demonstrated capability to undertake Type II Monitoring. Prior to agreement with a third-party service provider, they must demonstrate they have the following capabilities:

- Emergency manned mobile telephone number;
- Capacity to prioritise and deploy qualified personnel to execute each scientific monitoring plan (**Section 10.9.6.3**);
- Qualifications and capacity to prepare detailed supporting sampling analytical plans/ monitoring plans for each of the scientific monitoring plans described in **Section 10.9.6.3**;
- The ability to prioritise and mobilise resources to the region (i.e. logistics are in place); or resources are located within the region; and
- Capacity to mobilise personnel and resources to the region as soon as practicable.

After agreeing to a services agreement, should the service provider suggest amendments of **Section 10.7**, this will be managed through the MoC process outlined in **Section 10.4.6**.

A notification will be provided to the service provider within two hours of a known spill event, so the service provider can be 'at the ready', even in the event initiation criteria are not yet triggered.

10.9.6.2.2 Situational Awareness

In the event of a hydrocarbon spill, details that will be exchanged between SLB and the service provider describing situational awareness will include:

- Hydrocarbon type and size of spill;
- Is the spill under control;
- Potential environmental or external influences that may impact a monitoring response;
- Predicted behaviour and predicted trajectory of the spill;
- Potential sensitivities at risk;
- Any ongoing safety concerns; and
- Protection priorities.

10.9.6.3 Scientific Monitoring Plans

The service provider will develop and implement a variety of scientific monitoring plans if and when the initiation criteria are met (**Table 109**). The monitoring plan(s) required in the event of a Level 2 hydrocarbon spill are assessed based on the nature and scale of the MCS and the situational awareness at the time of any spill.

Due to the potential beaching of a hydrocarbon spill from the Otway Basin 2DMC MSS, in the event of a vessel collision, a number of monitoring plans may be considered to monitor the potential impacts of a hydrocarbon spill. **Table 109** provides rationale for the various monitoring plans that would be developed.

Any monitoring plans that are implemented are required to be adaptive to allow key sensitivities at risk to be identified. Such as, if a Control Agency makes a reasonable request for monitoring to be undertaken on a receptor which isn't specified here, any service agreement will provide SLB with the capacity to react to these requests.

Table 109 Scientific Monitoring Plan Aims, Objectives and Rationale

Scientific Monitoring Plan	Key Receptor(s)	Aim	Objective	Rationale
Marine water quality	Background water quality	To monitor the hydrocarbons in marine waters to support assessment of impacts and recovery of sensitivities and to verify hindcast modelling	Assess and document the extent and severity of hydrocarbon contamination utilising observations and/or in-water measurements made during operational monitoring. Provide data to assist further scientific monitoring plans.	Reductions in the water quality are likely to result due to aromatic hydrocarbons being entrained within the water column and dissolving. Impacts on the water quality from a hydrocarbon spill are important to understand and evaluate as this will ultimately impact on a number of other receptors and will be used to inform other monitoring plans described below.
Intertidal and shoreline sediment quality	Background sediment quality, particularly focused on sensitive locations	Gain an understanding of the characteristics, persistence and fate of spilled hydrocarbons within sediments	Estimate spilled hydrocarbon concentrations within sediment. Monitor changes over time in hydrocarbon concentrations. Provide data to assist assessment of impacts on benthic communities. Establish necessary response options.	Should a spill of hydrocarbons reach the shoreline it has the potential to impact on the sediment quality, and as such impact on intertidal biota (described below) which may be exposed to chronic toxicity levels of hydrocarbons.
Intertidal and shoreline habitats and benthos	Invertebrates, filter feeders, benthic primary producers, demersal fish, shorelines and intertidal habitats	Determine the impacts of spilled hydrocarbons on intertidal benthos and habitats	Monitor impacts on intertidal and shoreline habitats from hydrocarbon contamination. Define recovery parameters for benthos. Monitor benthos recovery to hydrocarbon contamination. Establish necessary response options.	Shoreline habitats can be impacted from a spill through stranded floating hydrocarbons, or droplets entrained within the water column, with hydrocarbons becoming increasingly entrained within the nearshore waters. Aquatic organisms utilising these habitats can be exposed to elevated levels of hydrocarbons over their thresholds which will ultimately impact the organism.

Scientific Monitoring Plan	Key Receptor(s)	Aim	Objective	Rationale
Seabirds and shorebirds population and recovery	Foraging seabirds and coastal shorebird populations	Assess impacts on seabird and shorebird populations.	Quantify foraging, nesting or breeding seabird and shorebird populations potentially impacted by spilled hydrocarbons. Quantify oiled avifauna, including mortalities. Establish necessary response options.	Seabirds and shorebirds can be impacted by hydrocarbons spills through the presence of hydrocarbons on the surface of the water and from hydrocarbons entrained within the water column. This can lead to potential behavioural, physiological and physical impacts such as deviation from migratory routes, disruption to their indigestion and/or coating their feathers resulting in the inability to fly.
Marine fauna (excluding avifauna)	Marine mammals, marine reptiles, boney fish, elasmobranchs	Assess impacts on non-avian marine fauna potentially impacted by a hydrocarbon spill.	Quantify oiled marine fauna, including mortalities.	Hydrocarbon spills resulting in a surface slick or entrained within the water column has the potential for long-term impacts to marine fauna. Contact between marine fauna and a surface slick or in-water concentrations of hydrocarbon has the potential to elicit lethal and sub-lethal impacts, including behavioural (avoidance of foraging habitats or migratory routes), physiological (inability to digest) and/or physical effects.
Socio economic impact monitoring (fisheries, aquaculture and tourism)	Target species or areas of importance for fishing/tourism	Assess impacts on fisheries (including aquaculture) and tourism activities	Monitor hydrocarbon concentration within tissue of species targeted by commercial fisheries. Identify potential impacts on human health as a result of hydrocarbon contamination. Assess recovery of tourism operations in area affected.	Commercial fishing operations for pelagic fish, shellfish or through aquaculture can be impact from a hydrocarbon spill which can include lethal and sub-lethal physiological and physical effects. Any exposure to commercial and recreational target species can result in the tainting of flesh and increase in toxicity above human consumption thresholds. In terms of tourism, a hydrocarbon spill can result in a negative perception on the environment impacted by the spill.

10.9.6.3.1 Development of Detailed Scientific Monitoring Plans

The agreed service provider will develop detailed scientific monitoring plans after receiving the initial notification in the event of a spill, and when the initiation criteria outlined in **Table 109** have been met. A draft scientific monitoring plan will be provided to SLB as soon as practicable, but within 24 hours after receiving the initial notification that a hydrocarbon spill has occurred. A final proposed monitoring plan will then be provided to the relevant Control Agency for review as soon as practicable, but within 24 hours of initial notification.

The monitoring plans will include, as a minimum:

- Objectives and rationale of the monitoring plan: Each plan developed will outline the key objectives, rationale and focus of the plan;
- Baseline information: It is important for each monitoring plan to specify the details of the baseline to be applied, or a method for selection of suitable reference/control sites. If possible, previous monitoring from published studies and findings is to be utilised;
- Spatial awareness: It is important for any scientific monitoring plan to provide information and outcomes obtained from the operational monitoring (such as real-time spill trajectory modelling) to support the proposed design;
- Methodology: The proposed survey methodology should consider the statistical methods and sampling effort required to achieve the objectives of the scientific monitoring plan. If sampling is proposed as part of the monitoring plan, industry recognised methods for collection and analysis of the samples must be used. This includes utilising accredited laboratories and following best practice guidelines and applicable legislation where applicable. The methodology should include, as a minimum:
  - Details of any permits or approvals required to undertake the work, including whether there are any exemptions;
  - Collection and analysis requirements (i.e. permits);
  - Personnel proposed to undertake the monitoring, including appropriate qualifications and skills;
  - Equipment required to complete the proposed monitoring;
  - HSSE requirements to complete the survey;
  - QA/QC requirements if appropriate;

Initiation criteria: The criteria used to initiate the proposed scientific monitoring plan;

- Termination criteria: Each monitoring plan will include a termination date at which time the monitoring can stop which is consistent with the objectives of the monitoring plan. These criteria must be adaptive and be able to change based on the actual circumstances of the impacts and/or risks of assessment;
- Management of change: The monitoring plans must be adaptive to ensure the impacts and risks are managed appropriately. As such, if a monitoring plan is required to change to adapt to these circumstances, then a process for change needs to be detailed so that any revision is provided to SLB and the relevant Control Agency for acceptance as soon as practicable. Any revisions undertaken must be tracked to clearly communicate the current status of the monitoring requirements; and

- Reporting: Each monitoring plan is required to detail the reporting of results during and post monitoring. This reporting will include ongoing situation reports during the implementation of monitoring; the timing of these situation reports will be based on the nature and scale of the impacts/risks. Post monitoring, a draft report and third-party peer reviewed report will be provided to SLB, the Control Agency and NOPSEMA which will include any recommendations resulting from the monitoring plan.

10.9.6.3.2 Implementation of Scientific Monitoring Plans

During the development of the monitoring plan(s) outlined in **Section 10.9.6.3** above, the service provider will undertake all planning actions required to mobilise to the site. This will include providing a brief proposal to SLB which will outline the resources and personnel required, transport arrangements and timeframes for implementation. The service provider will undertake all reasonable measures to mobilise to the site as soon as practicable. The ability for the service provider to mobilise within 24 hours will be required under the service agreement.

Due to the likelihood of a spill occurring, it is not considered reasonable to have these resources on standby during the Otway Basin 2DMC MSS. It would require considerable financial investments over and above the significant control measures implemented to reduce the risks of a vessel collision to **ALARP** and **Acceptable Levels**. Therefore, SLB consider the approach outlined above to be reasonably practicable based on the nature and scale of the risks associated with the Otway Basin 2DMC MSS.

10.9.6.3.3 Initiation Criteria for Scientific Monitoring Plan

The initiation criteria (**Table 110**) for each monitoring plan is broadly applied to enact the response described within this EP. However, it is important to note that the final decision to commence each monitoring plan will be based on the net environmental benefit in which the environmental sensitivities should be avoided if the monitoring proposed may reasonably result in further impacts and offer no net benefit.

Table 110 Scientific Monitoring Plan Initiation Criteria

Plan	Initiation Criteria
Marine water quality	Notification of a Level 2 or greater hydrocarbon spill.
Intertidal and shoreline sediment quality	Notification of a Level 2 or greater hydrocarbon spill. and Where modelling and/or Operational Monitoring indicates likely exposure to intertidal and/or shoreline sediments. or Reports are received of shoreline and/or shoreline contact from hydrocarbon spill.
Intertidal and shoreline habitats and benthos	Notification of a Level 2 or greater hydrocarbon spill. and Where modelling and/or Operational Monitoring indicates likely exposure to intertidal and/or shoreline habitats or benthos. or Reports are received of shoreline and/or shoreline contact from hydrocarbon spill.
Seabirds and shorebirds population and recovery	Notification of a Level 2 or greater hydrocarbon spill. and Where modelling and/or Operational Monitoring indicates likely exposure to seabird and/or shorebird populations. and/or Reports are received of contact with avifauna from hydrocarbon spill. and/or Reports of oiled or dead avifauna are received.
Marine fauna (excluding avifauna)	Notification of a Level 2 or greater hydrocarbon spill. and Where modelling and/or Operational Monitoring indicates likely exposure to non-avian marine fauna. and/or Reports are received of contact with non-avian marine fauna from hydrocarbon spill. and/or Reports of oiled or dead non-avian marine fauna are received.
Socio economic impact monitoring (fisheries, aquaculture and tourism)	Notification of a Level 2 or greater hydrocarbon spill. and Where modelling and/or Operational Monitoring indicates likely exposure to aquaculture operations. and/or Reports are received of commercial fisheries closures due to hydrocarbon contamination. and/or Reports are received of tourism operation closures due to hydrocarbon contamination.

10.9.6.3.4 Termination Criteria for Scientific Monitoring Plan

Each scientific monitoring plan that is undertaken as part of a response operation will continue until certain termination criteria have been met (**Table 111**), in consultation with the relevant Control Agency.

Table 111 Scientific Monitoring Plan Termination Criteria

Plan	Termination Criteria
Marine water quality	Hydrocarbon spill has ceased, there are no visible sheens present and no further sheens are predicted by the modelling. Monitoring data of in-water concentrations of hydrocarbons have been compiled and analysed. Reporting on sampling has been completed detailing extent and severity of spilled hydrocarbons which can enable further analysis of impacts on other receptors in any further scientific monitoring plans.
Intertidal and shoreline sediment quality	Hydrocarbon spill has ceased, there are no visible sheens present and no further sheens are predicted by the modelling. Any monitoring done shows concentrations of hydrocarbons present within sediments fall below relevant guidelines (e.g. ANZECC). Reporting on the sampling has been completed detailing the extent and severity of spilled hydrocarbons which can enable further analysis of impacts on benthic communities.
Intertidal and shoreline habitats and benthos	Hydrocarbon spill has ceased, there are no visible sheens present and no further sheens are predicted by the modelling. Impacts from hydrocarbon spill on benthos quantified and recovery evaluated. Reporting on the monitoring has been completed detailing the extent and severity of spilled hydrocarbon impacts on benthos.
Seabirds and shorebirds population and recovery	Hydrocarbon spill has ceased, there are no visible sheens present and no further sheens are predicted by the modelling. Objectives and values associated with any relevant species recovery plans and/or conservation advices have been met. Impacts from hydrocarbon spill on avifauna quantified and recovery evaluated. Reporting on the monitoring has been completed detailing the extent and severity of spilled hydrocarbon impacts on avifauna.
Marine fauna (excluding avifauna)	Hydrocarbon spill has ceased, there are no visible sheens present and no further sheens are predicted by the modelling. Objectives and values associated with any relevant species recovery plans and/or conservation advices have been met. Impacts from hydrocarbon spill on marine fauna (excluding avifauna) quantified and recovery evaluated. Reporting on the monitoring has been completed detailing the extent and severity of spilled hydrocarbon impacts on marine fauna (excluding avifauna).
Socio economic impact monitoring (fisheries, aquaculture and tourism)	Hydrocarbon spill has ceased, there are no visible sheens present and no further sheens are predicted by the modelling. Impacts to important commercial fisheries quantified and recovery evaluated. Impacts to seafood quality and secondary impacts on human health evaluated. Impacts on tourism ventures quantified and evaluated. Reporting on the monitoring has been completed detailing the extent and severity of spilled hydrocarbon impacts on commercial fisheries, aquaculture and tourism operations.

11 Conclusion

In accordance with the OPGGS Act, the EPBC Act and the associated Environment Regulations, SLB has prepared this EP to support the application process for the Otway Basin 2DMC MSS. The proposed start date for the survey is October 2019. The survey proposes to acquire seismic data over a linear total of approximately 14,000 km, including 13 tie lines that extend towards historic well sites in the coastal zone.

This EP assesses the potential risks and associated impacts from the proposed survey on the biological and socioeconomic values of the Operational Area. The methodology employed during the assessment included 1) an extensive literature review; 2) project specific STLM to examine the spatial spread and magnitude of acoustic outputs from the Otway Basin 2DMC MSS and to predict how this would affect various receptors; and 3) extensive stakeholder engagement. In addition to this assessment, the EP identifies the control measures and operational procedures that will be implemented to reduce potential environmental impacts from planned operational activities, and risks from unplanned activities to **ALARP** and to **Acceptable Levels**.

The marine environment within and surrounding the Operational Area is complex in terms of physical, biological and socioeconomic aspects. The Otway Basin 2DMC MSS Operational Area straddles the continental shelf, with water depths ranging from 50 to 5,600 m. Biodiversity is high due to the wide range of habitats which include localised areas of upwelling (i.e. Bonney Upwelling) and BIAs for blue whales and southern right whales. The Operational Area provides habitat for a wide variety of resident and migratory species of fish, whales, seals and seabirds. In addition, the Otway Basin 2DMC MSS Operational Area overlaps with commercial fisheries based in South Australian and Victorian state waters with additional Commonwealth-managed fisheries operating in some offshore areas.

Acoustic disturbance to marine fauna was identified as the primary environmental risk for the Otway Basin 2DMC MSS. The STLM results indicated that at 1 km the expected single shot sound exposure levels ranged from 164 dB 1 μPa^2 s in 50 m of water up to 170 dB 1 μPa^2 s in 4,800 m of water. The potential impacts on all faunal groups have been thoroughly reviewed throughout the EP with the following key findings:

- STLM results indicated that fish mortality or injury is possible from exposure to a single pulse of the acoustic source at full power at distances out to 250 m in the deepest water of the Operational Area, or 130 m in the shallowest waters. Exposure to multiple pulses from the moving source or doubling the noise dose with an infill line does not increase the risk of fish mortality or injury, since mortality effects are dominated by the peak impulsive effect of a single full power pulse;
- STLM results indicate that exposure to a single acoustic pulse could elicit permanent hearing damage to baleen whales within 50 m of the acoustic source. Cumulative exposure to multiple noise pulses could cause permanent hearing damage in baleen whales at distances out to around 1,200 m. Temporary hearing damage could occur if baleen whales were exposed to a single pulse at a distance of 80 – 130 m, or for whales remaining at one location for an extended time period within around 5 km of an active survey line, or around 7 km if an infill line is required. The higher frequency hearing range of other cetaceans mean that they are less susceptible to impacts and the STLM results indicate that there is no potential for either temporary or permanent hearing damage outside of 1 km from the active source; and
- STLM results indicated that exposure to a single pulse of the acoustic source could elicit mortality in zooplankton out to 4,500 m from the source, while fish and fish eggs would experience mortality out to 250 m from the source in deep water, and 130 m from the source in shallow water.

The EP also assessed the potential for cumulative effects associated with concurrent, consecutive or multiple sound sources during the Otway Basin 2DMC MSS. Two MSSs have recently been approved by NOPSEMA; however, these are located 300 and 400 km away from the Otway Basin 2DMC MSS Operational Area. There are two further EPs currently under consideration by NOPSEMA which are closer to the SLBs Operational Area; however, in the event that concurrent seismic activity does occur, SLB have committed to maintaining a minimum separation distance of at least 40 km between the active seismic sources, as per recent national and international best practice.

Through the development of the EP, SLB has undertaken an extensive stakeholder engagement programme with those stakeholders considered as 'relevant persons', including commercial and recreational fishers, industry bodies and associations, marine park authorities, tourism operators etc. The scale of the engagement programme extended well beyond the expectations set by industry best practice and the relevant legislation (sections 11A and 16 of the Environment Regulations).

The stakeholder engagement process has provided SLB with a deep level of understanding with regard to the potential impacts (both real and perceived) from interested parties. This process has been particularly useful in relation to understanding the risks to commercial fishers from the proposed operations and stakeholder feedback has been used to refine the survey design in terms of spatial and temporal extent, with the aim of reducing potential impacts and alleviating concerns from stakeholders where possible.

The key concerns raised in submissions during engagement were from commercial fishers who voiced concern that 1) catch rates of target species may be adversely affected by the proposed operations; and 2) that underwater noise would have detrimental effects on the larval stages of commercially fished species (primarily rock lobster and scallops). SLB consider that sufficient information and sufficient time has been provided to each stakeholder to consider the proposed seismic operations and that thorough responses, based on best available science (e.g. published literature, STLM results, fish tagging studies, catch data, etc.), have been prepared for each of the submissions received to date. Throughout the stakeholder engagement process, SLB has taken pride in the honesty of communications and the level of transparency conveyed regarding the proposed activity and associated impacts throughout the entire stakeholder engagement process.

A consultation strategy has been developed which defines the key principles and policies that demonstrate SLB's genuine commitment to ongoing meaningful engagement with stakeholders throughout the duration of the Otway Basin 2DMC MSS. SLB also has entered into contractual agreements with SIV, TSIC and SETFIA for engaging with the Victorian, Tasmanian and Commonwealth trawl fishers for the duration of the Otway Basin 2DMC MSS. SLB will undertake a close-out round of stakeholder engagement following the completion of the survey, to enable information sharing from both sides from the survey and engagement process, and to enable the opportunity for stakeholder feedback to reflect SLB's culture of continual improvement.

Multiple control measures will be implemented during the Otway Basin 2DMC MSS to reduce potential impacts to the marine environment and stakeholders to **ALARP** and an **Acceptable Level**. A number of these controls have been incorporated in response to stakeholder feedback. In particular, the following two revisions were made to the survey design to reduce potential conflict with commercial fisheries, with the added benefit of reducing potential impacts on the sensitivities to the marine environment within these areas:

- The Operational Area was revised to reduce the spatial overlap with inshore waters. An initial revision to omit waters less than 50 m deep meant that the proposed Operational Area was reduced by 25,000 km^2 and spatial overlap with most rock lobster fishing grounds and abalone dive fisheries was eliminated. This revision also addressed potential impacts on ecological sensitivities in the coastal zone (e.g. the Bonney Upwelling System and those species dependant on it for foraging); and

- A second revision was subsequently made to the Operational Area, which resulted in a further reduction of 73,000 km^2 when all waters shallower than 1,000 m were omitted off the west coast of Tasmania. This revision also addressed potential impacts on ecological sensitivities in the West Tasmania canyons and the associated benthic species.

These two revisions collectively reduced the Operational Area by approximately 100,000 km^2. Following this revision, 98% of the survey lines are now located in water depths greater than 200 m, and 89% of the Operational Area is in water depths greater than 1,000 m. Very little commercial fishing occurs in depths greater than 1,000 m. Therefore, spatial overlap with fisheries has been significantly reduced by these changes.

During the acquisition of the Otway Basin 2DMC MSS, SLB will issue '48-hour look-aheads' of the vessel's predicted passage to the fishing industry and other relevant marine users. These notifications will be updated every 24 hours. As part of the agreement SLB has with SETFIA, SETFIA will provide SMSs to the commercial fishers that use the Operational Area for their fishing activities, as they may not have email access whilst at sea. The SMS will contain very similar information that of the 48-hour look-ahead. These notifications are intended to minimise conflict and the loss of any fishing gear; however, if any fishing gear is lost or damaged on account of seismic operations, SLB will compensate those fishers for the replacement value of the lost gear.

Contraction of the Operational Area to offshore deeper waters have also reduced the potential overlap with seasonal whale activity along the coast; namely southern right whale calving off Victoria in winter and the feeding of blue whales in the Bonney Upwelling off South Australia in summer. In addition, humpback whales migrate north through Bass Strait during April/May, and south in November/December. To avoid overlap with this migration, even though the Operational Area is considered to be a significant distance away, SLB will make best intentions to acquire the southeast portion of the survey area after December 2019.

The legislative framework and requirements that SLB will comply with during the Otway Basin 2DMC MSS are detailed in the EP, along with a number of other relevant legal and environmental management requirements. Of particular relevance is the EPBC Act Policy Statement 2.1, which will be implemented to minimise the risk of acoustic disturbance to whales.

In an effort to increase the protection afforded to whales, SLB have proposed a modification to the standard Precautionary Zones outlined in the EPBC Act Policy Statement 2.1; where instead of having a 'Low-power Zone', SLB will extend the 500 m 'Shut-down Zone' out to 2 km to address the results of the STLM which predicted that cumulative exposure could cause PTS in baleen whales at distances out to 1,200 m. Beyond this Shut-down Zone the 'Observation Zone' will be implemented out to 3+ km from the acoustic source.

Two MMOs will be present onboard the seismic vessel to monitor for marine mammals in the Observation Zone and PAM will be used around the clock to acoustically detect cetaceans. The use of soft starts and delayed starts are a standard requirement of the EPBC Act Policy Statement 2.1and will be implemented during the survey; however, SLB has also committed to 'no energy' line turns, run-ins and run-outs in an effort to further reduce the spatial footprint of the survey.

In addition to these measures, SLB's survey design also provides a degree of mitigation against disturbance to marine mammals, namely:

- The Otway Basin 2DMC MSS Operational Area is located in Open Ocean and not in any confined water body or migratory corridor; and
- The 5 km spacing between survey lines will ensure the survey vessel will not focus in any specific area for a long period of time.

In addition to the Standard and Additional Control Measures provided in the EPBC Act Policy Statement 2.1, SLB has proposed a number of control measures to be adopted when operating within the BIAs for blue whales and southern right whales. These Additional BIA Control Measures include:

- A 4 km buffer will be observed around the offshore boundary of the Operational Area, within which the BIA control measures will be implemented;
- The Shut-down Zone will be further extended out from 2 km to 4 km horizontal distance from the acoustic source;
- Two experience MMOs will be posted on the bridge of the survey vessel during daylight hours while the acoustic source is active within the BIAs and 4 km buffer zone;
- An additional experienced MMO will be present on the support vessel to provide a secondary observation platform during daylight hours;
- Adaptive management measures will be in place for operations within the BIA and buffer zone; and
- If whale sightings are higher than anticipated, and adaptive management measures are being implemented repeatedly during the survey, a discussion with the DoEE will occur to discuss whether any further mitigation measures are required.

Additional control measures have also been proposed for the 13 tie lines which encroach slightly into the offshore extent of the Bonney Upwelling, as the upwelling system is a critical foraging area for blue whales. These additional control measures will be implemented alongside the Standard and Additional Control Measures and the BIA Additional Measures and include:

- The acquisition of the 13 western tie lines will only occur during day light hours and in good visibility conditions that allow visual observations well beyond the 3+ km Observation Zone;
- There will be two experienced MMOs on the bridge of the survey vessel during tie line acquisition to maximise visual coverage and increase potential for observing any whale that may enter the 3+ km Observation Zone;
- Within the defined operational window of October 2019 to June 2020, two periods have been identified where the biological significance of any potential impacts to whales in the inshore tie line areas will be lowest. These periods for the tie line acquisition will either take place at the start of the survey (i.e. 15 October-31 December 2019) or at the end of the survey (i.e. 1 March-30 April 2020). These two tie line acquisition periods were selected to minimise the potential overlap between seismic operations and:
  - The end of the southern right whale breeding season that ends in September/October;
  - The beginning of the southern right whale breeding season in May/June;
  - The arrival of pygmy blue whales to the Bonney Upwelling foraging area and their peak feeding activity in January and February; and
  - The northward humpback migration in April/May.
- Gill *et al*. (2011) documented that blue whale foraging typically occurs in the west of the upwelling system (in the vicinity of Kangaroo Island and Eyre Peninsula) early in the upwelling season (O), before spreading eastward between Cape Jaffa and Cape Otway. The proposed timing of the tie line acquisition at the start of the survey does overlap with the southward migration of humpback whales (November/December); however, tagging studies indicate that the majority of humpbacks move south along the east coast of Tasmania (Andrews-Goff *et al*., 2018) well away from the tie line locations; and

- Other baleen whale species (sei and fin whales) also utilise the Bonney Upwelling for foraging, so these species will also presumably benefit from tie line acquisition mitigation measures.

Adaptive Management Measures have been proposed for the duration of the Otway Basin 2DMC MSS and include:

- Relocation of the survey vessel to another line at least 10 km away in the event that high numbers of whale detections result in three or more shut-downs within a 24-hour period;
- Immediate shut-down of the acoustic source if a southern right whale mother and calf pair is observed, with start-up and soft-start procedures only commencing once the whales have disappeared from the observable distance for at least one hour, or approximately 8 km away; and
- A discussion will be held with the DoEE in the event that whale sightings are higher than anticipated in order to discuss the implementation of additional management measures.

In light of the survey design revisions and the extensive suite of proposed controls, the overall conclusion from the environmental risk assessment is that the impacts from the Otway Basin 2DMC MSS have been reduced to **ALARP** and **Acceptable Levels**. The survey will fully comply with all relevant legislation and industry best practice.

12 References

ABARES, 2018. '*Fishery Status Reports*'. Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), Department of Agriculture and Water Resources. http://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status

ABARES, 2018a. '*Southern Squid Jig Fishery*'. http://www.agriculture.gov.au/abares/Pages/southern-squid-jig-fishery.aspx#134-environmental-status

ACAP, 2018. '*Agreement on the Conservation of Albatrosses and Petrels – About ACAP*'. https://www.acap.aq/index.php/resources/education/1078-about-acap?lang=en

Adam, P., 2009. '*Australian saltmarshes in global context*'. In: Australian Saltmarsh Ecology. (ed.) N Saintilan. CSIRO Publishing, Victoria.

AFMA, 2006. '*Orange Roughy Conservation Programme*'. Available from: http://www.afma.gov.au/wp-content/uploads/2014/12/orange-roughy-conservation-programme.pdf

AFMA, 2009. '*The School Shark Rebuilding Strategy 2008*'. Canberra: Available from: http://www.afma.gov.au/wp-content/uploads/2010/07/school_shark_rebuild.pdf

AFMA, 2014. '*Blue warehou (Seriolella brama) Stock Rebuilding Strategy*'. Available from: http://www.afma.gov.au/wp-content/uploads/2014/12/Blue-Warehou-Rebuilding-Strategy-2014.pdf

AFMA, 2017. '*Southern Squid Jig Fishery Resource Assessment Group (SquidRAG) meeting 22*'. Meeting record, 16 October 2017, AFMA, Canberra.

AFMA, 2018. '*Southern bluefin tuna*'. www.afma.gov.au/fisheries-management/species/southern-bluefin-tuna.

AFMA, 2018a. '*Australian Fisheries Management Authority – About AFMA*'. https://www.afma.gov.au/about/about-afma

AFMA, 2018b. '*Petroleum industry consultation with the commercial fishing industry*'. https://www.afma.gov.au/sustainability-environment/petroleum-industry-consultation

AFMA, 2018c. '*Australian Fisheries Management Authority – Fishing rights and permits*'. https://www.afma.gov.au/fisheries-services/fishing-rights-permits

AFMA, 2018d. '*Australian Fisheries Management Authority – Bass Strait Central Zone Scallop Fishery Managements Arrangements Booklet July 2018*'. Australia Fisheries Management Authority, Canberra, Australia. Accessed from https://www.afma.gov.au/sites/g/files/net5531/f/uploads/2018/07/BSCZSF-Management-Arrangements-Booklet-2018-FINAL.pdf

AFMA, 2018e. '*Small Pelagic Fishery*'. http://www.afma.gov.au/fisheries/small-pelagic-fishery/

AFMA, 2018f. '*Southern and Eastern Scalefish and Shark Fishery*. http://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery/

AFMA, 2018g. '*Eastern Tuna and Billfish Fishery*' https://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page

AFMA, 2018h. '*Western Tuna and Billfish Fishery*' https://www.afma.gov.au/fisheries/western-tuna-and-billfish-fishery

AFMA, 2018i. '*Southern Bluefin Tuna Fishery*'. http://www.afma.gov.au/fisheries/southern-bluefin-tuna-fishery/

AFMA, 2018j. '*Southern Squid Jig Fishery*'. http://www.afma.gov.au/fisheries/southern-squid-jig-fishery/

AFMA, 2018k. '*Bass Strait Central Zone scallop fishery*'. https://www.afma.gov.au/fisheries/bass-strait-central-zone-scallop-fishery

Aguilar de soto, N., Atkins, J., Howard, S., Williams, J., Johnson, M., 2013. '*Anthropogenic noise causes body malformations and delays development in marine larvae*'. Scientific Report 3.

Aguilar Soto, N., Johnson, M., Madsen, P.T., Tyack, P.L., Bocconcelli, A., Borsani, J.F., 2006. '*Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (Ziphuis cavirostris)?*' Marine Mammal Science, 22(3): 690 – 699.

Aicher, B., Markl, H., Masters, W.M., Kirschenlohr, H.L., 1983. '*Vibration transmission through the walking legs of the fiddler crab, Uca pugilator (Brachyura, Ocypodidae) as measured by Laser Doppler Vibrometry'*. Journal of Comparative Physiology, 150: 483-491.

Ainslie, M.A., 2008. '*Review of published safety thresholds for human divers exposed to underwater sound'*. TNO Report, TNO-DV 2007 A598, 18p.

ALA, 2018. '*Atlas of Living Australia'*. http://www.ala.org.au Accessed 27 August 2018

Allen, J.K., Peterson, M.L., 2012. '*Radiated noise from commercial ships in the Gulf of Maine: implications for whale/vessels collisions'*. The Journal of the Acoustical Society of America, 132: EL229.

AMSA, 2015. '*Technical guidelines for preparing contingency plans for marine and coastal facilities*'. AMSA guidance document, 64p

AMSA, 2017. '*National Plan for Maritime Environmental Emergencies – 2017 Edition*'. Australian Maritime Safety Authority. Australian Government.

Andre, M., Kamminga, C., 2000. '*Rhythmic Dimension in the Echolocation Click Trains Of Sperm Whales, A Possible Function Of Identification And Communication'*. Journal of the Marine Biological Association of the UK 80: 163-169.

Andre, M., Soler, M., Lenoi, M., Dufrot, M., Quero, C., Alex, M., Antoni, L., Van Der Schar, M., Lopez-Bejar, M., Morell, M., Zaugg, S., Houegnigan, L, 2011. '*Low-Frequency Sounds Induce Acoustic Trauma In Cephalopods*'. Frontiers in Ecology and the Environment, 9: 489-493.

Andrews, K.S., Williams, G.D., Levin, P.S., 2010. *'Seasonal and ontogenetic changes in movement patterns of sixgill sharks'.* PLoS One, 5(9):e12549.

Andrews-Goff, V., Bestley, S., Gales, N.J., Laverick, S.M., Paton, D., Polanowski, A.M., Schmitt, N.T., Double, M.C., 2018. '*Humpback whale migrations to Antarctic summer foraging grounds through the southwest Pacific Ocean'*. Scientific Reports, 8, doi: 10.1038/s41598-018-30748-4.

Andriguetto-Filho, J.M., Ostrensky, A., Pie, M.R., Silva, U.A., Boeger,W.A., 2005. '*Evaluating the impact of seismic prospecting on artisanal shrimp fisheries'*. Continental Shelf Research, 25: 1720-1727.

ANSI S1.1-1994.R2004: '*American National Standards Acoustical Terminology'*. American National Standards Institute, New York.

Anthony, T.G., Wright, N.A., Evans, M.A., 2009. '*Review of diver noise exposure'*. Health and Safety Executive Research Report RR735, 62p.

Arnold, P., Marsh, H., Heinsohn, G., 1987. '*The occurrence of two forms of minke whales in east Australian waters with a description of external characters and skeleton of the diminutive or dwarf form'*. Sci. Rep. Whales Res. Inst., 38: 1 – 46.

Aroyan, J. L., McDonald, M. A., Webb, S. C., Hildebrand, J. A., Clark, D., Laitman, J. T, Reidneberg, J. S., 2000. '*Acoustic Models Of Sound Production And Propagation*'. In: Hearing by Whales and Dolphins, Ed: W. W. L. Au, A. N. Popper & R. N. Fay", 409-469 p. Springer, New York, U.S.

ASBTIA, 2018. '*Australian Southern Bluefin Tuna Industry Association Ltd (ASBTIA)*'. https://asbtia.com.au/about/

ASBTIA, 2018a. '*Shortest tuna season one of the best*'. https://asbtia.com.au/shortest-tuna-season-one-best-brian-jeffriess-abc-rural/

Attard, C.R.M., Beheregaray, L.B., Jenner, C., Gill, P., Jenner, M., Morrice, M., Bannister, J., LeDuc, R., Möller, L., 2010. '*Genetic diversity and structure of blue whales (Balaenoptera musulus) in Australian feeding aggregations*'. Conserv. Genet., doi:10.1007/s10592-010-0121-9.

Au, W. W. L., and Hastings, M. C. 2009. Principles of marine bioacoustics, Springer, New York. 679 pp.

Australian Bureau of Statistics, 2018. '*QuickStats*' http://abs.gov.au/websitedbs/D3310114.nsf/Home/2016%20QuickStats

Australian Heritage Council, 2009. '*Guidelines for the assessment of places for the National Heritage List*'. http://www.environment.gov.au/resource/guidelines-assessment-places-national-heritage-list

Australian Marine Parks, 2018. '*Benthic fact sheets*'. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/benthic-fact-sheets/

Australian Museum, 2018. '*Yellow-bellied Sea Snake*'. https://australianmuseum.net.au/yellow-bellied-sea-snake

Backhouse, G., Jackson, J., O'Connor, J., 2008. '*National Recovery Plan for Australian Grayling Prototroctes maraena*'. Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-australian-grayling-prototroctes-maraena. In effect under the EPBC Act from 27-Mar-2008.

Backus, R.H., Schevill, W.E., 1966. ''*Physeter clicks*,'' in Whales, Dolphins, and Porpoises, edited by K. S. Norris, University of California Press, Berkeley, pp. 510–528.

Baines, P.G., Edwards, R.J., Fandry, C.B., 1983. '*Observations of a new baroclinic current along the western continental slope of Bass Strait*'. Aust. J. Mar. Freshw. Res., 34: 155 – 157.

Baker, A.N., 1999. '*Whales & Dolphins of New Zealand & Australia: An identification guide*'. Victoria University Press, Wellington, New Zealand.

Ban, N., Hussein, A., Ardron, J. 2010. '*Cumulative impact mapping: Advances, relevance and limitations to marine management and conservation, using Canada's Pacific waters as a case study*'. Marine Policy. Vol 34, Issue 5. pp 876-886.

Bannister, J.L., Kemper, C.M., Warneke, R.M., 1996. '*The Action Plan for Australian Cetaceans*'. Australian Nature Conservation Agency. Available from http://www.environment.gov.au/resource/action-plan-australian-cetaceans

Bannister, J.L., Pastene, L.A., Burnell, S.R., 1999. '*First record of movement of a southern right whale (Eubalaena australis) between warm water breeding grounds and the Antarctic Ocean, south of 60°S*'. Marine Mammal Science, 15: 1337 – 1342.

Barrett-Lennard, L., Ford, J., Heise, K., 1996. '*The mixed blessing of echolocation: differences in sonar use by fish-eating and mammal-eating killer whales*'. Animal Behaviour 51: 553–565.

Barton, J., Pope, A., Howe, S., 2012. '*Marine Natural Values Study Vol 2: Marine Protected Areas of the Otway Bioregion*'. Parks Victoria Technical Series, Number 75, 125p.

Bass, A.H., Ladich, F., 2008. '*Vocal-Acoustic Communication: From Neurons To Behavior*'. In: Webb JF, Fay RR, Popper AN, editors. Springer handbook of auditory research. Vol. 32. New York: Springer. p. 253–278.

Basson, M., Hobday, A.J., Eveson, J.P., Patterson, T.A., 2012. '*Spatial interactions among juvenile southern bluefin tuna at the global scale: a large scale archival tag experiment*'. FRDC Report 2003/002.

Baumgartner, M.F., Van Parijs, S.M., Wenzel, F.W., Tremblay, C.J., Esch, H.C., Warde, A.M., 2008. '*Low frequency vocalizations attributed to sei whales (Balaenoptera borealis)*'. Journal of the Acoustical Society of America, 124(2): 1339 – 1349.

Bax, N., Williamson, A., Aguero, M., Gonzalez, E., Geeves, W., 2003. '*Marine Invasive Alien Species: A Threat To Global Biodiversity*'. Marine Policy, 27: 313 – 323.

Bejder, M., Johnston, D.W., Smith, J., Friedlaender, A., Bejder, L., 2016. '*Embracing conservation success of recovering humpback whale populations: evaluating the case of downlisting their conservation status in Australia*'. Marine Policy, 66: 137 – 141.

Bendell, A., 2011. '*Shafag Asiman Offshore Block 3D Seismic Survey Exploration Survey – Environmental Impact Assessment*'. Prepared for BP Azerbaijan, 23 August 2011. Reference No. P140167.

Berkenbusch, K., Abraham, E.R., Torres, L.G., 2013. '*New Zealand marine mammals and commercial fisheries*'. New Zealand Aquatic Environment and Biodiversity Report No. 119. Ministry for Primary Industries, Wellington, New Zealand. 113 p.

Bernard, H.J., Reilly, B., 1999. '*Pilot whales - Globicephala Lesson, 1828*'. In: Ridgway, S.H., S.R. Harrison, S.R. (eds.), *Handbook of Marine Mammals Vol. 6: The second book of dolphins and porpoises*. Page(s) 245 – 280.

Berra, T.M., 1982. '*Life history of the Australian grayling Prototroctes maraena (Salmoniformes: Prototroctidae) in the Tambo River, Victoria*'. Copeia. 1982(4):795-805.

Berthou, F., Balouët, G., Bodennec, G., and Marchand, M., 1987. '*The occurrence of hydrocarbons and histopathological abnormalities in oysters for seven years following the wreck of the Amoco Cadiz in Brittany (France)*'. Marine Environ Res, 23, 103–133.

Bestley, S., Gunn, J.S., Hindell, M.A., 2008. '*Feeding ecology of wild migratory tunas revealed by archival tag records of visceral warming*'. Journal Animal Ecology, 77: 1223 – 1233.

Bestley, S., Gunn, J.S., Hindell, M.A., 2009. '*Plasticity in vertical behaviour of migrating juvenile southern bluefin tuna (Thunnus maccoyii) in relation to oceanography of the south Indian Ocean*'. Fish Oceanography, 18: 237 – 254.

BHP Billiton, 2005. '*Draft Environmental Impact Statement*'. Report No. WA-255-P (2), Stybarrow Development, Melbourne, Australia.

Bilgmann, K., Möller, L.M., Harcourt, R.G., Gibbs, S.E., Beheregaray, L.B., 2007. '*Genetic differentiation in bottlenose dolphins from South Australia: association with local oceanography and coastal geography*'. Marine Ecology Progress Series, 341: 265 – 276.

Black, A., 2005. '*Light induced seabird mortality on vessels operating in the Southern Ocean: incidents and mitigation measures*'. Antarctic Science 17: 67-68.

Blackwell, S.B., Nations, C.S., McDonald, T.L., Thode, A.M., Mathias, D., Kim, K.H., Greene, C.R., Macrander, A.M., 2015. '*Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioural thresholds*'. PLoS One. 10(6): doi: 10.1371/journal.pone.0125720.

Blair, H.B., Merchant, N.D., Friedlaender, A.S., Wiley, D.N., Parks, S.E., 2016. '*Evidence for ship noise impacts on humpback foraging behaviour*'. Biology Letters, 12: 20160005/

Bocher, P., Labidoire, B., Cherel, Y., 2000. '*Maximum dive depths of common diving petrels (Pelecanoides urinatrix) during the annual cycle at Mayes Island, Kerguelen*'. J. Zool. Lond., 251: 517 – 524.

Boeger, W., Pei, M., Ostrensky, A., Cardaso, M., 2006. '*The effect of exposure to seismic prospecting on coral reef fishes*'. Brazilian Journal of Oceanography, 54: 235-239.

BOEM, 2014. '*Proposed Geological and Geophysical Activities, Mid-Atlantic and South Planning Areas, Final Programmatic Environmental Impact Statement*'. U.S. Department of the Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region. New Orleans.

Bolle, L.J., de Jong, C.A.F., Bierman, S.M., van Beek, P.J.G., van Keeken, O.A., Wessels, P.W., van Damme, C.J.G., Winter, H.V., Haan, D.D., Dekeling, R.P A., 2012. '*Common Sole Larvae Survive High Levels of Pile-Driving Sound in Controlled Exposure Experiments'.* PLoS ONE, 7(3), e33052. http://doi.org/10.1371/journal.pone.0033052.

BOM, 2018. '*Climate statistics for Australian locations*'. http://www.bom.gov.au/climate/averages/tables/cw_090015_All.shtml

Bone, C., 1998. '*Preliminary investigation into leatherback turtle, Dermochelys coriacea (L.) distribution, abundance and interactions with fisheries in Tasmanian waters*'. Unpublished Report. Tasmanian Parks and Wildlife Service.

Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren, T., og Toklum, K., 1996. '*Effekter av luftkanonskyting på egg, larver og yngel'*. Undersøkelser ved Havforskningsinstituttet og Zoologisk Laboratorium, UiB. (Engelsk sammendrag og figurtekster). Havforskningsinstituttet, Bergen. *Fisken og Havet,* nr. 3. 83 s.

Booth, J. D. 1989. Occurrence of the puerulus stage of the rock lobster, Jasus edwardsii at the New Plymouth Power Station, New-Zealand. New Zealand Journal of Marine and Freshwater Research, 23: 43-50.

Booth, J.D., Carruthers, A.D., Bolt, C.D., Stewart, R.A., 1991. '*Measuring the depth of settlement in the red rock lobster, Jasus edwardsii'*. New Zealand Journal of Marine and Freshwater Research, 25: 123 – 32.

Booth, J. D. 2001. Habitat preferences and behaviour of newly settled *Jasus edwardsii* (Palinuridae). Marine and Freshwater Research, 52: 1055-1065.

Booth, J. D. 2006. Jasus species. In Lobsters: biology, management, aquaculture and fisheries, pp. 340-358. Ed. by B. F. Phillips. Blackwell Publishing, Oxford.

Booth, J. D., and Ovenden, J. R. 2000. Distribution of Jasus spp. (Decapoda: Palinuridae) phyllosomas in southern waters: implications for larval recruitment. Marine Ecology Progress Series, 200: 241–255.

Booth, J. D., and Phillips, B. F. 1994. Early life history of spiny lobster. Crustaceana, 66: 271-294.

Booth, J. D.; Stewart, R. A. 1992: Distribution of phyllosoma larvae of the red rock lobster *Jasus edwardsii* off the east coast of New Zealand in relation to the oceanography. In: Hancock, D. A. ed. Australian Society for Fish Biology, Workshop Larval Biology. Bureau of Rural Resource Proceedings No. 15. Canberra, Australian Government Publishing Service. Pp. 138–148

Boult, P.J., McKirdy, D.M., Blevin, J.E., Heggeland, R., Lang , S.C., Vinall, D.R., 2006. '*The Morum Sub-basin Petroleum System, Otway Basin, South Australia*'. Search and Discovery Article #10095.

Boustany, A, M., Matteson, R., Castleton, M., Farwell, C., Block, B.A., 2010. '*Movements of pacific bluefin tuna (Thunnus orientalis) in the Eastern North Pacific revealed with archival tags'*. Prog. Oceanography, 8: 94 – 104.

Bowles, A. E., Smultea, M., Würsig, B., DeMaster, D. P. & Palka, D., 1994. '*Relative abundance and behaviour of marine mammals exposed to transmissions from the Heard Island Feasibility Test'*. Journal of the Acoustical Society of America 96, 2469–2484.

Bradford, R. W., Bruce, B. D., Chiswell, S. M., Booth, J. D., Jeffs, A., and Wotherspoon, S. 2005. Vertical distribution and diurnal migration patterns of *Jasus edwardsii* phyllosomas off the east coast of the North Island, New Zealand. New Zealand Journal of Marine and Freshwater Research, 39: 593-604.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allision, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M-N.M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell Jr, R.L., Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljunglad, D.K., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerbeek, K., Warneke, R.M., 2007. '*Past and present distribution, densities and movements of blue whales Balaenoptera musuclus in the Southern Hemisphere and northern Indian Ocean*'. Mammal Rev., 37(2): 116 – 175.

Brand, A.R., Wilson, U.A.W., 1996. *'Seismic surveys and scallop fisheries" a report on the impact of a seismic survey on the 1994 Isle of Man queen scallop fishery'*. Report to a consortium of oil companies by Port Erine Marine Laboratory, University of Liverpool, Port Erin, Isle of Man, 68.

Brandão, A., Best, P.B., Butterworth, D.S., 2011. '*Monitoring the recovery of the southern right whale in South African waters*'. International Whaling Commission Document SC/S11/RW18.

Bruce, B., Bradford, R., Griffin, D., Gardner, C., and Young, J. 2000. A synthesis of existing data on larval rock lobster distribution in southern Australia. Final Report to the Fisheries Research and Development Corporation, Proyect 96/107, CSIRO Marine and Atmospheric Research: 57 p.

Bruce, B. D., Bradford, R., Griffin, D., Gardner, C., and Young, J. 2007. Larval transport and recruitment processes of southern rock lobster. Fisheries Research and Development Corporation, Project 2002/007: CSIRO Marine and Atmospheric Research, Hobart.

Bruce, B., Bradford, R., Foster, S., Lee, K., Lansdell, M., Cooper, S., Przeslawski, R., 2018. '*Quantifying fish behaviour and commercial catch rates in relation to a marine seismic survey'*. Marine Environmental Research, 140: 18 – 30.

Bruce, B.D., Bradford, R.W., 2008. '*Spatial dynamics & habitat preferences of juvenile white sharks: identifying critical habitat and options for monitoring recruitment'*. Final Report to the Department of the Environment, Water, Heritage and the Arts - Marine Species Recovery Program. Hobart: CSIRO.

Bruce, G.D., Stevens, J.D., Malcolm, H., 2006. '*Movements and swimming behaviour of white sharks (Carcharadon carcharias) in Australian waters'*. Marine Biology, 150:161-172.

Brumm, H., Slabbekoorn, H., 2005. '*Acoustic communication in noise*'. Adv Study Behav., 35:151–209.

Buck, B.M., Chalfant, D.A., 1972. '*Deep water narrowband radiated noise measurement of merchant ships'*. Delco TR72-28, Rep. from Delco Electronics, Santa Barbara, CA, for U.S. Navy Off. Naval Res., Arlington, VA

Burnell, S.R., 2001. '*Aspects of the reproductive biology, movements and site fidelity of right whales off Australia*'. Journal of Cetacean Research and Management, 2: 89 – 102

Burnell, S.R., Bryden, M.M., 1997. '*Coastal residence periods and reproductive timing in southern right whales, Eubalaena australi*s'. Journal of Zoology, 241: 613 – 621.

Burtenshaw, J. C., Olesona, E. R., Hildebranda, J. A., McDonald, M. A., Andrew, R. K., Howe, M. B., Mercer, J. A 2004, "*Acoustic and satellite remote sensing of blue whale seasonality and habitat in the Northeast Pacific*", Deep Sea Research Part II: Topical Studies in Oceanography 51: 967.

Buscaino, G., Filiciotto, F., Buffa, G., Bellante, A., Di Stefano, V., Assenza, A., Fazio, F., Caola, G., Mazzola, S., 2010. '*Impact of an acoustic stimulus on the motility and blood parameters of European sea bass (Dicentrarchus labrax L.) and gilthead sea bream (Sparus aurata L.)'*. Marine Environmental Research, 69: 136-142.

Butler, A., Althaus, F., Furlani, D., Ridgway, K., 2002. '*Assessment of the conservation values of the Bonney upwelling area. A component of the Commonwealth Marine Conservation Assessment Program 2002 – 2004'*. Report to Environment Australia, 80p.

Caldwell, D.K., Caldwell, M.C., 1991. 'Pygmy sperm whale *Kogia breviceps* (de Blainville 1838): '*Dwarf sperm whale Kogia simus Owen, 1866*'. **In:** Ridgway, S.H. & R. Harrison, eds. Handbook of Marine Mammals Vol. 4: River Dolphins and the Larger Toothed Whales. Page(s) 235-260. London: Academic Press.

Campbell, R.A., 2003. '*Demography and genetic population structure of the Australian sea* lion (Neophoca cinerea)'. Ph.D. Thesis. Department of Zoology, University of Western Australia.

Caputi, N. 2008. Impact of the Leeuwin Current on the spatial distribution of the puerulus settlement of the western rock lobster (*Panulirus cygnus*) and implications for the fishery of Western Australia. Fisheries Oceanography, 17: 147-152.

CarbonNet, 2018. '*Executive Summary of the CarbonNet Pelican 3D Marine Seismic Survey (MSS) Offshore Habitat Assessments Final Report*'. Accessed from: http://earthresources.vic.gov.au/earth-resources/victorias-earth-resources/carbon-storage/the-carbonnet-project/marine-seismic-survey-habitat-impact-assessment-outcomes

Carey, W.M., 2009. '*Lloyd's Mirror-Image Interference Effects'*. Acoustics Today, 5(2): 14 – 20.

Carroll, A. G., Przeslawski, R., Duncan, A., Gunning, M., & Bruce, B., 2017. '*A critical review of the potential impacts of marine seismic surveys on fish & invertebrates*'. Marine pollution bulletin, 114(1), 9-24.

Carroll, E., Patenaude, N., Alexander, A., Steel, D., Harcourt, R., Childerhouse, S., Smith, S., Bannister, J., Constantine, R., Baker, C.S., 2011. '*Population structure and individual movement of southern right whales around New Zealand and Australia*'. Marine Ecology Progress Series, 432: 257 – 268.

Carroll, E.L., Baker, C.S., Watson, M., Alderman, R., Bannister, J., Gaggiotti, O.E., Grocke, D.R., Patenaude, N., Harcourt, R., 2015. '*Cultural traditions across a migratory network shape the genetic structure of southern right whales around Australia and New Zealand*'. Scientific Reports, 5: 16182, DOI:10.1038/srep161682.

Casper, B.M., 2011. '*The ear and hearing in sharks, skates, and rays*'. In: Farrell, A.P.(Ed.), Encyclopaedia of Fish Physiology: From Genome to Environment. Academic Press, San Diego, pp. 262–269.

Casper, B.M., Halvorsen, M.B., Popper, A.N., 2012. '*Are sharks even bothered by a noisy environment?*' Adv.Exp.Med.Biol.739, 93–97.

Casper, B.M., Smith, M.E., Halvorsen, M.B., 2013. '*Effects of exposure to pile driving sounds on fish inner ear tissues*'. Comp Biochem Physiol A, 166: 352–360

Castellote, M., Clark, C.W., Lammers, M.O., 2012. '*Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise'*. Biological Conservation, 147(1): 115 – 122.

Caton, A.E., 1991. '*Review of aspects of southern bluefin tuna biology, population and fisheries'*. In: World Meeting on Stock Assessment of Bluefin Tuna: Strengths and Weaknesses, Deriso, R,B,m Bayliff, W.H. (Eds). IATTC, La Jolla, CA, Special Report 7, pp. 181 – 357.

CBD, 2018. '*Convention on Biological Diversity – Introduction*'. https://www.cbd.int/intro/default.shtml

Cerchio, S., Stindberg, S., Collins, T., Bennett, C., Rosenbaum, H., 2014. '*Seismic surveys negatively affect humpback whales singing activity off northern Angola'*. PLoS ONE, 9(3): e86464, doi:10.1371/journal.pone.0086464.

Chaloupka, M., Osmond, M., Kaufman, G., 1999. '*Estimating seasonal abundance trends and survival probabilities of humpback whales in Hervey Bay (east coast Australia)*'. Marine Ecology Progress Series, 184: 291 – 301.

Chiswell, S. M., Wilkin, J., Booth, J. D., and Stanton, B. 2003. Trans-Tasman Sea larval transport: Is Australia a source for New Zealand rock lobsters? Marine Ecology Progress Series, 247: 173-182.

Christian, J.R., Mathieu, A., Thompson, D.H., White, D., Buchanan, R., 2003. *'Effect of Seismic Energy on Snow Crab (Chionoecetes opilio)'*. Report No. SA694 to the Canadian National Energy Board (Calgary, Alberta) by LGL Ltd (King City, Ontario) and Oceans Ltd (St John's, Newfoundland). 106 pp.

Cirano, M., Middleton, J.F., 2003. '*Aspects of the mean wintertime circulation along Australia's southern shelves: numerical studies*'. Journal of Physical Oceanography, 34: 668 – 684.

Clapham, P., Young, S., Brownell, R.L., 1999. '*Baleen whales: conservation issues and the status of the most endangered populations*'. Mammal Rev., 29(1): 35 – 60.

Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., van Parijs, S.M., Frankel, A., Ponikaris, D., 2009. *'Acoustic masking in marine ecosystems: intuitions, analyses and implication'*. Mar Ecol Prog Ser., 395:201–222.

Clark, M.R., Rouse, H., Lamarche, G., Ellis, J., Hickey, C., 2017. '*Preparation of environmental impact assessments: general guidelines for offshore mining and drilling with particular reference to New Zealand'*. NIWA Science and Technology Series, NIWA Project EMOM163, 105p.

Codarin, A., Wysocki, L.E., Ladich, F., Picciulin, M., 2009. '*Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy)'*. Marine Pollution Bulletin, doi: 10.1016/j.marpolbul.2009.07.011.

Cogger, H.G., 1975. '*Sea snakes of Australia and New Guinea*'. In**:** Dunson, W.A., ed. *The Biology of Sea Snakes*. Page(s) 59-139. Baltimore: University Park Press.

Cohen, P. J., and Gardner, C. 2007. Regional patterns in puerulus catches from eastern and western Tasmania. Journal of Crustacean Biology, 27: 592-596.

Coleman, N., 1988. '*Monitoring of scallop spatfall and growth rates at Lakes Entrance, September 1987 to May 1988*'.

Collette, B., Chang, S.K., Di Natale, A., Fox, W., Juan Jorda, M., Miyabe, N., Nelson, R., Uozumi, Y., Wang, S., 2011. *Thunnus maccoyii*. The IUCN Red List of Threatened Species 2011: e.T21858A9328286. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T21858A9328286.en

Collins, M., Cullen, J. M., Dann, P., 1999. '*Seasonal and annual foraging movements of little penguins from Phillip Island Victoria*'. Wildlife Research 26: 705-721.

Colman, J. G., Grebe, C. C., Hearn, R. L., 2008. '*The challenges and complexities of impact assessment for a seismic survey in a remote coral reef environment'*. IAIA08 Conference Proceedings, The Art and Science of Impact Assessments 28th Conference of the International Association for Impact Assessments, 4 – 10 May 2008, Perth Convention Exhibition Centre, Perth, Australia.

Colman, J.G., 1997. '*A review of the biology and ecology of the whale sh*ark'. Journal of Fish Biology, 51:1219-1234

Commonwealth of Australia, 2012. '*Conservation Management Plan for the Southern Right Whale – a Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999, 2011-2021*'. 72pp

Commonwealth of Australia, 2013. '*Recovery plan for the Australian sea lion (Neophoca cinerea)*'. 43pp.

Commonwealth of Australia, 2015. '*South-east marine region profile: a description of the ecosystems, conservation values and uses of South-east Marine Region'*. 88p.

Commonwealth of Australia, 2015a. '*Conservation Management Plan for the blue whale – a Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999*'. 57pp.

Commonwealth of Australia, 2017. '*National strategy for reducing vessel strike on cetaceans and other marine megafauna'*. 35p.

Commonwealth of Australia, 2017a. '*Recovery plan for marine turtles in Australia'*. 154p.

Conservation Values Atlas, 2018. '*Conservation Values Atlas*'. http://www.environment.gov.au/topics/marine/marine-bioregional-plans/conservation-values-atlas

Constantine, R., Aguilar Soto, N., Johnson, M., 2012. '*Sharing the waters: minimising ship collisions with Bryde's whales in the Hauraki Gulf*'. Research Progress Report. February 2012. 22 p.

Corkeron, P.J., 1995. '*Humpback whales (Megaptera novaeangliae) in Hervey Bay, Queensland: behaviour and responses to whale-watching vessels'*. Can. J. Zool., 73: 1290 – 1299.

Corkeron, P.J., Bryden, M.M., 1992. '*Sightings of Risso's dolphin, Grampus griseus (Cetacea: Delphinidae), off Fraser Island, Queensland'*. Australian Mammalogy, 15: 129 – 130.

Corkeron, P.J., Van Parijs, S.M., 2001. '*Vocalizations of eastern Australian Risso's dolphins, Grampus griseus*'. Canadian Journal of Zoology, 79(1): 160 – 164.

Corwin, J., 1978. '*The relation of inner ear structure to the feeding behavior in sharks and rays*'. Scanning Electron Microsc 2:1105–1112

Cresswell, G.R., Domingues, C.M., 2009. '*The Leeuwin Current south of Western Australia'*. Journal of the Royal Society of Western Australia, 92: 83 – 100.

Croll, D. A., Marinovic, B., Benson, S., Chavez, F. P., Black, N., Ternullo, R., Tershy, B. R 2005, '*From wind to whales: trophic links in a coastal upwelling system'*, Marine Ecology Progress Series 289: 117-130.

CSIRO, 2018. '*Playing Tag with tuna in the bight*'. https://blogs.csiro.au/ecos/tuna-tagging/

Cudahy, E., Parvin, S., 2001. '*The effects of underwater blast on divers'*. Naval Submarine Medical Research Laboratory, NSMRL Report 1218, 64p.

Culik, B., 2005. '*Pseudorca crassidens. Review on Small Cetaceans: Distribution, Behaviour, Migration and Threats*'. Compiled for the Convention on Migratory species (CMS).

Cummings, W. C., Thompson, P. O 1971. '*Underwater sounds from the blue whale, Balaenopetera musculus*'. Journal of the Acoustical Society of America 50: 1193-1198.

Currie, DR, Sorokin, S.J., Ward, TM., 2009. *'Infaunal macroinvertebrate assemblages of the eastern Great Australian Bight: effectiveness of a marine protected area in representing the region's benthic biodiversity*'. Marine and Freshwater Research, 60: 459-74.

Dale, J.J., Gray, M.D., Popper, A.N., Rogers, P.H., Block, B.A., 2015. '*Hearing thresholds of swimming Pacific bluefin tuna'*. J. Comp. Physiol. A., 201: 441 – 454.

Dalebout, M.L., Robertson, K.M., Frantzis, A., Engelhaupt, D., Mignucci-Giannoni, A.A., Rosario-Delestre, R.J., Baker, C.S., 2005. '*Worldwide structure of mtDNA diversity among Cuvier's beaked whales (Ziphius cavirostris): Implications for threatened populations*'. Molecular Ecology, 14: 3353-3371.

Dalen, J., 1994. '*Impact of seismic impulsive energy on marine organisms*'. Offshore oil activities and fisheries interactions workshop, Swakopmund, Namibia, 8-9 February 1994. Pages 60-75.

Dalen, J., Dragsund, E., Naess, A., Sand, O., 2007. *'Effects of Seismic Surveys on Fish, Fish Catches and Sea Mammals'.* Report for the Cooperation group – Fishery Industry and Petroleum Industry. Report no.: 2007-0512. Det Norske Veritas AS, 24.04.07. Høvik. 29p.

Dalen, J., Knutsen, G.M., 1987. '*Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations*'. In Merklinger, H.M. (ed.) *Progress in Underwater Acoustics.* Plenum Publishing Corporation: 93-102.

Daley, R., Stevens, J., Last, P.R., Yearsley, G.K., 2002. '*Field Guide to Australian Sharks and Rays'*. CSIRO Marine Research and Fisheries Research and Development Corporation.

Davies, T.W., Duffy, J.P., Bennie, J., Gaston, K.J., 2014. '*The nature, extent, and ecological implications of marine light pollution*'. Ecological Environment, 12(6), 347-355. doi: 10.1890/130281

Dawbin, W.H., Cato, D.H., 1992. '*Sounds of a pygmy right whale (Caperea marginata)*'. Marine Mammal Science, 8(3): 213 – 219

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P. Hartmann, K. Semmens, J.M., 2017. '*Exposure to seismic air gun signals causes physiological harm and alters behaviour in the scallop Pecten fumatus'*. *PNAS* 114(37) doi/10.1073/pnas.1700564114

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., 2016. '*Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries*'. Report to the Fisheries Research and Development Corporation. Report prepared by the University of Tasmania, Hobart.

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., 2016a. '*Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries'*. Report to the Fisheries Research and Development Corporation. Report prepared by the University of Tasmania, Hobart.

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Semmens, J.M., 2016b. '*Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster Jasus edwardsii larvae (Decapoda: Palinuridae)'*. Scientific Reports 6: 22723 doi:10.1038/srep22723

Deda, P., Elbertzhagen, I., & Klussmann, M., 2007. '*Light pollution and the impacts on biodiversity, species and their habitats'*. In C. o. M. S. o. W. A. (UNEP-CMS) (Ed.), (pp. 133-139): Conservation of Migratory Species of Wild Animals (UNEP-CMS)

Deecke, V.B., Ford, J.K.B., Spong, P., 2000. '*Dialect change in resident killer whales: implications for vocal learning and cultural transmission*'. Animal Behaviour, 60: 629 – 638.

Deng, X., Hwang, C., Coleman, R., Featherstone, W.E., 2008. '*Seasonal and interannual variations of the Leeuwin Current off Western Australia from TOPEX/Poseidon Satellite Altimetry*'. Terr. Atmos. Ocean. Sci., 19(1-2): 135 – 149.

Department of Industry, Innovation and Science, 2018. '*Otway Basin Geology*'

Department of the Environment and Heritage, 2006. '*A guide to The Integrated Marine and Coastal Regionalisation of Australia - version 4.0 June 2006 (IMCRA v4.0)*'

DEWHA, 2013. '*Recovery Plan for the White Shark (Carcharodon carcharias)'*. 58p. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/recovery-plan-white-shark-carcharodon-carcharias

DEWNR, 2012. '*Encounter Marine Park Management Plan 2012'*. 39p.

DEWNR, 2012a. '*Southern Kangaroo Island Marine Park Management Plan 2012*'. 26p.

DEWNR, 2012b. '*Western Kangaroo Island Marine Park Management Plan 2012'.* 29p.

DEWNR, 2012c. '*Upper South East Marine Park Management Plan 2012'.* 28p.

DEWNR, 2012d. '*Lower South East Marine Park Management Plan 2012*'. 27p.

Di lorio, L., Clark, C.W., 2010. '*Exposure to seismic survey alters blue whale acoustic communication*'. Biol. Lett. 6: 51 – 54.

Director of National Parks, 2013. '*South-east Commonwealth Marine Reserves Network Management Plan 2013-23*'.

Discover Tasmania, 2018. '*Diving*'. https://www.discovertasmania.com.au/what-to-do/outdoors-and-adventure/diving

Discover Tasmania, 2018a. '*Surfing*'. https://www.discovertasmania.com.au/what-to-do/outdoors-and-adventure/surfing

DNV, 2011. '*Assessment of the Risk of Pollution from Marine Oil Spills in Australian Ports and Waters*'. Prepared for Australian Maritime Safety Authority, Report No. PP002916.

DoAWR, 2002. '*National Competition Policy Review of Commonwealth Fisheries Legislation*'. Accessed from http://www.agriculture.gov.au/fisheries/domestic/review-comm-fishleg

DoAWR, 2018. '*Department of Agriculture and Water Resources – The Australian Fishing Zone*'. http://www.agriculture.gov.au/fisheries/domestic/zone

DoAWR, 2018a. '*Department of Agriculture and Water Resources – Recreational Fishing*'. http://www.agriculture.gov.au/fisheries/recreational

DOC, 2016. '*Report of the Sound Propagation and Cumulative Exposure Models Technical Working Group*'. Marine Species and Threats, Department of Conservation, Wellington, New Zealand. 59 p.

DoEE, 2012. '*Key Threatening Process Nomination Form – 2012 Assessment Period*'. https://www.environment.gov.au/system/files/pages/87ef6ac7-da62-4a45-90ec-0d473863f3e6/files/nomination-marine-seismic.pdf

DoEE, 2014. '*Streamlining Offshore Petroleum Environmental Approvals*'. Australian Government – Department of the Environment and Energy. Available from https://www.environment.gov.au/system/files/pages/06872cd4-b755-4ecf-a4e7-dd16145e1384/files/offshore-program-report.pdf

DoEE, 2018. '*The Ramsar Convention on Wetlands*'. http://www.environment.gov.au/water/wetlands/ramsar

DoEE, 2018a. '*Species Profile and Threats Database: Prototroctes maraena – Australian grayling*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26179

DoEE, 2018b. '*Species Profile and Threats Database: Hoplostethus atlanticus – Orange roughy, deep-sea perch, red roughy*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68455

DoEE, 2018c. '*Species Profile and Threats Database: Thunnus maccoyii – Southern bluefin tuna'*. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=69402

DoEE, 2018d. '*Species Profile and Threats Database: Carcharodon carcharias – White shark, great white shark*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64470

DoEE, 2018e. '*Species Profile and Threats Database: Rhincodon typus – Whale shark*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66680

DoEE, 2018f. '*Species Profile and Threats Database: Lamna nasus – Porbeagle, mackerel shark*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83288

DoEE, 2018g. '*Species Profile and Threats Database: Dermochelys coriacea – Leatherback turtle, leathery turtle*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1768

DoEE, 2018h. '*Species Profile and Threats Database: Caretta caretta – Loggerhead turtle*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1763

DoEE, 2018i. '*Species Profile and Threats Database: Pelamis platurus – Yellow-bellied Seasnake*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1091

DoEE, 2018j. '*Species Profile and Threats Database: Balaenoptera bonaerensis – Antarctic minke whale, dark-shoulder minke whale*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67812

DoEE, 2018k. '*Species Profile and Threats Database – Physeter macrocephalus – sperm whale*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59

DoEE, 2018l. '*Species Profile and Threats Database: Mesoplodon grayi – Gray's beaked whale, scamperdown whale*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75

DoEE, 2018m. '*Species Profile and Threats Database: Orcinus orca – Killer whale, Orca*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=46

DoEE, 2018n. '*Species Profile and Threats Database: Neophoca cinerea – Australian sea-lion, Australian sea lion*'. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=22

DoEE, 2018o. '*Biologically Important Areas of Regionally Significant Marine Species*'. http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B2ed86f5a-4598-4ae9-924f-ac821c701003%7D

DoEE, 2018p. '*National Conservation Values Atlas*'. http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

DoEE, 2018q. '*SPRAT – Species Profile and Threats Database*'. http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl Accessed on 20 August 2018

DoEE, 2018r. '*Murray Marine Park*'. http://www.environment.gov.au/topics/marine/marine-reserves/south-east/murray

DoEE, 2018s. '*Coorong and Lakes Alexandrina and Albert Ramsar Wetland – Fact Sheet*'. http://www.environment.gov.au/water/wetlands/publications/coorong-and-lakes-alexandrina-and-albert-ramsar-wetland-factsheet

DoEE, 2018t. '*Directory of Important Wetlands in Australia (DIWA) Spatial Database*'. http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7BED248FC1-7237-4A74-91AC-2DA3FC277E0A%7D

DoEE, 2018u. '*Conservation Advice for Subtropical and Temperate Coastal Saltmarsh*' http://www.environment.gov.au/system/files/pages/b2a8d6af-0445-4064-8ff7-48cc9a484ab9/files/118-conservation-advice.pdf

DoEE, 2018v. '*Australian Whale Sanctuary*'. http://www.environment.gov.au/marine/marine-species/cetaceans/australian-whale-sanctuary

DoEE, 2018w. '*Australian National Shipwreck Database*'. https://dmzapp17p.ris.environment.gov.au/shipwreck/public/wreck/search.do;jsessionid=73B732ACFB7F4E97189B4AF1ACCFC4A0

DoEE, 2018x. *'Australian Marine Mammal Centre – Vessel/Whale Collisions (ship strike)'*. https://data.marinemammals.gov.au/report/shipstrike

DoEE, 2018y. *White Shark Recovery Plan*. http://www.environment.gov.au/system/files/resources/a0dfdef5-a1ba-41a6-bd3f-8a6a0a4bdd5a/files/greatwhiteshark.pdf

DoEE, 2019. '*Approved Conservation Advice (including Listing Advice) for the Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community*.' Canberra. http://www.environment.gov.au/biodiversity/threatened/communities/pubs/132-conservation-advice.pdf.

DoEWHA, 2008. '*EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*'

DoSEWPC, 2011. '*National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011 – 2016*'. Commonwealth of Australia, Hobart, 33p.

DoSEWPC, 2012. '*Giant Kelp Marine Forests of South East Australia Ecological Community*'.

DoSEWPC, 2018. '*Giant Kelp Marine Forests of South East Australia Ecological Community Map*'. http://www.environment.gov.au/biodiversity/threatened/communities/maps/pubs/107-map.pdf

DoSEWPC, 2018a. '*Subtropical and Temperate Coastal Saltmarsh Ecological Community Map*'. http://www.environment.gov.au/biodiversity/threatened/communities/maps/pubs/118-map.pdf

DOSITS, 2018. '*Beaked whales – beaked whales sounds*'. https://dosits.org/galleries/audio-gallery/marine-mammals/toothed-whales/beaked-whales/

Double, M.C., Andrews-Goff, V., Jenner, K.C.S., Jenner, M-N., Laverick, S.M., Branch, T.A., Gales, N.J., 2014. '*Migratory movements of pygmy blue whale (Balaenoptera musculus brevicauda) between Australia and Indonesia as revealed by satellite telemetry*'. PLoS One, 9: e93578.

DPIPWE, 2018. '*Commercial Fishing*'. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing

DPIPWE, 2018a. '*Sea fishing & Aquaculture – Commercial Fishing Licence Requirements*'. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/commercial-fishing-licences-and-seasons/commercial-fishing-licences

DPIPWE, 2018b. '*Commercial Scalefish Fishery*'. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scalefish-fishery/commercial-scalefish

DPIPWE, 2018c. '*Latest Commercial Scallop Season*'. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scallop-fishery/latest-commercial-scallop-season

DPIPWE, 2018d. '*Recreational Fishing*'. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/recreational-fishing

Dredge, I.D., Marsden, J.R., Williams, 2016. '*Scallop fisheries, mariculture, and enhancement in Australasia*'

DSE, 2003. '*Port Phillip Bay (Western Shoreline) & Bellarine Peninsula Ramsar Site Strategic Management Plan*'. Available from: https://web.archive.org/web/20131016093549/http://www.dse.vic.gov.au/__data/assets/pdf_file/0010/100144/Port_Phillip_Bay_and_Bellarine_Peninsula_Ramsar_Site_Strategic_Management_Plan.pdf

DSEWPC, 2013. '*Recovery Plan for the White Shark (Carcharadon carcharias)*'. Available from http://www.environment.gov.au/system/files/resources/ce979f1b-dcaf-4f16-9e13-010d1f62a4a3/files/white-shark.pdf

Dunlop, R.A., Cato, D.H., Noad, M.J., 2010. '*Your attention please: increasing ambient noise levels elicits a change in communication behaviour in humpback whales (Megaptera novaeangliae)*'. Proc. R. Soc. London, Ser. B, 277: 2521 – 2529.

Dunlop, R.A., Cato, D.H., Noad, M.J., Stokes, D.M., 2013. '*Source levels of social sounds in migrating humpback whales (Megaptera novaeangliae)*'. Journal of the Acoustical Society of America, 134(1): 706 – 714.

Dunlop, R.A., Noad, M.J., Cato, D.H., Stokes, D., 2007. '*The social vocalization repertoire of east Australian migrating humpback whales (Megaptera novaeangliae)*'. Journal of the Acoustical Society of America, 122(5): 2893 – 2905.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Paton, D., Cato, D.H., 2015. '*The behavioural response of humpback whales (Megaptera novaeangliae) to a 20 cubic inch air gun*'. Aquatic Mammals, 41(4): 412 – 433.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Slade, R., Paton, D., Cato, D.H., 2016. '*Response of humpback whales (Megaptera novaeangliae) to ramp-up of a small experimental air gun array*'. Marine Pollution Bulletin, 103: 72 – 83.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Slade, R., Paton, D., Cato, D.H., 2017. '*The behavioural response of migrating humpback whales to a full seismic airgun array*'. Proc. R. Soc. B., 284: 20171901. http://dx.doi.org/10.1098/rspb.2017.1901

Dunlop, R.A., Noad, M.J., McCauley, R.D., Scott-Hayward, L., Kniest, E., Slade, R., Paton, D., Cato, D.H., 2017a. '*Determining the behavioural dose-response relationship of marine mammals to air gun noise and source proximity*'. Journal of Experimental Biology, 220: 2878 – 2886; doi:10.1242/jeb.160192.

Dyndo, M., Wisniewska, D.M., Rojano-Donate, L., Madsen, P.T., 2015. '*Harbour porpoises react to low levels of high frequency vessel noise*'. Scientific Reports, 5: 11083, DOI:10/1038/srep11083.

Ellison, W.T., Racca, R., Clark, C.W., Streever, B., Frankel, A.S., Fleishman, E., Angliss, R., Berger, J., Ketten, D., Guerra, M., Leu, M., McKenna, M., Stormo, T., Southall, B., Suydam, R., Thomas, L., 2016. '*Modelling the aggregated exposure and responses of bowhead whales Balaena mysticetus to multiple sources of anthropogenic underwater sound*'. Endangered Species Research, 30: 95 – 108.

Encyclopaedia Britannica, 2018. '*Sponge*'. Article written by Sara, M., last updated 12 October 2018, https://www.britannica.com/animal/sponge-animal

Engas, A., Lokkeborg, S., Ona, E., Soldal, A., 1996. '*Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus)*'. Canadian Journal of Fisheries and Aquatic Sciences, 53: 2238-2249.

ENRC, 2002. '*Environment and Natural Resources Committee – Inquiry into the management of the fishing charter industry in Victoria*'. October 2002, Parliamentary Paper No. 202 of session 1999 – 2002, Parliament of Victoria, 98p.

Ensor, P., Sekiguchi, K., Cotton, J., Hucke-Gaete, R., Kariya, T., Komiya, H., Ljungblad, D., Marite, H., Olson, P., Rankin, S., 2002. '*2001-2002 IWC-Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Circumpolar Cruises, Area V*'. Available from the IWC secretariat. Cambridge, UK – unpublished (as cited in the EPBC Act Conservation Advice)

EPA, 2010. '*Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts (pp. 130)*'. Perth: Environmental Protection Authority, Western Australia.

Erbe, C., 2002. '*Hearing abilities of baleen wha*les'. Defence R&D Canada, Contract Number" W7707-01-0828, 40p.

Erbe, C., Reichmuth, C., Cinningham, K., Lucke, K., Dooling, R., 2016. '*Communication masking in marine mammals: a review and research strategy*'. Marine Pollution Bulletin, 103: 15 – 38.

Evans, G.W., Lercher, P., Meis, M., Ising, H., Kofler, W.W., 2001. '*Community noise exposure and stress in children*'. J. Acoust. Soc. Am., 109(3): 1023 – 1027.

Evans, K., Bax, N., Smith, D.C., 2017. *'Australia state of the environment: marine environment'*. Independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra, 238p.

Evans, K., Patterson, T., Eveson, P., Hobday, A., Lansdell, M., Cooper, S., davies, C., 2017a. *'Southern bluefin tuna: spatial dynamics and potential impacts of noise associated with oil and gas exploration'*. Final Report GABRP Project 4.3. Great Australian Bight Research Program, GABRP Research Report Series Number 18, 96pp.

Eveson, P., Farley, J., 2016. *'The aerial survey index of abundance: 2016 updated results'.* Working Paper CCSBT-ESC/1609/09 prepared for the twenty first CCSBT Extended Scientific Committee meeting, 5-10 September, Kaohsiun, Taiwan.

Fall, J., Fields, L., 1996. '*Subsistence uses of fish and wildlife before and after the Exxon Valez oil spill*'. In "Proceedings of the Exxon Valdez oil spill symposium". Eds. Rice, S., Spies, R., Wolfe, S., Wright, B., 819-836. Bethesda, MD: American Fisheries Society.

Fay, R.R., Popper, A.N., 2000. '*Evolution of hearing in vertebrates: the inner ears and processing*'. Hearing Research, 149: 1-10.

Fewtrell, J.L., 2003. '*The response of marine finfish and invertebrates to seismic survey noise'* (Doctoral dissertation, Curtin University).

Fewtrell, J.L., McCauley, R.D., 2012. '*Impact of air gun noise on the behaviour of marine fish and squid*'. *Marine pollution bulletin*, *64*(5), 984-993.

Fiedler, P.C., Reilly, S.B., Hewitt, R.P., Demer, D.A., Philbrick, V.A., Smith, S., Armstrong, W., Croll, D.A., Tershy, B.R., Mate, B.R., 1998. *'Blue whale habitat and prey in the California Channel Islands'.* Deep Sea Research Part II: Topical Studies in Oceanography, 45.

Filby, N.E., Bossley, M., Sanderson, K.J., Martinez, E., Stockin, K.A., 2010. '*Distribution and population demographics of common dolphins (Delphinus delphis) in the Gulf St. Vincent, South Australia*'. Aquatic Mammals, 36(1): 33 – 45.

Fine, M.L., Thorson, R.F., 2008. '*Use of Passive Acoustics for Assessing Behavioral Interactions in Individual Toadfish*'. Trans Am Fish Soc. 137:627–637.

Finneran, J.J., 2016. '*Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*'. May 2016. San Diego, California: SPAWAR Systems Center Pacific.

Fisheries Victoria, 2010. '*Victorian giant crab fishery management plan'*. Fisheries Victoria Management Report Series No. 79, November 2010.

Fitzgibbon, Q.P., Day, R.D., McCauley, R.D., Simon, C.J., Semmens, J.M., 2017. *'The impact of seismic air gun exposure on the haemolymph physiology and nutritional condition of spiny lobster, Jasus edwardsii'*. Marine Pollution Bulletin, 2017.08.004, doi.org/10.1016

Fletcher, L.M., Zaiko, A., Atalah, J., Richter, I., Dufour, C.M., Pochon, X., Wood, S.A., Hokpins, G.A., 2017. '*Bilge Water as a Vector for the Spread of Marine Pests: A Morphological, Metabarcoding and Experimental Assessment*'. Biological Invasions, DOI 10.1007/s10530-017-1489-y.

FoodSA, 2018. *'Australian Southern Bluefin Tuna Industry Association'*.

Ford, J., Gilmour, P., 2013. *'The state of recreational fishing in Victoria: a review of ecological sustainability and management options'*. A report to the Victorian National Parks Association, Melbourne, 76p.

Fordyce, R.E., Marx, F.G., 2012. '*The pygmy right whale Caperea marginata: the last of the cetotheres*'. Proceedings of the Royal Society B., 280: 20122645.

Francis, M., Natanson, L., Campana, S., 2002. '*The Biology and Ecology of the Porbeagle Shark, Lamna nasus'*. In: Camhi, M., E. Pikitch & E. Babcock, eds. Sharks of the Open Ocean: Biology, Fisheries and Conservation. Page(s) 105-113. Blackwell Publishing, United Kingdom.

FRDC, 2018. '*Giant Crab* – Pseudocarcinus gigas'. http://fish.gov.au/2012-Reports/Giant_Crab

Fujioka, K., Hobday, A.J., Kawabe, R., Miyashita, K., Itoh, T., Takao, Y., 2010. '*Interannual variation in summer habitat use by juvenile southern bluefin tuna (Thunnus maccoyii) in southern western Australia'*. Fish Oceanography, 19: 183 – 195.

GABIA, 2018. '*Great Australian Bight Fishing Industry Association Inc'*. http://www.gabia.com.au/

Gales, N., Double, M.C., Robinson, S., Jenner, C., Jenner, M., King, E., Gedamke, J., Paton, D., Raymond, B., 2009. '*Satellite tracking of southbound East Australian humpback whales (Megaptera novaeangliae): challenging the feast or famine model for migrating whales'*. 2008 meeting of the International Whaling Commission – Scientific Committee, Paper SC/61/SH17, 12 pp.

Gausland, I., 2000. '*Impact of seismic surveys on marine life'*. The Leading Edge, 19: 903 – 905.

Gausland, I., 2003. '*Seismic surveys impact on fish and fisheries'*. Report for Norwegian Oil Industry Association (OLF).

Gavrilov, A.N., McCauley, R.D., Salgado-Kent, C., Tripovich, J., Burton, C., 2011. '*Vocal characteristics of pygmy blue whales and their change over time*'. Journal of the Acoustical Society of America, 130(6): 3651 – 3660.

Gedamke, J., Costa, D.P., Dunstan, A., 2001. '*Localization and visual verification of a complex minke whale vocalization*'. Journal of the Acoustical Society of America, 109(6): 3038 – 3047.

Geoscience Australia, 2018. '*ProvExplorer – Otway Basin*' http://www.ga.gov.au/provexplorer/provinceDetails.do;jsessionid=1BD8A7AA5A481EFFEF8D85B04AA0EAE3?eno=436513

Geoscience Australia, 2018a. '*Sorell Basin*'. http://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/offshore-southern-australia/sorell

Geoscience Australia, 2018b. '*Maritime Boundary Definitions*'. http://www.ga.gov.au/scientific-topics/marine/jurisdiction/maritime-boundary-definitions

Gill, P.C. 2001. '*The blue whale feeding area off western Victoria & southeast South Australia*'. Victorian Regional Ripples 8(3).

Gill, P.C., 2002. '*A blue whale (Balaenoptera musculus) feeding ground in a southern Australian coastal upwelling zone*'. Journal of Cetacean Research and Management, 4: 179 – 184

Gill, P.C., Morrice, M.G., Page, B., Pirzl, R., Levings, A.H., Coyne, M., 2011. '*Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia'*. Marine Ecology Progress Series 421: 243-263

Gill, P.C., Pirzl, R., Morrice, M.G., Lawton, K., 2015. '*Cetacean diversity of the continental shelf and slope off southern Australia'*. The Journal of Wildlife Management, 79(4): 672 – 681.

Giri, K., Hall, K., 2015. '*South Australian Recreational Fishing Survey 2013/14'*. Fisheries Victoria, Internal Report Series No. 62, published by the Victorian Government, Department of Economic Development, Jobs, Transport and Resources, 75p.

Golder, A., 2007. '*Literature review, synthesis, and design of monitoring of ambient artificial light intensity on the OCS regarding potential effects on resident marine fauna*'. Prepared for: U.S. Department of the Interior, Minerals Management Service. (pp. 1-96). Anchorage, Alaska.

Goldsworthy, S.D., Page, B., 2009. '*A review of the distribution of seals in South Australia'*. Australian Research and Development Institute, Adelaide, SARDI Publication No. F2009/000368-1, 21p.

Goldsworthy, S.D., Shaughnessy, P.D., 1994. '*Breeding biology and haul-out pattern of the New Zealand fur-seal, Arctocephalus forsteri, at Cape Gantheaume, South Australia'*. Wildlife Research, 21: 365 – 376.

Gomon, M.F., Bray, D.J., Kuiter, R., 2008. '*Fishes of Australia's southern coast*'. Reed New Holland, Australia.

Goodall, C., Chapman, C., Neil, D., 1990. '*The acoustic response threshold of the Norway lobster, Nephrops norvegicus (L.) in a free sound field'*. In: Wiese K, Krenz WD, Tautz J, Reichert H, Mulloney B (eds) Frontiers in crustacean neurobiology. Birkha È user, Basel, pp 106±113 *(PDF) Acoustic detection and communication by decapod crustaceans*. Available from: https://www.researchgate.net/publication/8196581_Acoustic_detection_and_communication_by_decapod_crustaceans

Goodall, R.N.P., 2002. '*Spectacled porpoise Phocoena dioptrica'*. In: W. F. Perrin, B. Wursig and J. G. M. Thewissen (eds), Encyclopedia of Marine Mammals, pp. 1158-1161. Academic Press, San Diego, California, USA

Goold, J.C., 1996. '*Acoustic assessment of populations of common dolphins Delphinus delphis in conjunction with seismic surveying'*. J. Mar. Biol. Ass. UK., 76: 811 – 820.

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R., Thompson, D., 2003. '*A Review of the Effects of Seismic Surveys on Marine Mammals'*. Marine Technology Society Journal, 37(4):16 – 34.

Gordon, J., Moscrop, A., 1996. '*Underwater noise pollution and its significance for whales and dolphins*'. In Simmonds, M.P. and Hutchinson, J.D. (Eds.), The conservation of whales and dolphins. John Wiley and Sons, Ltd.

Goudie, R.I., Ankney, C.D., 1986. '*Body Size, Activity Budgets, and Diets Of Sea Ducks Wintering In Newfoundland*'. Ecology, 67: 1475–1482.

Graham, A.L., Cooke, S.J., 2008. '*The effects of noise disturbance from various recreational boating activites common to inland waters on the cardiac physiology of a freshwater fish, the largemouth bass (Micropterus salmoides)*'. Aquatic Conservation and Freshwater Ecosystems 18, 1315-1324.

Gray, H., van Waerebeek, K., 2011. '*Postural instability and akinesia in a panspotted tropical dolphin Stenella attenuata, in proximity to operating airguns of a geophysical seismic vessel*'. Journal for Nature Conservation 19(6): 363 – 367.

Gray, M.D., Rogers, P.H., Popper, A.N., Hawkins, A.D., Fay, R.R., 2016. *'Large tank acoustics: how big is big enough?'.* Pages 363-370 The Effects of Noise on Aquatic Life II. Springer + Business Media, New York.

Green, J.A., White, C.R., Bunce, A., Frappell, P.B., Butler, P.J., 2009. '*Energetic consequences of plunge diving in gannets*'. Endangered Species Research, 10: 269 – 279.

Gurjao, L.D., Freitas, J.P., Araújo, D.S., 2005. '*Observations of Marine Turtles During Seismic Surveys off Bahia, North-eastern Brazil*'. Marine Turtle Newsletter No. 108, 2005

Hale, P.T., Barreto, A.S., Ross. G.J.B., 2000. '*Comparative Morphology and Distribution of the aduncus and truncatus forms of Bottlenose Dolphin Tursiops in the Indian and Western Pacific Oceans'*. Aquatic Mammals, 26(2): 101-110.

Halfwerk, W., Holleman, L.J.M., Lessells, C.M., Slabbekoorn, H., 2011. '*Negative impact of traffic noise on avian reproductive success*'. J Appl Ecol., 48:210–219.

Hamer, D.J., Ward, T.M., Shaughnessy, P.D., Clark, S.R., 2011. '*Assessing the effectiveness of the Great Australian Bight Marine Park in protecting the endangered Australian sea lion (Neophoca cinerea) from by-catch mortality in shark gill-nets*'. Endangered Species Research, 14: 203 – 2016.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S., Wilson, B., 2008. '*Phocoena dioptrica*'. The IUCN Red List of Threatened Species 2008: e.T41715A10545460. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41715A10545460.en

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K.A., Karkzmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. & Wilson, B. 2012. *Lissodelphis peronii*. The IUCN Red List of Threatened Species 2012: e.T12126A17877993. http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T12126A17877993.en. Downloaded on 20 July 2017.

Handegard, N., Tronstad, T., Hovem, J., Jech, J., 2013. '*Evaluating the Effect of Seismic Surveys on Fish – The Efficacy of Different Exposure Metrics to Explain Disturbance*'. Canadian Journal of Fisheries and Aquatic Sciences, 70:1271 – 1277.

Handegard, N.O., Michalsen, K., Tjostheim, D., 2003. '*Avoidance behaviour in cod (Gadus morhua) to a bottom-trawling vessel*'. Aquatic Living Resources, 16(3):265-270

Harrington, J. J., McAllister, J., Semmens, J.M., 2010. *'Assessing the short-term impact of seismic surveys on adult commercial scallops (Pecten fumatus) in Bass Strait'*. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania.

Harris, R.E., Miller, G.W., Richardson, W.J., 2001. '*Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea'*. Marine Mammal Science, 17(4): 795 – 812.

Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Lokkeborg, S., Misund, O., Ostensen, O., Fonn, M., Haugland, E., 2004. *'Influence of seismic shooting on the lesser sandeel (Ammodytes marinus)*'. ICES Journal of Marine Science, 61: 1165-1173.

Hastings, M.C., Reid, C.A., Grebe, C.C., Hearn, R.L., Colman, J.G., 2008. '*The effects of seismic airgun noise on the hearing sensitivity of tropical reef fishes at Scott Reef, Western Australia. Underwater noise measurement, impact and mitigation'*. Proc Inst Acoust, 30(5).

Hawkins, A. D., Pembroke, A., Popper, A., 2015. '*Information gaps in understanding the effects of noise on fishes and invertebrates*'. Reviews in Fish Biology and Fisheries, 25: 39–64.

Hawkins, A.D., Popper, A.N., 2017. '*A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates*'. ICES Journal of Marine Science, doi:10.1093/icesjms/fsw205. ICES Journal of Marine Science. 10.1093/icesjms/fsw205.

Hayakawa, Y., Booth, J. D., Nishida, S., Sekiguchi, H., Saisho, T., and Kittaka, J. 1990. Daily settlement of the puerulus stage of the red rock lobster *Jasus edwardsii* at Castlepoint, New Zealand. Nippon Suisan Gakkaishi, 56: 1703-1716.

Hazel, J., Lawler, I.R., Marsh, H., Robson, S., 2007. '*Vessel speed increases collision risk for the Green turtle Chelonia mydas*'. Endangered Species Research, 3:105-113.

Heap, A.D., Harris, P.T., Hinde, A., Woods, M., 2005. '*Benthic marine bioregionalisation of Australia's Exclusive Economic Zone*'. Report to the National Oceans Office on the development of a national benthic marine bioregionalisation in support of regional marine planning, 142p.

Hedd, A., Gales, R., Brothers, N., Robertson, G., 2008. '*Diving behaviour of the shy albatross Diomedea cauta in Tasmania: initial findings and dive recorder assessment'*. Ibis, 139(3): 452 – 460.

Heislers, S., Parry, G., 2007. '*Species diversity and composition of benthic infaunal communities found in Marine National Parks along the outer Victorian coast'*. Parks Victoria Technical Series 53.

Henry, G.W., Lyle, J.M., 2003. '*The national recreational and indigenous fishing survey*'. FRDC Project No. 99/158, NSW Fisheries Final Report Series No. 48, 190p.

Hildebrand, J.A., 2009. '*Anthropogenic and natural sources of ambient noise in the ocean*'. Marine Ecology Progress Series, 395: 5 - 20.

Hinojosa, I.A. 2015. Settlement and recruitment processes in the southern rock lobster, *Jasus edwardsii*: The influence of oceanographic features, pueruli behaviour and kelp habitat. PhD Thesis. University of Tasmania.

Hobday, A.J., Evans, K., Eveson, J.P., Farley, J.H., Hartog, J.R., Basson, M., Patterson, T.A., 2015. '*Distribution and migration – southern bluefin tuna (Thunnus maccoyii)*'. In, '*Biology and Ecology of Bluefin Tuna.*

Hobday, A.J., Kawabe, R., Takao, Y., Miyashita, K., Itoh, T., 2009. '*Correction of an abundance index using acoustic tag data for juvenile southern bluefin tuna in southern Western Australia*'. In, '*Tagging and tracking of marine animals with electronic devices II. Reviews: Methods and technologies in fish biology and fisheries*', Nielsen, J., Silbert, J.R., Hobday, A.J., Lutcavage, M.E., Arrizabalaga, H., Fragosa, N. (Eds), pp. 405 – 422, Springer, Netherlands.

Holt, M.M., Noren, D.P., Veirs, V., Emmons, C.K., Veirs, S., 2008. '*Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise*'. Journal of the Acoustical Society of America, 125(1): EL27 – EL32.

Hooker, S.K., 2009. '*Overview toothed whales*'. In, W. F. Perrin and B. Würsig and J. G. M. Thewissen (Ed.), Encyclopedia of marine mammals, pp. 1173–1179. Academic Press, United States.

Hortle, M.E., Cropp, D.A., 1987. 'S*ettlement of the commercial scallop, Pecten fumatus (Reeve) 1855, on artificial collectors in eastern Tasmania*'. Aquaculture, 66 (1987), pp. 79-95

Horwood, J., 2009. '*Sei whale Balaenoptera borealis'.* In, W. F. Perrin and B. Würsig and J. G. M. Thewissen (Ed.), Encyclopedia of marine mammals, pp. 1001-1003. Academic Press, United States

Hosack, G.R., Dambacher, J.M., 2012. '*Ecological indicators for the Exclusive Economic Zone of Australia's South-east Marine Region*'. A report prepared for the Australian Government Department of Sustainability, Environment, Water, Population and Communities, CSIRO Wealth from Oceans Flagship, Hobart.

Hoskins, A.J., Dann, P., Ropert-Coudert, Y., Kato, A., Chiaradia, A., Costa, D.P., Arnould, J.P.Y., 2008. '*Foraging behaviour and habitat selection of the little penguin Eudyptyla minor during early chick rearing in Bass Strait, Australia*'. Marine Ecology Progress Series, 366: 293 – 303.

IOGP, 2017. '*Seismic Surveys & Marine Mammals*'. Joint IOGP/IAGC position paper, Report 576, 12p.

ISO, 2018. '*ISO31000:2018 – Risk Management – Guidelines*'. International Organization for Standardization

Itoh, T., Kemps, H.A., Totterdell, J.A., 2011. '*Diet of young southern bluefin tuna Thunnus maccoyii in the south western coastal waters of Australia in summer*'. Fish. Sci., 77: 337 – 344.

Iversen, R.T.B., 1967. '*Response of the yellowfin tuna (Thunnus albacares) to underwater sound*'. In 'Marine Bioacoustics', Tavolga, W.N. (Ed), Pergamon Press, Oxford, pp. 105 – 121.

IWC, 2007. '*Report of the Scientific Committee Annex K*'. Report of the Stranding Working Group on Environmental Concerns. Journal of Cetacean Research and Management Supplement 9: 227-296.

IWC, 2010. '*Report of the Southern Right Whale Die-Off*'. Workshop 15–18 March 2010, Centro Nacional Patagónico, Puerto Madryn, Argentina SC/62/Rep1Jackson *et al.*, 2014 – humpback

Jackson, J.A., Steel, D.J., Beerli, P., Congdon, B.C., Olavarria, C., Leslie, M.S., Pomilla, C., Rosenbaum, H., Baker, C., 2014. '*Global diversity and oceanic divergence of humpback whales (Megaptera novaeangliae)*'. Proceedings of the Royal Society B, 281: 20133222

Jakupsstovu, S., Olsen, D., Zachariassen, K., 2001. '*Effects of seismic activities on the fisheries at the Faroe Islands'*. Fiskerirannsóknanstovan Report, Tórshavn, Faroe Islands. 92 s.

Jeffs, A. G., and Holland, R. C. 2000. Swimming behaviour of the puerulus of the spiny lobster *Jasus edwardsii* (Hutton,1875). Crustaceana, 73: 847–856.

Jeffs, A. G., Diebel, C. E., and Hooker, S. H. 1997. Arrangement and significance of pinnate sensory setae on antennae of the puerulus and post-puerulus of the spiny lobster, *Jasus edwardsii* (Palinuridae). Marine and Freshwater Research, 48: 681-686.

Jeffs, A. G., Montgomery, J. C., and Tindle, C. T. 2005. How do spiny lobster post-larvae find the coast? New Zealand Journal of Marine and Freshwater Research, 39: 605-617.

Jeffs, A. G., Willmott, M. E., and Wells, R. M. G. 1999. The use of energy stores in the puerulus of the spiny lobster *Jasus edwardsii* across the continental shelf of New Zealand. Comparative Biochemistry and Physiology, 123A: 351-357.

Jeffs, A. G.; Chiswell, S. M.; Booth, J. D. 2001: Distribution and condition of pueruli of the spiny lobster *Jasus edwardsii* offshore from north-east New Zealand. Marine and Freshwater Research 52: 1211–1216.

Jefferson, T.A., Newcomer, M.W., Leatherwood, S., Van Waerebeek, K., 1994. '*Right whale dolphins Lissodelphis borealis (Peale, 1848) and Lissodelphis peronii (Lacepede, 1804)*'. In: S. H. Ridgway and R. Harrison (eds), Handbook of marine mammals, pp. 335-362. Academic Press.

Jenner, K.C.S., Jenner, M-N., McCabe, K.A., 2001. '*Geographical and temporal movements of humpback whales in Western Australian waters'*. APPEA J. 2001: 749 – 765.

Jensen, A., Silber, G., 2004. '*Large Whale Ship Strike Database*'. U.S. Department of Commerce. 37 pp

Jensen, F.H., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M., Madsen, P.T., 2009. '*Vessel noise effects on delphinid communication'*. Marine Ecology Progress Series, 395: 161 – 175.

Jensen, F.H., Marrero Perez, J., Johnson, M., Aguilar Soto, N., Nadsen, P.T., 2011. '*Calling under pressure: short-finned pilot whales make social calls during deep foraging dives*'. Proceedings of the Royal Society B, doi:10.1098/rspb.2010.2604.

Jochens, A., Biggs, D., Engelhaupt, D., Gordon, J., Jaquet, N., Johnson, M., Leben, R., Mate, B., Miller, P., Ortega-Oritz, J., Thode, A., Tyack, P., Wormuth, J., Wűrsig, B., 2016. '*Sperm whale seismic study in the Gulf of Mexico; summary report, 2002 – 2004'*. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2006-034, 352p.

Johnson, M., Madsen, P.T., Zimmer, W.M.X., Anguilar de Soto, A., Tyack, P.L., 2004. '*Beaked whales echolocate on prey*'. Biology Letters, 271: s383 – s386.

Johnson, M., Soto, N., Madsen, P., 2009. '*Studying the behaviour and sensory ecology of marine mammals using acoustic recording tags: a review*'. Marine Ecology Progress Series, 395: 55-73.

Joyce, W., Campana, S., Natanson, L., Kohler, N., Pratt Jr., H., Jensen, C., 2002. '*Analysis of stomach contents of the porbeagle shark (Lamna nasus Bonnaterre) in the northwest Atlantic*'. ICES Journal of Marine Science. 53:1263-1269.

Kaifu, K., Segawa, S., & Tsuchiya, K., 2007. '*Behavioral responses to underwater sound in the small benthic octopus Octopus ocellatus*'. The Journal of the Marine Acoustics Society of Japan, 34(4), 266-273.

Kailola, P.J., Williams, M.J., Stewart, P.C., Reichelt, R.E., McNee, A., Grieve, C., 1993. '*Australian Fisheries Resources*'. Canberra: Department of Primary Industries and the Fisheries Research and Development Corporation, Bureau of Rural Sciences.

Kämpf, J., 2010. '*On preconditioning of coastal upwelling in the eastern Great Australian Bight*'. Journal of Geophysical Research, 115, doi: 10.1029/2010JC006294.

Kämpf, J., Doubell, M., Griffin, D., Matthews, R.L., Ward, T.M., 2004. '*Evidence of a large seasonal coastal upwelling system along the southern shelf of Australia*'. Geophysical Research Letters, 31, doi: 10.1029/2003GL019221.

Kato, H., 2002. Bryde's Whales *Balaenoptera edeni* and *B. brydei*. **In:** Perrin W.F., B. Wrsig & H.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. Page(s) 171-177. Academic Press.

Kato, H., Bannister, J., Burton, C., Ljundblad, D., Matsuoka, K., Shimada, H., 1996. '*Report on the Japan/IWC Blue Whale Cruise 1995-96 off the Southern Coast of Australia*'. Paper SC/48/SH9 presented to the IWC Scientific Committee.

Keevin, T.M., Hempen, G.L., 1997. '*The environmental effects of underwater explosions with methods to mitigate impacts'*. Corps of Engineering St Louis MO St Louis District.

Kemper, C.M., 2002. '*Distribution of the pygmy right whale, Caperea marginata, in the Australasian region*'. Marine Mammal Science, 18(1): 99 – 111.

Kemper, C.M., 2004. '*Osteological variation and taxonomic affinities of bottlenose dolphins, Tursiops spp., from South Australia'*. Australian Journal of Zoology, 52: 29-48.

Kemper, C.M., Middleton, J.F., van Ruth, P.D., 2013. '*Association between pygmy right whales (Caperea marginata) and areas of high marine productivity off Australia and New Zealand'*. New Zealand Journal of Zoology, 40(2): 102 – 128.

Kemper, C.M., Mole, J., Warnecke, R.M., Ling, J.K., Needham, P.N., Wapstra, J.E., 1997. '*Southern right whales in south-eastern Australia- aerial surveys in 1991-1993 and incidental information from 1904*'. In: Hindell, M., Kemper, C. (Eds), 'Marine mammal research in the Southern Hemisphere: status, ecology and medicine'. Surrey Beatty and Sons, Surrey Beatty and Sones, Chipping Norton, p 40 -55.

Ketos Ecology, 2009. '*Turtle Guards: A method to reduce the marine turtle mortality occurring in certain seismic survey equipment*.' Ketos Ecology Report, 14 pp.

Kimmerer, W.J., McKinnon, A.D., 1984. '*Zooplankton abundances in Bass Strait and western Victoria shelf waters, March 1983*'. Proc. R. Soc. Vict. 96: 161-167.

Kirkland, P.C., Dobie, R.A., Yantis, P.A., 1989. '*Underwater noise and the conservation of divers' hearing: a review, Volume 1'*. Technical Report APL-UW TR 8930, October 1989, 247p.

Kirkwood, R., Pemberton, D., Gales, R., Hoskins, A., Mitchell, T., Shaughnessy, P., Arnould, J., 2010. '*Continued population recovery by Australian fur seals'*. Marine and Freshwater Research, 61: 695 – 701.

Klimley, A.P., Myrberg, J.A.A., 1979. '*Acoustic stimuli underlying withdrawal from a sound source by adult lemon sharks, Negaprion brevirostris (Poey)*'. Bulletin of Marine Science 29: 447–458.

Knuckey, I., Sivakumaran, K.P., 1999. '*Spawning and reproductive characteristics of blue warehou in south-east Australian waters*'. FRDC Final Report, Project 96-142. 49 pp.

Komak, S., Boal, J.G., Dickel, L., Budelmann, B.U., 2005. '*Behavioural responses of juvenile cuttlefish (Sepia officinalis) to local water movements*'. Marine and Freshwater Behaviour and Physiology, 38(2), 117-125.

Kosheleva, V., 1992. '*The impact of airguns used in marine seismic exploration on organisms living in the Barents Sea*'. Fisheries and offshore petroleum exploration. 2nd International Conference, Bergen, Norway, 6-8 April.

Kostyuchenko, L., 1973. *'Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea'*. Hydrobiol. J., 9:45–48.

Kropach, C., 1971. *'Sea snake (Pelamis platurus) aggregations on slicks in Panama'.* Herpetologica, 27: 131–35.

La Bella, G., Cannata, S., Froglia, C., Modica, A., Ratti, S., Rivas, G., 1996. '*First assessment of effects of air-gun seismic shooting on marine resources in the central Adriatic Sea*'. In SPE Health, Safety and Environment in Oil and Gas Exploration and Production Conference. Society of Petroleum Engineers.

Lack, M., Pollard, K., Willcock, A., 2003. '*Managing Risk and Uncertainty in Deep-Sea Fisheries: Lessons from Orange Roughy*'. TRAFFIC Oceania and WWF Australia. Available from: http://www.wwf.org.au/publications/orange_roughy.

Lacroix, D.L., Lanctot, R.B., Reed, J.A., McDonald, T.L., 2003. '*Effect of underwater seismic surveys on molting male long-tailed ducks in the Beaufort Sea, Alaska'*. Can. J. Zool., 81: 1862 – 1875.

Ladich F., Collin S.P., Moller P., Kapoor B.G., 2006. '*Fish Communication'*. Enfield (CT): Science Publisher.

Laist, D.W., 1987. '*Overview of the biological effects of lost and discarded plastic debris in the marine environment*'. Marine Pollution Bulletin 18(6): 319 – 326

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., Podesta, M., 2001. '*Collisions between ships and whales'*. Marine Mammal Science, 17(1): 35 – 75.

Lalas, C., McConnell, H., 2016. '*Effects of seismic surveys on New Zealand fur seals during daylight hours: do fur seals respond to obstacles rather than airgun noise?*' Marine Mammal Science, 32(2): 643 – 663.

Last, P.R., Stevens, J.D., 1994. '*Sharks and Rays of Australia'*. Melbourne, Victoria: CSIRO

Last, P.R., Stevens, J.D., 2009. '*Sharks and Rays of Australia (Second Edition)*'. Collingwood, Victoria: CSIRO Publishing.

Law, R.J., Hellou, J., 1999. '*Contamination of fish and shellfish following oil spill incidents'*. Environmental Geosciences, 6(2): 90 – 98.

Lenhardt, M.L., 1994. '*Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta). In Proceedings of the fourteenth annual symposium on sea turtle biology and conservation*' (KA Bjorndal, AB Bolten, DA Johnson & PJ Eliazar, eds.) NOAA Technical Memorandum, NMFSSEFC-351, National Technical Information Service, Springfield, Virginia (pp. 238-241).Leonard & Horn, 2012

Leonard, M.L., Horn, A.G., 2012. '*Ambient noise increases missed detections in nestling birds*'. Biol Lett. 8:530–532.

Lesage, V., Barrette, C., Kingsley, M.C.S., Sjare, B., 1999. '*The effects of vessel noise on the vocal behaviour of belugas in the St. Lawrence River Estuary, Canada.'* Marine Mammal Science, 15(1): 65- 84.

Lesser, J.H.R., 1978. '*Phyllosoma larvae of Jasus edwardsii (Hutton) (Crustacea: Decapoda: Palinuridae) and their distribution off the east coast of the North Island, New Zealand*.' New Zeal. J. Mar. Fresh., 12: 357–370.

Ling, J.K., 1991. '*Recent sightings of killer whales, Orcinus orca (Cetacea: Delphinidae), in South Australia'*. Transactions of the Royal Society of South Australia, 226: 95 – 98.

Ling, J.K., 1999. '*Exploitation of fur seals and sea lions from Australian, New Zealand and adjacent subantarctic islands during the eighteenth, nineteenth and twentieth centuries'*. Aust. Zool., 31: 323 – 350.

Linnane, A., James, C., Middleton, J., Hawthorne, P., and Hoare, M. 2010. Impact of wind stress anomalies on the seasonal pattern of southern rock lobster (*Jasus edwardsii*) settlement in South Australia. Fisheries Oceanography, 19: 290-300.

Linnane, A., McGarvey, R., Gardner, C., Walker, T. I., Matthews, J., Green, B., and Punt, A. E. 2014. Large-scale patterns in puerulus settlement and links to fishery recruitment in the southern rock lobster (*Jasus edwardsii*), across south-eastern Australia. ICES Journal of Marine Science, 71: 528-536.

Linnane, A., McGarvey, R., Feentra, J., Hawthorne, P., 2017. '*Southern Zone Rock Lobster (Jasus edwardsii) Fishery Status Report 2016/17'.* Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000715-11. SARDI Research Report Series No 969. 17p.

Linnane, A., McGarvey, R., Feenstra, J., Hawthorne, P., 2018. '*Southern Zone Rock Lobster (Jasus edwardsii) Fishery Stock Assessment 2016/17*'. SARDI Publication No. F2007/000276-12, SARDI Research Report Series No. 988, 90p.

Linnane, A., McGarvey, R., Feenstra, J., Graske, D., 2018a. '*Northern Zone Rock Lobster (Jasus edwardsii) Fishery Stock Assessment 2016/17'*. SARDI Publication No. F2007/000320-12, SARDI Research Report Series No. 989, 91p.

Linnane, A., and Walsh, P. 2011. Standarising data collection across the southern rock lobster fisheries of South Australia, Victoria and Tasmania. Report to the Fisheries Research and Development Corporation. South Australia Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000393-1. SARDI Research Report Series No. 447. 101pp.

Littnan, C.L., Arnould, J.P.Y., 2002. '*At-sea movements of female Australian fur seals Arctocephalus pusillus doriferus*'. Australian Mammalogy, 24: 65 – 72.

Løkkeborg, S., Ona, E., Vold, A., Salthaug, A., 2012. '*Sounds from seismic airguns: gear- and species-specific effects on catch rates and fish distribution'*. Can. J. Fish. Aquat. Sci., 69(8): 1278–1291. doi:10.1139/f2012-059.

Lowry, H., Lill, A., Wong, B.B., 2012. '*How noisy does a noisy miner have to be? Amplitude adjustments of alarm calls in an avian urban 'adapter*'. PLoS One, 7:e29960

Luczkovich, J.J., Daniel, H.J., Hutchinson, M., Jenkins, T., Johnson, S.E., Pullinger, R.C., Sprague, M.W., 2000. '*Sounds Of Sex And Death In The Sea: Bottlenose Dolphin Whistles Suppress Mating Choruses Of Silver Perch'*. Bioacoustics10:323–334.

Lugli, M., Yan, H.Y., Fine, M.L., 2003. '*Acoustic Communication In Two Freshwater Gobies: The Relationship Between Ambient Noise, Hearing Thresholds And Sound Spectrum'*. J Comp Phys A. 189:309–320.

Lusseau, D., Bain, D.E., Williams, R., Smith, J.C., 2009. '*Vessel traffic disrupts the foraging behaviour of southern resident killer whales Orcinus orca'*. Endangered Species Research, 6: 211 – 221.

Lyle, J.M., Tracey, S.R., Stark, K.E., Wotherspoon, S., 2009. '*2007 – 08 survey of recreational fishing in Tasmania'*. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, 107p.

MacDiarmid, A., Beaumont, J., Bostock, H., Bowden, D., Clark, M., Hadfield, M., Heath, P., Lamarche, G., Nodder, S., Orpin, A., Stevens, C., Thompson, D., Torres, L., Wysoczanski, R., 2012. '*Expert Risk Assessment of Activities in the New Zealand Exclusive Economic Zone and Extended Continental Shelf*', prepared for the Ministry for the Environment, NIWA Client Report No: WLG2011-39, 139pp

MacDiarmid, A.B., 1989. '*Moulting and reproduction of the spiny lobster Jasus edwardsii (Decapoda: Palinurudae) in northern New Zealand'*. Marine Biology, 103: 303 – 310.

Macduff-Duncan, C., Davies, G 1995. '*Managing seismic exploration in a nearshore environmentally sensitive areas*'. Society of Petroleum Engineers, DOI:10.2118/30431-MS.

Madsen, P.T., Wahlberg, M., Mohl, B., 2002. '*Male sperm whale (Physeter macrocephalus) acoustics in a high-latitude habitat: implications for echolocation and communication*'. Behav. Ecol. Sociobiol., 53: 31 – 41.

Madsen, P.T., Møhl, B., Nielsen, B.K., Wahlberg, M., 2002a. '*Male sperm whale behaviour during exposures to distant seismic survey pulses*'. Aquatic Mammals, 28(3): 231 – 240.

Malme, C.I., Wursig, B., Bird, J.E., Tyack, P., 1988. '*Observations of feeding gray whale responses to controlled industrial noise exposure*'. In Sackinger, W.M., Jeffroes. M.O. (Eds), '*Port and ocean engineering under arctic conditions – symposium on noise and marine mammals*'.

Malonado, M., Bergquist, P.R., 2002. '*Phylum Porifera*'. Young, C.M. (Ed), '*Atlas of marine invertebrate larvae*'. Academic, London, pp. 21 – 50.

Mariani, S., Uriz, M.J., Turon, X., 2003. '*Methodological bias in the estimations of important meroplanktonic components from near-shore bottoms*'. Mar. Ecol. Prog. Ser., 253: 67 – 75.

Mariani, S., Uriz, M.J., Turon, X., Alcoverro, T., 2006. '*Dispersal strategies in sponge larvae: integrating the life history of larvae and the hydrologic component*'. Oecologia, 149(1): 174 – 184.

Marten, K., 2000. '*Ultrasonic analysis of Pygmy Sperm Whale (Kogia breviceps) and Hubbs' Beaked Whale (Mesoplodon carhubbsi) Clicks*'. Aquatic Mammals 26(1): 45 – 48.

MAST, 2015. '*Recreational boating fatalities in Tasmania – 1 January 2001 – 31 December 2015.* Comparisons of fatality data 1987 – 2000 and 2001 – 2015. Summary 1978 – 2015'. 25p.

Mate, B.R., Stafford, K.M., Ljungblad, D.K., 1994. '*A change in sperm whale (Physeter macrocephalus) distribution correlated to seismic surveys in the Gulf of Mexico*'. Conference paper in The Journal of the Acoustical Society of America, 96(5): 3268 – 3269.

Matishov, G.G., 1992. '*The reaction of bottom fish larvae to airgun pulses in the context of the vulnerable Barents Sea ecosystem*'. Fisheries and offshore petroleum and exploitation. 2nd International Conference, Bergen, Norway 6-8 April 1992.

McCauley, R. D., Jenner, C., Jenner, M. N., Murdoch, J., McCabe, K., 1998. '*The response of humpback whales to offshore seismic survey noise: Preliminary results of observations about a working seismic vessel and experimental exposures*'. APPEA Journal 2000: 692-708.

McCauley, R., Day, R., Swadling, K., Fitzgibbon, Q., Watson, R., Semmens, J., 2017. '*Widely Used Marine Seismic Survey Air Gun Operations Negatively Impact Zooplankton*'. Nature, Ecology & Evolution 1, 0195. DOI: 10.1038/s41559-017-0195.

McCauley, R., Fewtrell, J., Popper, A., 2003. '*High intensity anthropogenic sound damages fish ears*'. Journal of the acoustical society of America, 113: 1-5.

McCauley, R., Fewtrell, J., Duncan, A., Jenner, C., Jenner, M., Penrose, J. D, Prince, R., Adhitya, A., Murdoch, J., McCabe, K., 2003a. '*Marine Seismic Surveys: Analysis and Propagation of Air-gun Signals in Environmental implications of offshore oil and gas development in Australia: further research*'. APPEA Ltd.

McCauley, R.D., 1994. '*The environmental implications of offshore oil and gas development in Australia seismic surveys*'. In: *Environmental Implications of Offshore Oil and Gas Development in Australia - The Findings of an Independent Scientific Review*, J.M. Swan, J.M. Neff and P.C. Young, (eds.), pp. 123-207. Australian Petroleum Exploration Association, Sydney.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., McCabe, K., 2000. '*Marine Seismic Surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid*'. Prepared for Australian Petroleum Production Exploration Association, Project CMST 163, Report R99-15.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., McCabe, K., 2000a. '*Marine Seismic Surveys – A Study of Environmental Implications*'. APPEA Journal. 40.

McConnell, H., 2014. '*Statement of Evidence of Helen McConnell for OMV New Zealand Limited – Oiled Wildlife*'. Prepared for the OMV Maari Field Development Marine Consent Application, 17 September 2014, pp.48.

McCrea-Strub, A., Kleisner, K., Sumaila, U.R., Swartz, W., Watson, R., Zeller, D., Pauly, D., 2011. '*Potential impact of the Deepwater Horizon oil spill on commercial fisheries in the Gulf of Mexico*'. Fisheries, 36(7): 332 – 336.

McDonald, M.A., 2006. '*An acoustic survey of baleen whales off Great Barrier Island*'. New Zealand Journal of Marine and Freshwater Research, 40: 519 – 529.

McDonald, M.A., Calambokidis, J., Teranishi, A.M., Hildebrand, J.A., 2001. 'The *acoustic calls of blue whales off California with gender data*'. The Journal of the Acoustical Society of America, 109: 1728-1735.

McDonald, M.A., Hildebrand, J.A., Webb, S.C., 1995. '*Blue and fin whales observed on a seafloor array in the Northeast Pacific*'. Journal of the Acoustical Society of America, 98(2): 712 – 721.

McGregor, P.K., Horn, A.G., Leonard, M.L., Thomsen, F., 2013. '*Chapter 14 - Anthropogenic noise and conservation*'. In Brumm, H. (Ed) '*Animal Communication and Noise*', DOI:10.1007/978-3-642-41494-7_14.

McInnes, K.L., Hubbert, G.D., 2003. '*A numerical modelling study of storm surges in Bass Strait*'. Aust. Met. Mag., 52: 143 – 156.

McKenna, M.F., Calambokidis, J., Oleson, E.M., Laist, D.W., Goldbogen, J.A., 2015. '*Simultaneous tracking of blue whales and large ships demonstrates limited behavioural responses for avoiding collision*'. Endangered Species Research, 27: 219 – 232.

Mead, J.G., 1989. '*Beaked whales of the genus Mesoplodon*'. In Ridgway, S.H., Harrison, R. (eds), '*Handbook of marine mammals vol 4.: River dolphins and the larger toothed whales*'. 349 – 430. Academic Press, London.

Middleton, J.E., Bye, J.A.T., 2007. '*A review of the shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland*'. Progress in Oceanography, 75: 1 – 41

Middleton, J.F., Cirano, M., 2002. '*A northern boundary current along Australia's southern shelves: the Flinders Current*'. Journal of Geophysical Research, 107(C9), doi: 10.1029/2000JC000701.

Middleton, J.F., Cirano, M., 2005. '*Wintertime circulation off southeast Australia: strong forcing by the East Australian Current*'. Journal of Geophysical Research, 110, doi: 10.1029/2004JC002855.

Middleton, J.F., Platov, G., 2003. '*The mean summertime circulation along Australia's southern shelves: a numerical study*'. Journal of Physical Oceanography, 33: 2270 – 2287.

Miles, N.G., Walsh, C.T., Butler, G., Ueda, H., West, R.J., 2013. '*Australian diadromous fishes: challenges and solutions for understanding migrations in the 21st century*'. Marine and Freshwater Research, 65:12-24.

Miller, B.S., Collins, K., Barlow, J., Calderan, S., Leaper, R., McDonald, M., Ensor, P., Olson, P., Olavarria, C., Double, M.C., 2014. '*Blue whale songs recorded around South Island, New Zealand 1964-2013*'. Journal of the Acoustical Society of America, 135: 1616-1623.

Miller, C.A., Best, P.B., Perryman, W.L., Baumgartner, M.F., Moore, M.J., 2012. '*Body shape changes associated with reproductive status, nutritive condition and growth in right whales Eubalaena glacialis and* E. australis'. Marine Ecology Progress Series, 4559: 135 – 156.

Miller, B.S., Kelly, N., Double, M.C., Childerhouse, S.J., Laverick, S., Gales, N., 2012a. '*Cruise report on SORP 2012 blue whale voyages: development of acoustic methods'*. Paper SC/64/SH11 presented to the IWC Scientific Committee.

Miller, I., Cripps, E., 2013. *'Three dimensional marine seismic survey has no measurable effect on species richness or abundance of a coral reef associated fish community'.* Marine Pollution Bulletin 77: 63-70.

Miller, P., Aoki, K., Rendell, L., Amano, M., 2008. '*Stereotypical resting behaviour of the sperm whale'*. Current Biology, 18: 21 – 23.

Miller, P.J.O., Johnson, M.P., Madsen, P.T., Biassoni, N., Quero, M., tyack, P.L., 2009. '*Using at-sea experiments to study the effects of airguns on the foraging behaviour of sperm whales in the Gulf of Mexico'*. Deep Sea Research Part I: Oceanographic Research Papers, 56(7): 1168 – 1181.

Minchin, D., 2003. *'Introductions: some biological and ecological characteristics of scallops'*. Aquatic Living Resources, 16: 521–532.

Miyashita, T., Kato, H., Kasuya, T., 1995. '*Worldwide map of cetacean distribution based on Japanese sighting data*'. Volume 1. National Research Institute of Far Seas Fisheries, Shizuoka, Japan. 140p.

Mizroch, S.A., Rice, D.W., Breiwick, J.M., 1984. '*The Sei whale Balaenoptera borealis'*. Marine Fisheries Review, 46(4): 25 – 29.

MMOA, 2019. '*Position Statement 5: Passive Acoustic Monitoring (PAM) Operator Qualifications*.' https://www.mmo-association.org/mmoa-activities/position-statements?id=113

Mobsby, D., Koduah, A., 2017. '*Australian fisheries and aquaculture statistics 2016*'. Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.

Møhl, B., Wahlberg, M., Madsen, P.T., Heerfordt, A., Lund, A., 2003. '*The monopulsed nature of sperm whale clicks*'. Journal of the Acoustical Society of America, 114(2): 1143 – 1154.

Möller, L.M., Allen, S.J., Harcourt, R.G., 2002. '*Group characteristics, site fidelity and seasonal abundance of bottlenose dolphins Tursiops aduncus in Jervis Bay and Port Stephens, south-eastern Australia*'. Australian Mammalogy, 24: 11 – 21.

Möller, L.M., Beheregaray, L.B., 2001. '*Coastal bottlenose dolphins from southeastern Australia are Tursiops aduncus according to sequences of the mitochondrial DNA control region*'. Marine Mammal Science, 17(2): 249 – 263.

Möller, L.M., Bilgmann, K., Charlton-Robb, K., Beheregaray, L., 2008. '*Multi-gene evidence for a new bottlenose dolphin species in southern Australia*'. Molecular Phylogenetics and Evolution, 49: 674 – 681.

Mollet, H.F., Cailliet, G.M., 1996. '*Using Allometry to Predict Body Mass from Linear Measurements of the White Shark*'. In: Klimley, A.P & D.G Aimley, eds. Great White Sharks The Biology of Carcharodon carcharias. Page(s) 81-89. United States of America: Academic Press.

Montgomery, J. C., Jeffs, A., Simpson, S. D., Meekan, M., and Tindle, C. 2006. Sound as an orientation cue for the pelagic larvae of reef fishes and decapod crustaceans. Advances in Marine Biology, 51: 143-196.

Mooney, T.A., Samson, J.E., Schlunk, A.D., Zacarias, S., 2016. '*Loudness-dependent behavioral responses and habituation to sound by the longfin squid (Doryteuthis pealeii)*'. Journal of Comparative Physiology A, 202(7), 489-501.

Moore, B., Lyle, J., Hartmann, K., 2018. '*Tasmanian scalefish fishery assessment 2016/17'*. University of Tasmania and Institute for Marine & Antarctic Studies Report, 203p.

Moore, S.F., Dwyer, R.L., 1974. '*Effects of oil on marine organisms: a critical assessment of published data*'. Water Research, 8(10): 819 – 827.

Morgan, L.E., Shepherd, S.A., 2006. '*Population and spatial structure of two common temperate reef herbivores: abalone and sea urchins*'. In: Kritzer, J.P., Sale, P.F. (Eds), 'Marine Metapopulations', Academic Press, San Diego, pp. 205 – 234.

Morrice, M.G, Gill, P.C., Hughes, J., Levings, A.H., 2004. '*Summary of aerial surveys conducted for the Santos Ltd EPP32 seismic survey, 2-13 December 2003*'. Report # WEG-SP 02/2004, Whale Ecology Group-Southern Ocean, Deakin University. unpublished. (as cited in the EPBC Act Conservation Advice Note).

Morris, C.J., Cote, D., Martin, B., Kehler, D., 2018. '*Effects of 2D seismic on the snow crab fishery*'. Fisheries Research 197: 67-77.

Moulton, V.D., Miller, G.W., 2005. '*Marine mammal monitoring of a seismic survey on the Scotian Slope, 2003*'. Pages 29 – 40, in Lee, K., Bain, H., Hurley, G.V. (Eds), 2005. Acoustic monitoring and marine mammal surveys in The Gully and Outer Scotian Shelf before and during active seismic programs. Environmental Studies Research Funds Report No. 151, 154pp.

MSL, 2012. '*Oil Spill Trajectory Modelling for MC3D Survey. Assessment of potential coastal impacts from a simulated surface release*'. Prepared for WesternGECO. MetOcean Solutions Limited. Report P0128-01.

Murray, S.O., Mercade, E., Roitblat, H.L., 1998. '*Characterizing the graded structure of false killer whale (Pseudorca crassidens) vocalizations*'. Journal of the Acoustical Society of America, 104(3): 1679 – 1688.

Myrberg Jr, A.A., 2001. '*The acoustical biology of elasmobranchs*'. Environmental Biology of Fishes, 60: 31-45

National Parks SA, 2018. '*National Parks South Australia*'. https://www.environment.sa.gov.au/marineparks/home

Neff, J.M., Burns, W.A., 1996. '*Estimation of polycyclic aromatic hydrocarbon concentrations in the water column based on tissue residues in mussels and salmon: An equilibrium partitioning approach*'. Environ. Toxicol. Chem., 15, 2240–2253.

Nelms, S.E., Piniak, W.E.D., Weir, C.R., Godley, B.J., 2016. '*Seismic surveys and marine turtles: An underestimated global threat?*' Biological Conservation, 193, 49–65. https://doi.org/10.1016/j.biocon.2015.10.020

Newall, P.R., Lloyd, L.N., 2012. '*Lavinia Ramsar Site Ecological Character Description*'. Lloyd Environmental report to NRM North. Lloyd Environmental, Syndal, Victoria. 2 March 2012. Accessed on 11 Dec 2018 from: http://www.environment.gov.au/system/files/resources/649a031f-1373-46c3-b814-1acf89b3e5d7/files/5-ecd.pdf

NGNM, 2015. '*Ngootyoong Gunditj Ngootyoong Mara South West Management Plan, May 2015*'. 128p.

Nicol, D.J., 1987. '*A Review and Update of the Tasmanian Cetacean Stranding Record to the end of February 1986*'. University of Tasmania Environmental Studies Working Paper. 21:96 pp.

Nieblas, A-E., Sloyan, B.M., Hobday, A.J., Coleman, R., Richardson, A.J., 2009. '*Variability of biological production in low wind-forced regional upwelling systems: a case study off southeastern Australia*'. Limnol. Oceanogr., 54(5): 1548 – 1558.

NMFS, 2013. '*National Marine Fisheries Services. Marine mammals: Interim Sound Threshold Guidance*' (webpage), National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html

NMFS, 2016. '*Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing – Underwater acoustic thresholds for onset of permanent and temporary threshold shifts*'. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

NMSC, 2009. '*National boating usage study – preliminary survey report*'. National Marine Safety Committee, December 2009, 84p.

NNTT, 2018. '*Search Register of Indigenous Land Use Agreements*'. National Native Title Tribunal. http://www.nntt.gov.au/searchRegApps/NativeTitleRegisters/Pages/Search-Register-of-Indigenous-Land-Use-Agreements.aspx [accessed September 2018]

NOAA, 2018. '*Fin whale*'. https://www.fisheries.noaa.gov/species/fin-whale

NOAA, 2018a. '*How oil harms animals and plants in marine environments*'. https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/how-oil-harms-animals-and-plants-marine-environments.html

Noad, M.J., Cato, D.H., 2001. '*A combined acoustic and visual survey of humpback whales off southeast Queensland*'. Memoirs of the Queensland Museum, 47(2): 507 – 523.

Noad, M.J., Cato, D.H., Paton, D.A., 2006. '*Absolute and relative abundance estimates of Australian east coast humpback whales (Megaptera novaeangliae)*'. Journal of Cetacean Research and Management, 3.

Noad, M.J., Dunlop, R.A., Paton, D., Cato, D.H., 2008. '*An update of the east Australian humpback whale population (E1) rate of increase*'. Paper submitted to the International Whaling Commission Scientific Committee, SC/60/SH31, 13p.

NOPSEMA, 2016. '*Environment plan content requirements*'. Guidance Note, N04750-GN1344, revision No. 3, April, 2016, 40p.

NOPSEMA, 2018. '*Acoustic impact evaluation and management*'. Information Paper N-04750-IP1765, revision No.1, September 2018, 38p.

NOPSEMA, 2018a. '*Petroleum activities and Australian marine parks*'. Guidance Note: N-04750-GN 1785 Rev 0.

NOPTA, 2018. '*Title Holders Report-20180723*'. http://www.nopta.gov.au/search.html?query=production+licences

Nowacek, D.P., Thorne, L.H., Johnston, D.W., Tyack, P.L., 2007. '*Responses of cetaceans to anthropogenic noise*'. Mammal Rev., 37(2): 81 – 115.

Ocean Research Group, 2015. '*Sperm Whales*'. http://www.oceanicresearch.org/education/wonders/spermwhales.htm

Odell, D.K., McClune, K.M., 1999. '*False killer whale Pseudorca crassidens (Owen 1846)*'. **In:** Ridgway, S.H. & R. Harrison, eds. Handbook of Marine Mammals. Vol. 6: The second book of dolphins and the porpoises. Page(s) 213-243. Academic Press, San Diego.

OGP, I.,2011. '*An overview of marine seismic operations*' (Report No. 448) (I. A. o. G. Contractors, Trans.). In I. A. o. O. a. G. Producers (Ed.), (pp. 50). London.

Oleson, E., Barlow, J., Gordon, J., Rankin, S., Hildebrand, J., 2003. '*Low frequency calls of Bryde's whales*'. Marine Mammal Science, 19(2): 407-419.

ORCV, 2018. '*King Island Ocean Yacht Race*'. https://www.orcv.org.au/king-island-about-the-race

Ovenden, J.R., Tillett, B.J., Macbeth, M., Broderick, D., Filardo, F., Street, R., Tracey, S.R., Semmens, J., 2016. '*Stirred but not shaken: population and recruitment genetics of the scallop (Pecten fumatus) in Bass Strait, Australia'.* ICES Journal of Marine Science, Volume 73, Issue 9, 1 September 2016, Pages 2333–2341, https://doi.org/10.1093/icesjms/fsw068

Parks, S., Clark, C., Tyack, P., 2007. '*Short- and long-term changes in right whale calling behaviour: the potential effects of noise on acoustic communication*'. Journal of the Acoustical Society of America, 122(6): 3725 – 3731

Parks, S., Johnson, M., Nowacek, D., Tyack, P., 2011. '*Individual right whales call louder in increased environmental noise*'. Biology letters, 7: 33 – 35

Parks, S.E., Tyack, P.L., 2005. *'Sound production by North Atlantic right whales (Eubalaena glacialis) in surface active groups'*. Journal of the Acoustical Society of America, 117: 3297 – 3306.

ParksTAS, 2018. *'Port Davey Marine Reserve'*. https://www.parks.tas.gov.au/index.aspx?base=3126

ParksVIC, 2005. *'Point Addis Marine National Park, Point Danger Marine Sanctuary, and Eagle Rock Marine Sanctuary Management Plan October 2005'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0019/313426/Point-Addis-Marine-National-Park-Management-Plan.pdf

ParksVIC, 2006. *'Twelve Apostles Marine National Park and The Arches Marine Sanctuary Management Plan, July 2006'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0020/313445/Twelve-Apostles-Marine-National-Park-and-The-Arches-MS-Management-Plan.pdf

ParksVIC, 2006a. *'Port Phillip Heads Marine National Park Management Plan, July 2006'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0003/313374/Port-Phillip-Heads-Marine-National-Park-Management-Plan.pdf

ParksVIC, 2007. *'Merri Marine Sanctuary Management Plan May 2007'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0015/313350/Merri-Marine-Sanctuary-Management-Plan.pdf

ParksVIC, 2007a. *'Barwon Bluff Marine Sanctuary Management Plan April 2007'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0019/313237/Barwon-Bluff-Marine-Sanctuary-Management-Plan.pdf

ParksVIC, 2007b. *'Marengo Reefs Marine Sanctuary Management Plan April 2007'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0003/313347/Marengo-Reef-Marine-Sanctuary-Management-Plan.pdf

ParksVIC, 2018. *'Marine Natural Values Study Summary – Discovery Bay Marine National Park'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0017/314720/20_1036.pdf

ParksVIC, 2018a. *'Marine Natural Values Study Summary – Twelve Apostles Marine National Park'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0018/314721/20_1037.pdf

ParksVIC, 2018b. *'Marine National Values Study Summary – Point Addis Marine National Park'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0019/314722/20_1038.pdf

ParksVIC, 2018c. *'Marine Natural Values Study Summary – Port Phillip Heads Marine National Park'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0020/314723/20_1039.pdf

ParksVIC, 2018d. *'Marine Natural Values Study Summary – Merri Marine Sanctuary'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0003/314733/20_1049.pdf

ParksVIC, 2018e. *'Marine Natural Values Study Summary – Eagle Rock Marine Sanctuary'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0006/314736/20_1052.pdf

ParksVIC, 2018f. *'Marine Natural Values Study Summary – Barwon Bluff Marine Sanctuary'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0008/314738/20_1054.pdf

ParksVIC, 2018g. *'Marine Natural Values Study Summary – Point Danger Marine Sanctuary'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0007/314737/20_1053.pdf

ParksVIC, 2018h. *'Marine Natural Values Study Summary – Marengo Reefs Marine Sanctuary'*. Available from https://parkweb.vic.gov.au/__data/assets/pdf_file/0005/314735/20_1051.pdf

ParksVIC, 2018i. '*Marine Natural Values Study Summary – The Arches Marine Sanctuary*'. https://parkweb.vic.gov.au/__data/assets/pdf_file/0004/314734/20_1050.pdf

ParksVIC, 2018j. '*Ex-HMAS Canberra Recreation Reserve*'. Available from https://parkweb.vic.gov.au/explore/parks/ex-hmas-canberra-recreation-reserve

Parliament of Australia, 2018. "Bonn Convention-amendments". https://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Treaties/BonnConventionAmendment/Report_1/section?id=committees%2Freportjnt%2F024158%2F25836

Parry, G.D., Gason, A., 2006. '*The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia*'. Fisheries Research, 79:272 – 284

Parry, G.D., Heislers, S., Werner, G.F., Asplin, M.D., Gason, A., 2002. '*Assessment of Environmental Effects of Seismic Testing on Scallop Fisheries in Bass Strait*'. Marine and Freshwater Resources Institute Report No. 50. Marine and Freshwater Resources Institute, Queenscliff, Victoria.

Parvin, S.J., Cudahy, E.A., Fothergill, D.M., 2002. '*Guidance for diver exposure to underwater sound in the frequency range 500 to 2,500 Hz*'. Underwater Defence Technology.

Patenaude, N.J., Portway, V.A., Schaeff, C.M., Bannister, J.L., Best, P.B., Payne, R.S., Rowntree, V.J., Rivarola, M., Baker, C.S., 2007. '*Mitochondrial DNA diversity and population structure among southern right whales (Eubalaena australis)*'. Journal of Heredity, 98(2): 147 – 157.

Paton, D., Gibbs, N., 2003. '*Documented and anecdotal cetacean sightings, in the Samoa, Fiji, Vanuatu and Solomon Islands Regions*'.

Patterson, H., Noriega R., Georgeson, L., Larcombe, J., Curtotti, R., 2017. '*Fishery status reports 2017*'. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Patterson, H., Stobutzki, I., Curtotti, R., 2015. '*Southern bluefin tuna fishery*'. Available from http://data.daff.gov.au/data/warehouse/9aam/fsrXXd9abm_/fsr15d9abm_20151030/24_FishStatus2015SthnBluefinTuna_1.0.0.pdf

Patterson, T.A., Evans, K., Carter, T.I., Gunn, J.S., 2008. '*Movement and behaviour of large southern bluefin tuna (Thunnus maccoyii) in the Australian region determined using pop-up satellite archival tags*'. Fish. Oceanog., 17: 352 – 367.

Patterson, T.A., Eveson, J.P., Hartog, J.R., Evans, K., Cooper, S., Lansdell, M., Hobday, A.J., Davies, C.R., 2018. '*Migration dynamics of juvenile southern bluefin tuna*'. Scientific Reports, 8, 14553.

Payne, J.F., Andrews, C.A., Fancey, L.L., Cook, A.L., Christian, J.R., 2007. '*Pilot study on the effects of seismic air gun noise on lobster (Homarus americanus)*'. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2712.

Payne, J.F., Coady, J., White, D., 2009. '*Potential Effects of Seismic Air Gun Discharges on Monkfish Eggs (Lophius americanus) and Larvae*'. National Energy Board, Canada.

Payne, J.F., Andrews, C., Fancey, L., White, D., Christian, J., 2008. '*Potential Effects of Seismic Energy on Fish and Shellfish: an Update Since 2003*'. DFO Can. Sci. Adv Res. Doc.2008/060.

Pearson, W., Skalski, J., Malme, C., 1992. '*Effects of sounds from geophysical survey device on behaviour of captive rockfish (Sebastes spp.)*'. Canadian Journal of Fisheries and Aquatic Sciences, 49: 1343-1356.

Pearson, W.H., Skalski, J.R., Sulkin, S.D., Malme, C.I., 1994. '*Effects of seismic energy releases on the survival and development of zoeal larvae of dungeness crab (Cancer magister)*'. Mar. Environ. Res., 38: 93–113.

Pecl G, Frusher S, Gardner C, Haward M, Hobday A, Jennings S, Nursey-Bray M, Punt A, Revill H, van Putten I (2009). The east coast Tasmanian rock lobster fishery – vulnerability to climate change impacts and adaptation response options. Report to the Department of Climate Change, Australia.

Peel, D., Smith, J.N., Childerhouse, S., 2016. '*Historical data on Australian whale vessel strikes*'. International Whaling Commission, SC/66b/HIM/05.

Peña, H., Handegard N.O., Ona E., 2013. '*Feeding Herring Schools Do Not React To Seismic Airgun Surveys*'. ICES Journal of Marine Science. doi: 10.1093/icesjms/fst079.

Pendoley, K., 1997. '*Sea turtles and management of marine seismic programs in Western Australia*'.

Pendoley, K., 2005. '*Sea Turtles and the Environmental Management of Industrial Activities in North West Western Australia*' PhD Thesis, Murdoch University, Australia. 310p.

Perić, T., 2016. '*Wastewater Pollution from Cruise Ships in Coastal Sea Area of the Republic of Croatia*'. Scientific Journal of Maritime Research, 30: 160 – 164.

Perrin, W.F., Brownell, R.L., 2002. '*Minke Whales Balaenoptera acutorostrata and B. bonaerensis*'. In: Perrin W.F., Würsig B., Thewissen, H.G.M., (eds.) Encyclopedia of Marine Mammals. Page(s) 750-754. Academic Press.

Peteiro, L.G., Babarro, J.M.F., Labarta, U., Fernandex-Reiriz, M.J., 2006. '*Growth of Mytilus galloprovincialis after the Prestige oil spill*'. ICES Journal of Marine Science, 63(6): 1005 – 1013.

Petrella, V., Martinez, E., Anderson, M., Stockin, K., 2012. '*Whistle characteristics of common dolphins (Delphinus sp.) in the Hauraki Gulf, New Zealand*'. Marine Mammal Science, 28: 479 - 496.

Picciulin, M., Sebastianutto, L., Codarin A., Calcagno, G., Ferrero, E.A., 2012. '*Brown Meagre Vocalization Rate Increases During Repetitive Boat Noise Exposures: A Possible Case Of Vocal Compensation*'. Journal of the Acoustical Society of America132:3118–3124.

Pichegru, L., Nyengera, R., McInnes, A.M., Pistorius, P., 2017. '*Avoidance of seismic survey activities by penguins*'. Scientific Reports, 7: 16305, doi:10.1038/s41598-017-16569-x.

Pickett, G., Eaton, D., Seaby, R., Arnold, G., 1994. '*Results of bass tagging in Poole Bay during 1992*'. Ministry of Agriculture Fisheries and Food.

Pidcock, S., Burton, C., Lunney, M., 2003. '*The potential sensitivity of marine mammals to mining and exploration in the Great Australian Bight Marine Park Marine Mammal Protection Zone – An independent review and risk assessment report to Environment Australia*'. 114p

PIRSA, 2011. '*Management plan for the South Australian charter boat fishery*'. Approved by the Minister for Agriculture and Fisheries pursuant to section 44 of the Fisheries Management Act 2007, 66p.

PIRSA, 2012. '*Management plan for the South Australian commercial abalone fishery*'. The South Australian Fisheries Management Series, Paper Number 60, September 2012, 90p.

PIRSA, 2013. '*Management plan for the South Australian commercial Southern Zone rock lobster fishery*'. The South Australian Fisheries Management Series, paper number 63, 103p.

PIRSA, 2014. '*Management plan for the South Australian commercial marine scalefish fishery. Part B – Management arrangements for the taking of sardines*'. The South Australian Fisheries Management Series, paper number 68, 89p.

PIRSA, 2016. '*Draft Management Plan for Recreational Fishing in South Australia*'. Public consultation document, prepared by Fisheries & Aquaculture PIRSA, January 2016, 77p.

PIRSA, 2017. '*Draft ecologically sustainable risk assessment of the South Australian commercial giant crab fishery*'. Accessed from http://www.pir.sa.gov.au/__data/assets/pdf_file/0004/298660/Draft_ecologically_sustainable_risk_assessment_of_the_SA_Commercial_Giant_Crab_Fishery.pdf

PIRSA, 2017a. '*Policy for the management of the South Australian commercial miscellaneous dive fishing activities*'. Accessed from https://www.pir.sa.gov.au/__data/assets/pdf_file/0004/311449/APPROVED_SA_Misc_Dive_fishery_Policy_for_management_Jan_2018_with_updat....pdf

PIRSA, 2018. '*Commercial Fishing*'. http://www.pir.sa.gov.au/fishing/commercial_fishing

PIRSA, 2018a. '*Commercial Licensing and Registration*'. http://www.pir.sa.gov.au/fishing/commercial_fishing/licensing_registration

PIRSA, 2018b. '*Management policy for commercial fishing of giant crabs in South Australia*'. Primary Industries and Regions SA, document ID: A3308123, 23p.

Pirzl, R., 2008. '*Spatial ecology of Eubalaena australis: habitat selection at multiple scales*'. PhD Thesis, School of Life and Environmental Sciences, Deakin University, Melbourne.

Pirzl, R., Thiele, D., Bannister, J.L., Burnell, S.R., 2008. '*ENSO and SAM affect reproductive output in southern right whales*'. Report to the Department of Environment, Water, Heritage and the Arts, Canberra

Pitman, R.L., 2002. '*Mesoplodont Whales Mesoplodon spp.*' **In:** Perrin, W.F., Wursig, B. & Thewissen, J.G.M., eds. Encyclopaedia of Marine Mammals. Page(s) 738-742. London, Academic Press

Pogonoski, J.J., Pollard, D.A., Paxton, J.R., 2002. '*Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes*'. Canberra, ACT: Environment Australia. Available from: http://www.environment.gov.au/coasts/publications/marine-fish-action/pubs/marine-fish.pdf

Pomilla, C., Rosenbaum, H.C., 2005. '*Against the current: an inter-oceanic whale migration event*'. Biology Letters, 1: 476 – 479.

Poore, G.C.B., Wilson, R.S., Gomon, M., Lu, C.C., 1985. '*Museum of Victoria Bass Strait Survey, 1979-1984*'. Museum of Victoria: Melbourne.

Poot, H., Ens, B.J., de Vries, H., Donners, M.A.H., Wernand, M.R., Marquenie, J.M., 2008. '*Green Light for Nocturnally Migrating Birds*'. Ecology and Society, 13(2).

Popper A.N., 2003. '*Effects of Anthropogenic Sounds on Fishes*'. Fisheries 28(10): 24-31.Poupart *et al*., 2017

Popper, A., Hastings, M., 2009. '*The effects of anthropogenic sources of sound on fishes*'. Journal of Fish Biology, 75: 455-489.

Popper, A., Hawkins, A., Fay, R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W., Gentry, R., Halvorsen, M., Lokkeborg, S., Rogers, P., Southall, S., Zeddies, D., Tavlga, W., 2014. '*Sound exposure guidelines for fishes and sea turtles*'. A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Acoustical Society of America and Springer Press. 88 pp.

Popper, A., Smith, M., Cott, P., Hanna, B., MacGillivray, A., Austin, M., Mann, D., 2005. '*Effects of exposure to seismic airgun use on hearing of three fish species*'. Journal of the acoustical society of America, 117: 3958-3971.

Poupart, T.A., Waugh, S.M., Bost, C., Bost, C-A., Dennis, T., Lane, R., Rogers, K., Sugishita, J., Taylor, G.A., Wilson, K-J., Zhang, J., Arnould, J.P.Y., 2017. 'V*ariability in the foraging range of Eudyptula minor across breeding sites in central New Zealand*'. New Zealand Journal of Zoology, 44(3): 225 – 244.

Prideaux, M., 2012. '*The impact of recreational boats around whales and dolphins in their Australian habitats: a preliminary review for the International Fund for Animal Welfare*'. Revised 24 May 2012, International Fund for Animal Welfare, Sydney, Australia.

Przeslawski, R., Hurt, L., Forrest, A., Carroll, A., 2016. '*Potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin*'. FRDC Report 2014/041. Geoscience Australia, Canberra. 60 pp.

Przeslawski, R., Bruce, B., Carroll, A., Anderson, J., Bradford, R., Brock, M., Durrant, A., Edmunds, M., Foster, S., Huang, Z., Hurt, L., Lansdell, M., Lee, K., Lees, C., Nichols, P., Williams, S., 2016a. '*Marine Seismic Survey Impacts on Fish and Invertebrates*'. Final Report for the Gippsland Marine Environmental Monitoring Project. Geoscience Australia, Canberra.

Przeslawski, R., Brooke, B., Carroll, A.G., Fellows, M., 2018. '*An integrated approach to assessing marine seismic impact: Lessons learnt from the Gippsland Marine Environmental Monitoring project*'. Ocean and Coastal Management 160, 117-123.

Przeslawski, Z., Huang, J., Anderson, A.G., Carroll, M., Edmunds, L., Hurt, S., Williams., 2018a. '*Multiple field-based methods to assess the potential impacts of seismic surveys on scallops'*. Mar. Pollut. Bull. 129: 750-761

Queensland Museum, 2018. '*Dispersal & Reproduction*'. http://www.qm.qld.gov.au/Find+out+about/Animals+of+Queensland/Sea+Life/Sponges/Dispersal+and+reproduction#.W-tm7dUzbIU

Radford, A., Kerridge, E., Simpson, S., 2014. '*Acoustic Communication In A Noisy World: Can Fish Compete With Anthropogenic Noise?'*. Behavioural Ecology 25(5): 1022-1030.

Radford, A.N., Lèbre, L., Lecaillon, G., Nedelec, S.L., Simpson, S.D., 2016. '*Repeated exposure reduces the response to impulsive noise in European seabass*'. Glob. Chang. Biol., 22: 3349-3360.

Ramsar, 2018. '*Australia names the Glenelg Estuary and Discovery Bay as a Ramsar Site*'. Website accessed 11 Dec 2018:https://www.ramsar.org/news/australia-names-the-glenelg-estuary-and-discovery-bay-as-a-ramsar-site-0

Reeves, R., Pitman, R.L., Ford, J.K.B., 2017. *Orcinus orca*. The IUCN Red List of Threatened Species 2017: e.T15421A50368125. http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T15421A50368125.en

Reeves, R.R., Stewart, B., Clapham, P., Powell, J., Folkens, P., 2002. '*Guide to marine mammals of the world*'. New York, Alfred A. Knopf.(Ed).

Reid, T.A., Hindell, M.A., Eades, D.W., Newman, M., 2002. '*Seabird Atlas of South-eastern Australian Waters*'. Birds Australia Monograph 4. Birds Australia, Melbourne.

Rennie, S., Hanson, C.E., McCauley, R.D., Pattiaratchi, C., Burton, C., Bannister, J., Jenner, C., Jenner, M-N., 2009. '*Physical properties and processes in the Perth Canyon, Western Australia: links to water column production and seasonal pygmy blue whale abundance'*. J. Mar. Syst., 77: 21 – 44.

Rennie, S.J., Pattiaratchi, C.B., McCauley, R.D., 2007. '*Eddy formation through the interaction between the Leeuwin current, Leeuwin undercurrent and topography'*. Deep-sea Research Part II: Topical Studies in Oceanography, 54: 818 – 836.

RFAC, 2008. '*Recreational fishing in Australia – 2011 and beyond: a national industry development strategy*'. Report by the Recreational Fishing Advisory Committee, 30p.

Rice, D.W., 1998. '*Marine mammals of the world. Systematics and distribution'*. Special publication number 4. Kansas: Society for Marine Mammalogy.

Rich, C., Longcore, T., 2006. '*Ecological Consequences of Artificial Night Lighting'* C. Rich & T. Longcore (Eds.), Richardson, A.J., Matear, R.J., Lenton, A., 2017. '*Potential impacts on zooplankton of seismic Surveys'*. CSIRO, Australia. 34 pp.

Richardson, J., Greene, C., Malme, C., Thompson, D., 1995. '*Marine Mammal and Noise'*. Academic Press, San Diego, U.S.

Ridgway, K.R., 2007. '*Seasonal circulation around Tasmania: an interface between eastern and western boundary dynamics'*. Journal of Geophysical Research, 112, doi:10.1029/2006JC003898.

Ridgway, K.R., Condie, S.A., 2004. '*The 5500-km-long boundary flow off western and southern Australia*'. Journal of Geophysical Research, 109, doi:10.1029/2003JC002921.

Ridgway, S.H., 1983. '*Dolphin hearing and sound production in health and illness*'. Pages 247–296 in R. R. Fay and G. Gourevitch, eds. Hearing and other senses: Presentations in honor of E. G. Weaver. The Amphora Press, Groton, CT.

Risch, D., Corkeron, P.J., Ellison, W.T., van Parijs, S.M., 2012. '*Changes in humpback whale song occurrence in response to an acoustic source 200 km away'*. PLoS One, 7(1): doi:10.1371/journal.pone.0029741.

Robbins, J., Dalla Rosa, L., Allen, J.M., Mattila, D.K., Secchi, E.R., Friedlaender, A.S., Stevick, P.T., Nowacek, D.P., Steel, D., 2011. '*Return movement of a humpback whale between the Antarctic Peninsula and American Samoa: a seasonal migration record'*. Endangered Species, 13: 117 – 121.

Roberts, L., Cheesman, S., Breithaupt, T., Elliott, M., 2015. '*Sensitivity of the mussel Mytilus edulis to substrate-borne vibration in relation to anthropogenically-generated noise'*. Marine Ecology Progress Series, 538. 10.3354/meps11468.

Rogers, P.J., Tsolos, A., Boyle, M.K., Steer, M., 2017. '*South Australian Charter Boat Fishery Data Summary'*. SARDI Publication No. F2011/000438-2. SARDI Research Report Series No. 967, 22p.

Rolland, R.M., Parks, S.E., Hunt, K.E., Castellote, M., Corkeron, P.J., Nowacek, D.P., Wasser, S.K., Kraus, S.D., 2012. '*Evidence that ship noise increases stress in right whales'*. Proc. R. Soc. B., 279: 2363 – 2368.

Romano, T.A., Keogh, M.J., Kelly, C., Feng, P., Berk, L., Schlundy, C.E., Carder, D.A., Finneran, J.J., 2004. '*Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure*'. Can. J. Fish. Aquat. Sci., 61: 1124 – 1134.

Ross, D., 1976. '*Mechanics of underwater noise'*. New York, Pergamon Press, 375pp.

Ross, G.J.B., 2006. '*Review of the Conservation Status of Australia's Smaller Whales and Dolphins'*. Report to the Australian Department of the Environment and Heritage, Canberra, 124p.

Rowe, S., 2007. '*A review of methodologies for mitigating incidental catch of protected marine mammals*'. DOC Research and Development Series 283. Department of Conservation, Wellington.

Royal Society of Canada, 2004. *'Report of the Expert Panel on Science Issues Related to Oil and Gas Activities, Offshore British Columbia'*. An Expert Panel Report Prepared by the Royal Society of Canada at the request of Natural Resources Canada, Ottowa, ON.

RPS, 2018. '*Marine Fauna Observer's Report. Western Platform Multi-client 3D Seismic Survey 25 November 2017 to 15 February 2018*'. RPS Report No. AOE08285, 91p.

Saetre, R., Ona, E., 1996. '*Seismic investigations and damages on fish eggs and larvae; an evaluation of possible effects on stock level'.* Fisken og Havet: 1-17, 1-8.

Salmon, M., Wyneken, J., Fritz, E., Lucas, M., 1992. '*Seafinding by hatchling sea turtles: role of brightness, silhouette and beach slope as orientation cues*'. Behaviour Journal, 122: 56-77.

Samson, J.E., Mooney, T.A., Gussekloo, S.W.S., Hanlon, R.T., 2014. '*Graded behavioural responses and habituation to sound in the common cuttlefish Sepia officinalis*'. J. Exp. Biol. 217, 4347–4355.

Santulli, A., Modica, A., Messina, C., Ceffa, L., Curatolo, A., Rivas, G., Fabi, G., D'Amelio, V., 1999. '*Biochemical responses of European sea bass (Dicentrarchus labrax L.) to the stress induced boy offshore experimental seismic prospecting*'. Marine Pollution Bulletin, 38: 1105-1114.

Sara, G., Dean, J.M., D'Amato, D., Busciano, G., Oliveri, A., Genovese, S., Ferro, S., Buffa, G., Lo Martire, M., Mazzola, S., 2007. '*Effect of boat noise on the behaviour of bluefin tuna Thunnus thynnys in the Mediterranean Sea'*. Marine Ecology Progress Series, 331: 243 – 253.

SARDI, 2017. '*SARDI strategic plan 2018 – 2023, November 2017'*. Accessed from http://www.pir.sa.gov.au/__data/assets/pdf_file/0004/300856/SARDI_Strategic_Plan_2018-23.pdf

Sause, B.L., Gwyther, D., Hanna, P.J., O'Connor, N.A., 1987. '*Evidence for winter – spring spawning of the scallop Pectan alba (Tate) in Port Phillip bay, Victoria, Australia*'.

Schahinger, R.B., 1987. '*Structure of coastal upwelling events observed off the south-east coast of South Australia during February 1983-April 1984*'. Australian Journal of Marine and Freshwater Research 38: 439-459.

Scholik, A., Yan, H., 2002. '*Effects of boat engine noise on the auditory sensitivity of the fathead minnow, Pimphales promelas*'. Environmental biology of fishes, 63: 203-209.

Seafood Frontier, 2018. '*Southern Bluefin Tuna'*. http://seafoodfrontier.com.au/product/southern-bluefin-tuna

Serventy, D.L., Serventy,V.N., Warham, J., 1971. '*The Handbook of Australian Seabirds'*. A.H. & A.W. Reed, Sydney.

SETFIA, 2019. '*Final Report to Schlumberger on Otway Regional 2D Survey Area*'. Prepared by the South East Trawl Fishing Industry Association, 19 December 2018, Updated 16 March 2019 and 17 May 2019.

Shaughnessy, P., Briggs, S., Constable, R., 2001. '*Observations on seals at Montague Island, New South Wales'*. Australian Mammalogy, 23: 1 – 7.

Shaughnessy, P., Goldsworthy, S., Hamer, D., Page, B., McIntosh, R., 2011. '*Australian sea lions Neophoca cinerea at colonies in South Australia: distribution and abundance, 2004 to 2008'*. Endangered Species Research, 13: 87 – 98.

Shaughnessy, P.D., 1999. '*The action plan for Australian seals'*. 62pp. Shepherd, 2008

Shepherd, S.A., 2008. '*Abalone of Gulf St Vincent'*. In: Shepherd, S.A., Bryars, S., Kirkegaard, I.R., Harbison, P., Jennings, J.T. (Eds), 'Natural History of Guld St Vincent', Royal Society of South Australia, Adelaide, pp. 448 – 455.

SIA, 2018. '*About Seafood Industry Australia (SIA)'*. https://seafoodindustryaustralia.com.au/about/

Simmonds, M., Dolman, S., and Weilgart, L 2004. '*Oceans of Noise 2004*.' A Whale and Dolphin Conservation Science Report.

Širović, A., Hildebrand, J.A., Wiggins, S.M., 2007. '*Blue and fin whale call source levels and propagation range in the Southern Ocea*n'. Journal of the Acoustical Society of America, 122(2): 1208 – 1215.

SIV, 2018. '*Seafood Industry Australia, Strategic Plan 2018 – 23'*.

SIV/TSIC, 2018. '*Policy in relation to mining, gas and petroleum sector consultation with the professional seafood industry'*. Prepared by Seafood Industry Victoria and Tasmanian Seafood Industry Council, Version 1, April 2018, 6p.

Skalski, J., Pearson, W., Malme, C., 1992. '*Effects of sounds from a geophysical device on catch-per-unit-effort in a hook-and-line fishery for rockfish (Sebastes spp.)'.* Canadian Journal of Fisheries and Aquatic Sciences, 49: 1357-1365.

Skaret, G., Axelsen, B.E., Mottestad, L., Ferno, A., Johannessen, A., 2005. '*The behaviour of spawning herring in relation to a survey vessel'*. ICES Journal of Marine Science, 62: 1061 – 1064.

Slotte, A., Hansen, K., Dalen, J., Ona, E., 2004. *'Acoustic Mapping Of Pelagic Fish Distribution And Abundance In Relation To A Seismic Shooting Area Off The Norwegian West Coast'*. Fisheries Research 67(2): 143-150.

Smith, A., 2018. '*Victoria's ultimate tuna season!'* Feature article in Fishing Monthly Magazine, first published November 2015, http://www.fishingmonthly.com.au/Articles/Display/19196-Victorias-ultimate-tuna-season

Smith, D., 1994. '*Blue warehou. In the South East Trawl Fishery – A scientific review with particular reference to quota management*'. Ed. By Tilzey, R. Bureau of Resources Sciences Bulletin

Smith, J.N., Grantham, H.S., Gales, N., Double, M.C., Noad, M.J., Paton, D., 2012. '*Identification of humpback whale breeding and calving habitat in the Great Barrier Reef*'. Marine Ecology Progress Series, 447: 259 – 272.

Smith, M. E., 2004. '*Noise-induced stress response and hearing loss in goldfish (Carassius auratus*)'. Journal of Experimental Biology, 207: 427-435.

Smith, N., 1970. '*The problem of oil pollution of the sea'*. Advances in Marine Biology, 8: 215 – 306.

Smyth & Bahrdt Consultants, 2004. '*Kooyang Sea Country Plan'*. Prepared by Smyth and Bahrdt Consultants, on behalf of the Framlingham Aboriginal Trust and Winda Mara Aboriginal Corporation.

Social Research Institute, 2015. '*Transport Safety Victoria – Boating Behaviour 2014'*. Final Report March 2015, 110p.

Solan, M., Hauton, C., Godbold, J. A., Wood, C. L., Leighton, T. G., White, P., 2016. '*Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties*'. Scientific reports, 6, 20540.

Soldevilla, M.S., Henderson, E.E., Campbell, G.S., Wiggins, S.M., Hildebrandt J.A., Roch, M.A., 2008. '*Classification of Risso's and Pacific white-sided dolphins using spectral properties of echolocation clicks*'. The Journal of the Acoustical Society of America, 124:609–624.

Solé, M., Lenoir, M., Durfort, M., López-Bejar, M., Lombarte, A., Van der Schaar, M., André, M., 2013. '*Does exposure to noise from human activities compromise sensory information from cephalopod statocysts?*'. Deep Sea Research Part II: Topical Studies in Oceanography, *95*, 160-181.

Solé, M., Lenoir, M., Durfort, M., López-Bejar, M., Lombarte, A., André, M., 2013a. '*Ultrastructural damage of Loligo vulgaris and Illex coindetii statocysts after low frequency sound exposure*'. PLoS One, 8(10), e78825.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Thomas, J., Tyack, P., 2007. '*Marine mammal noise exposure criteria: Initial scientific recommendations'*. Aquatic Mammals, 33.

Southall, B.L., 2005. '*Shipping noise and marine mammals: a forum for science, management, and technology'*. Final report of the 2004 NOAA symposium "shipping noise and marine mammals", 40p.

Southall, B.L., Hatch, L., 2008. *'Impacts of Anthropogenic Underwater Sound in the Marine Environment, Module 5: Shipping*' OSCPAR Convention for the protection of the marine environment of the north-east Atlantic, Draft preliminary comprehensive overview of the impacts of anthropogenic underwater sound in the marine environment.

Spear, L.B., 2001. '*Seabird migration'*. Encyclopaedia of Ocean Sciences, 236 – 246.

SRL, 2018. '*Southern Rock Lobster Limited*'. https://www.southernrocklobster.com/

Stafford, K.M., Bohnenstiehl, D.R., Tolstoy, M., Chapp, E., Mellinger, D.K., Moore, S.E., 2004. '*Antarctic-type blue whale calls recorded at low latitudes in the Indian and eastern Pacific Oceans*'. Deep-sea Research Part I: Oceanographic Research Papers, 51: 1337 – 1346.

Stamation, K.A., Croft, D.B., Shaughnessy, P.D., Waples, K.A., 2007. '*Observations of humpback whales (Megaptera novaeangliae) feeding during their southward migration along the coast of southeastern New South Wales, Australia: Identification of a possible supplemental feeding ground*'. Aquatic Mammals, 33(2): 165 – 174.

Stanley, J. A., Hesse, J., Hinojosa, I. A., and Jeffs, A. G. 2015. Inducers of settlement and moulting in post-larval spiny lobster. Oecologia 178: 685-697.

Steffe, A., Murphy, J., 1992. '*Offshore prawn catches in the Newcastle region, May to November 1991*'. Fisheries Research Institute, NSW, Cronulla, NSW.

Steiner, S., Bisig, C., Petri-Fink, A., Rothen-Rutishauser, B., 2016. '*Diesel Exhaust: Current Knowledge of Adverse Effects and Underlying Cellular Mechanisms*'. Arch. Toxicol., 90: 1541 – 1553.

Stevens, J., 2005. '*Tope or school shark Galeorhinus galeus (Linneaus, 1758)*'. In: Fowler, S.L., R.D. Cavanagh, M. Camhi, G.H. Burgess, G.M. Cailliet, S.V. Fordham, C.A. Simpfendorfer & J.A. Musick, eds. Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Gland: IUCN.

Stimpert, A.K., DeRuiter, S.L., Southall, B.L., Moretti, D.J., Falcone, E.A., Goldbogen, J.A., Friedlaender, A., Schorr, G.S., Calambokidis, J., 2014. '*Acoustic and foraging behaviour of a Baird's beaked whale, Berardius bairdii, exposed to simulated sonar*'. Scientific Reports 4: 7031. DOI: 10.1038/srep07031.

Stockin, K.A., Burgess, E.A., 2005. '*Opportunistic feeding of an adult humpback whale (Megaptera novaeangliae) migrating along the coast of southeastern Queensland, Australia*'. Aquatic Mammals, 31(1): 120 – 123

Stone, C.J., 2003. '*The effects if seismic activity on marine mammals in UK waters, 1998-2000*'. Rep. No. 323. Joint Nature Conservation Committee, Aberdeen.

Stone, C.J., Tasker, M.L., 2006. '*The effects of seismic airguns on cetaceans in UK waters*'. J. Cetacean. Res. Manage., 8(3): 255 – 263.

Streever, B., Raborn, S., Kim, K., Hawkins, A., Popper, A., 2016. '*Changes In Fish Catch Rates In The Presence Of Air Gun Sounds In Prudhoe Bay, Alaska*'. Arctic, 69(4): 346-358.

Streftaris, N., Zenetos, A., Papathanassiou, E., 2005. '*Globalisation in marine ecosystems: the story of non-indigenous marine species across European seas*'. *Oceanogr. Marine Biol.* 43:419–453.

Surfing Atlas, 2008. '*Limestone Coast*'. http://www.surfingatlas.com/division/26

Sverdrup, A., Kjellsby, P.G., Kruger, P.G., Floys, R., Knudsen, F.R., Enger, P.S., Serck-Hanssen, G., Helle, K.B., 1994. '*Effects of Experimental Seismic Shock on Vasoactivity of Arteries, Integrity of the Vascular Endothelium and on Primary Stress Hormones of the Atlantic Salmon*'. Fish Biology, 45: 973 – 995.

TASGov, 2009. '*Tasmanian Government Gazette*'. Dated Wednesday 11 February 2009, Gazette No. 20 918, available from http://www.gazette.tas.gov.au/editions/2009/february_2009/20918_-_Gazette_11_February_2009.pdf

TASGov, 2018. '*Sea fishing and aquaculture – recreational fishing seasons*'. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/recreational-fishing/recreational-fishing-seasons

Tasmanian Abalone Council, 2018. '*Economic and Social Outcomes for Tasmania*'. https://tasabalone.com.au/about-the-industry/

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P., Pitman, R.L., 2008. *Berardius arnuxii*. The IUCN Red List of Threatened Species 2008: e.T2762A9478212. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T2762A9478212.en

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P., Pitman, R.L., 2008a. *Mesoplodon grayi*. The IUCN Red List of Threatened Species 2008: e.T13247A3428839. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T13247A3428839.en

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P., Pitman, R.L., 2008b. *Mesoplodon layardii*. The IUCN Red List of Threatened Species 2008: e.T13249A3429897. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T13249A3429897.en

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P., Pitman, R.L., 2008c. *Hyperoodon planifrons*. The IUCN Red List of Threatened Species 2008: e.T10708A3208830. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T10708A3208830.en

Taylor, G.A., 2000. '*Action plan for seabird conservation in New Zealand. Part A: Threatened Seabirds*'. Threatened Species Occasional Publication No. 16, 236p.

Taylor, J.G., 1994. '*Whale Sharks, the giants of Ningaloo Reef*'. Page(s) 176 pp. Sydney: Angus & Robertson.

Te Ara, 2018. '*Octopus in New Zealand*'. https://teara.govt.nz/en/octopus-and-squid/page-4

Telfer, T., Sincock, J., Bryd, G., Reed, J., 1987. '*Attraction of Hawaiian Seabirds to lights: Conservation efforts and effect of moon phase*'. Wildlife Society Bulletin 15: 406-413.

Thiele, L., 1983. '*Underwater noise from the propellers of a triple screw container ship*'. Rep. 82.54 from Ødegaard & Danneskiold-Samsoe K/S for Greenl. Fisheries Investig., Copenhagen, Danemark.

Thomas, J., Kastelein, R., Supin, A., 1992. '*Marine mammal sensory systems*'. Plenum Press, New York.

Thompson, P.M., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G., Merchant, N.D., 2013. '*Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises*'. Proceedings of the Royal Society B, 280: 20132001.

Thomsen, F., Franck, D., Ford, J.K.B., 2001. '*Characteristics of whistles from the acoustic repertoire of resident killer whales (Orcinus orca) off Vancouver Island, British Columbia*'. Journal of the Acoustical Society of America, 109(3): 1240 – 1246.

Thomson, R., Sporcic, M., Foster, S., Haddon, M., Potter, A., Carroll, A., Przeslawski, R., Knuckey, I., Koopman, M., Hartog, J., 2014. '*Examining Fisheries Catches and Catch Rates for Potential Effects of Bass Strait Seismic Surveys*'. CSIRO and Geoscience Australia, Hobart and Canberra. 84 pp.

Tomczak, M., 1987. '*The Bass Strait water cascade during summer 1981 – 1982*'. Continental Shelf Research, 7(6): 561 – 572.

Torres, L, Barlow, D., Hodge, K., Klinck, H., Steel, D., Baker, C.S., Chandler, T., Gill, P., Ogle, M., Lilley, C., Bury, S., Graham, B., Sutton, P., Burnett, J., Double, M., Olsen, P., Bott, N., Constantine, R., 2017. '*New Zealand Blue Whales: Recent Findings and Research Progress*'. Journal of Cetacean Research and Management, IWC, 2017

Torres, L. G., Gill, P.C., Graham, B., Steel, D., Hamner, R.M., Baker, C.S., Constantine, R., Escobar-Flores, P., Sutton, P., Bury, S., Bott, N., Pinkerton, M.H. 2015. '*Population, habitat and prey characteristics of blue whales foraging in the South Taranaki Bight, New Zealand*'. SC/66a/SH6, International Whaling Commission.

Torres, L., Klinck, H. 2016. '*Blue whale ecology in the South Taranaki Bight region of New Zealand: January-February 2016 Field Report*'. Oregon State University. March 2016.

Tracey, S.R., Lyle, J.M., Ewing, G., Hartmann, K., Mapleston, A., 2013. '*Offshore recreational fishing in Tasmania 2011/12'*. Prepared by the Institute for Marine and Antarctic Studies, University of Tasmania, 98p.

Triantafillos, L., Brooks, K., Scirmer, J., Pascoe, S., Cannard, T., Dichmont, C., Thebaud, O., Jebreen, E., 2014. '*Developing and testing social objectives for fisheries management'*. FRDC Project No. 2010/040, Primary Industries and Regions, South Australia, 807p.

TRLFA, 2018. '*Tasmanian Rock Lobster Fisherman's Association – Current Fishery Management'*. http://www.tasrocklobster.com/trlfa/index.php?c=21

TSIC, 2018. '*Tasmanian Seafood Industry Council'*. https://www.tsic.org.au/

TSIC, 2019. '*Tasmanian Seafood Industry Council Industry communication & engagement concerning proposed Schlumberger 2D seismic survey in the Otway Region'*. 10p.

Tsolos, A., Boyle, M., 2015. '*Non-confidential 2014/15 data summary of the South Australian Charter Boat Fishery'*. SARDI Aquatic Sciences, data summary to PIRSA Fisheries and Aquaculture, November 2015, 14pp.

TSSC, 2009. '*Commonwealth Listing Advice on Galeorhinus galeus'*. Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68453-listing-advice.pdf

TSSC, 2013. *Threatened Species Scientific Committee. Advice for the River Murray and associated wetlands, floodplains and groundwater systems, from the junction with the Darling River to the sea. Canberra*: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/92-committee-advice.pdf

TSSC, 2015. '*Conservation Advice – Megaptera novaeangliae'*. Established under the Environment Protection and Biodiversity Conservation Act 1999 and approved on 1 October 2015, 14p.

United Nations, 2018. '*United Nations – Indigenous Peoples. United Nations Declaration on the Rights of Indigenous Peoples*'. https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html

Vabø, R., Olsen, K., Huse, I., 2002. '*The effect of vessel avoidance of wintering Norwegian spring spawning herring*'. Fisheries research, 58(1), 59-77.

Valenzuela, L.O., Sironi, M., Rowntree, V.J., Seger, J., 2009. '*Isotopic and genetic evidence for culturally inherited sites fidelity to feeding grounds in southern right whales (Eubalaena australis)*'. Molecular Ecology, 18: 782 – 791.

van Ginkel, C., Becker, D., Gowans, S., Simard, P., 2017. '*Whistling in a noisy ocean: bottlenose dolphins adjust whistle frequencies in response to real-time ambient noise levels'*. Bioacoustics 2017. https://doi.org/10.1080/09524622.2017.1359670

van Ruth, P.D., Ward, T.M., 2014. '*Meso-zooplankton abundance, distribution and community composition in the Eastern Great Australian Bight*'. Transactions of the Royal Society of South Australia, 133:2, 274-283, DOI: 10.1080/03721426.2009.10887124

Veirs, S., Veirs, V., Wood, J.D., 2016. '*Ship noise extends to frequencies used for echolocation by endangered killer whales'*. Peer J., 4: e1657, doi:10.7717/peerj.1657.

Verfuss, U.K., Gillespie, D., Gordon, J., Marques, T.A., Miller, B., Plunkett, R., Theriault, J.A., Tollit, D.J., Zitterbart, D.P., Hubert, P., Thomas, L., 2018. *'Comparing methods suitable for monitoring marine mammals in low visibility conditions during seismic surveys'*. Marine Pollution Bulletin, 126: 1 -18.

VFA, 2010. *'Giant crab management plan'*. Fisheries Victoria Report Series No 79, November 2010, accessed from https://vfa.vic.gov.au/operational-policy/fisheries-management-plans/victorian-giant-crab-fishery/giant-crab-management-plan#

VFA, 2015. *'Victorian wild harvest abalone fishery management plan'*. Published by the Victoria Department of Economic Development, Jobs, Transport and Resources, Melbourne, March 2015, 44p.

VFA, 2017. *'Victorian rock lobster fishery management plan 2017'*. Published by the Victorian Fisheries Authority, December 2017, 52p.

VFA, 2018. *'Victorian Fisheries Authority – About us'*. https://vfa.vic.gov.au/about

VFA, 2018a. *Undertaking seismic surveys in Victorian managed waters*. https://vfa.vic.gov.au/about/publications-and-resources/undertaking-seismic-surveys-in-victorian-managed-waters

VFA, 2018b. *Victorian Rock Lobster Fishery. Stock Assessment Report, 2015/16 Season*. Victorian Fisheries Authority, Victorian Government. (undated report, accessed via VFA website in September, 2018 https://vfa.vic.gov.au/commercial-fishing/rock-lobster

VFA, 2018c. *'Australian sardine'*. https://vfa.vic.gov.au/about/publications-and-resources/status-of-victorian-fisheries/australian-sardine

VFA, 2018d. *'Victorian Fisheries Authority – Scallop'*. https://vfa.vic.gov.au/commercial-fishing/scallop#fishery_overview

VFA, 2018e. *'Victorian Fisheries Authority – Recreational'*. https://vfa.vic.gov.au/recreational-fishing

VFA, 2018f. *'Catch limits and closed seasons'*. https://vfa.vic.gov.au/recreational-fishing/recreational-fishing-guide/catch-limits-and-closed-seasons

Virtue, P., Green, C., Pethybridge, H. R., Moltschaniwskyj, N. A., Wotherspoon, S. J., Jackson, G., 2011. *'Arrow squid: stock variability, fishing techniques, trophic linkages-facing the challenges'*.

Visit Victoria, 2018. *'Great Ocean Road – scuba diving'*. https://www.visitvictoria.com/regions/great-ocean-road/things-to-do/outdoor-activities/water-sports/scuba-diving

Visit Victoria, 2018a. *'Great Ocean Road – whale watching'*. https://www.visitvictoria.com/things-to-do/nature-and-wildlife/wildlife-and-zoos/whale-watching

Visit Victoria, 2018b. *'Great Ocean Road – surfing'*. https://www.visitvictoria.com/regions/great-ocean-road/things-to-do/outdoor-activities/water-sports/surfing-and-windsurfing

Wagner, T.L., Cooper, C.D., Gross, J.A., Coffin, A.B., 2015. *'The effect of seismic waterguns on the inner ears of round goby'*. Journal of Great Lakes Research, 41(4): 1191-1196.

Waite, A.M., Thompson, P.A., Pesant, S., Feng, M., Beckley, L.E., Domingues, C.M., Gaughan, D., Hanson, C.E., Holl, C.M., Koslow, T., Meuleners, M., Montoya, J.P., Moore, T., Muhling, B.A., Paterson, H., Rennie, S., Strzelecki, J., Twomey, L., 2007. *'The Leeuwin Current and its effies: an introductory overview'*. Deep-Sea Research II, 54: 789 – 796.

Wang, J.Y, 2018. *'Bottlenose dolphin, Tursiops aduncus, Indo-Pacific bottlenose dolphin'*. In 'Encyclopaedia of Marine Mammals (Third Edition', Wursig, B., Thewissen, J.G.M., Kovas, K.M., 2018, p. 125 – 130.

Ward, T., McLeay, L., Dimmlich, W., Rogers, P., McClatchie, S., Matthews, R., Kampf, J., Van Ruth, P., 2006a. ‘*Pelagic ecology of a northern boundary current system: effects of upwelling on the production and distribution of sardine (Sardinops sagax), anchovy (Engraulis australis) and southern bluefin tuna (Thunnus maccoyii) in the Great Australian Bight*’. Fish Oceanography. 15: 191 – 207.

Ward, TM., Sorokin, S.J., Currie, D.R., Rogers, P.J., McLeay, L.J., 2006. ‘*Epifaunal assemblages of the eastern Great Australian Bight: effectiveness of a benthic protection zone in representing regional biodiversity*’. Continental Shelf Research, 26: 25-40.

Wardle, C., Carter, T., Urquhart, G., Johnstone, A., Ziolkowski, A., Hampson, G., Mackie, D., 2001. *‘Effects of seismic air guns on marine fish*’. Continental Shelf Research, 21: 1005-1027.

Warneke, R.M., Shaughnessy, P.D., 1985. ‘*Arctocephalus pusillus, the South African and Australian fur seal: taxonomy, evolution, biogeography, and life history’*. In ‘Studies of Sea Mammals in South Latitudes’, eds. Ling, L.K., Bryden, M.M., pp. 53 – 77.

Water Technology, 2012. *‘Port of Warrnambool Safer Boating and Harbour Facility Study’.* Report prepared for Warrnambool City Council by Water Technology Pty Ltd.

Watson, G.F., Chaloupka, M.Y., 1982. ‘*Zooplankton of Bass Strait: species composition, systematics and artificial key to species*’. Technical Report No.1, Victorian Institute of Marine Sciences, Department of Zoology, University of Melbourne.

Weilgart, L., 2012. *‘A review of the impacts of seismic airgun surveys on marine life’*. Accessed from http://www.eccea.com/uploads/File/Seismic%20effects.pdf

Weilgart, L.S., 2007. *‘A brief review of known effects of noise on marine mammals’*. International Journal of Comparative Psychology, 20: 159 – 186.

Weilgart, L.S., 2013. *‘A review of the impacts of seismic airgun surveys on marine life’*. Submitted to the CBD Expert Workshop on Underwater Noise and its Impacts on Marine and Coastal Biodiversity, 25 -27 February 2014, London, UK. Available at http://www.cbd.int/doc/?meeting=MCBEM-2014-01.

Weilgart, L.S., Whitehead, H., 1990. *‘Vocalizations of the North Atlantic pilot whale (Globicephala melas) as related to behavioural contexts’*. Behavioural Ecology and Sociobiology, 26(6): 399 – 402.

Weir, C., Dolman, S.J., 2007. *‘Comparative review of the regional marine mammal mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard’*. Journal of International Wildlife Law and Policy, 10: 1 – 27.

Weir, C.R., 2007. *‘Observation of marine turtles in relation to seismic airgun sound off Angola’*. Marine Turtle Newsletter, 116: 17 - 20

Weir, C.R., 2008. *‘Overt responses of humpback whales (Megaptera novaeangliae), sperm whales (Physeter macrocephalus), and Atlantic spotted dolphins (Stenella frontalis) to seismic exploration off Angola’*. Aquatic Mammals, 34(1): 71 – 83.

WFSA, 2018. *‘Wildcatch Fisheries SA – represented industries’*. https://www.wfsa.org.au/about-wfsa/represented-industries.html

WhaleFacts, 2018. *‘Pygmy Right Whale’*. https://www.whalefacts.org/pygmy-right-whale-facts/

WHC, 2018. ‘*World Heritage Convention – the criteria for selection*’. https://whc.unesco.org/en/criteria/

Whitehead, H. 1996. *‘Variation in the feeding success of sperm whales: temporal scale, spatial scale and relationship to migrations*’. Journal of Animal Ecology, 65(4): 429-438.

Whitlock, R.E., Hazen, E.L., Walli, A., Farwell, C., Bograd, S.J., Foley, D.G., Castleton, M., Block, B.A., 2015. '*Direct quantification of energy intake in an apex marine predator suggests physiology is a key driver of migrations*'. Sci. Adv., e1400270.

Wildlife Tours, 2018. '*Surf beaches on the Great Ocean Road*'. https://wildlifetours.com.au/surf-beaches-great-ocean-road/

Wilewska-Bien, M., Granhag, L., Andersson, K., 2016. '*The Nutrient Load From Food Waste Generated Onboard Ships in the Baltic Sea*'. Marine Pollution Bulletin, 105: 359 – 366.

Wilkin, J. L., and Jeffs, A. G. 2011. Energetics of swimming to shore in the puerulus stage of a spiny lobster: Can a post-larval lobster afford the cost of crossing the continental shelf? Limnology and Oceanography: Fluids and Environments, 1: 163–175.

Williams A., Althaus F., Smith T., Daley R., Barker B., Fuller M., 2012. '*Developing and applying a spatially-based seascape analysis (the "habitat proxy" method) to inform management of gulper sharks*'. Compendium of Discussion Papers. Report to the Australian Fisheries Management Authority. CSIRO, Australia.

Willis, J., Hobday, A.J., 2007. '*Influence of upwelling on movement of southern bluefin tuna (Thunnus maccoyii) in the Great Australian Bight*'. Mar. Freshwater Res., 58: 699 – 708.

Wilson, R.S., Poore, G.C.B., 1987. '*The Bass Strait Survey: biological sampling stations, 1979-1983*'. Occasional Papers from the Museum of Victoria 3: 1-14.

Woinarski, J., Burbidge, A., Harrison, P., 2014. '*The Action Plan for Australian Mammals 2012*'. CSIRO Publishing.

Womersley, H.B.S. 1984. '*The marine benthic flora of southern Australia*'. Part 1. D.J. Woolman, Government Pinter, South Australia.

Woodside, 2007. '*Impacts of seismic airgun noise on fish behaviour: a coral reef case study*'.

Wright, A.J., Consentino, M., 2015. '*JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys: we can do better*'. Marine Pollution Bulletin, 100(1), http://dx.doi.org/10.1016/j.marpolbul.2015.08.045.

Würsig, B., Cipriano, F., Slooten, E., Constantine, R., Barr, K., Yin, S., 1997. '*Dusky dolphin (Lagenorhynchus obscurus) off New Zealand: status of present knowledge*'. Report of the International Whaling Commission, 47:715-722.

Wysocki, L. E., Davidson III, J. W., Smith, M. E., Frankel, A. S., Ellison, W. T., Mazik, P. M., Bebak, J., 2007. '*Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout Oncorhynchus mykiss*'. Aquaculture, 272(1-4), 687-697.

Yearsley, G.K., Last, P.R., Ward, R.D., 1999. '*Australian Seafood Handbook: an Identification Guide to Domestic Species*'. Hobart, CSIRO Marine Research.

APPENDIX A

Sound Transmission Loss Modelling Report

OTWAY BASIN 2D MULTI-CLIENT SEISMIC SURVEY

Sound Transmission Loss Modelling

Prepared for:

Schlumberger
Level 5, Capital Building
256 St Georges Terrace
Perth, WA 6000

SLR Ref: 640.11793-R01
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December 2018

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Schlumberger (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
640.11793-R01-v1.0	30 November 2018	Binghui Li	Briony Croft	Dan Govier

EXECUTIVE SUMMARY

Schlumberger Australia Pty Limited (SLB) proposes to undertake a 2D marine seismic survey in the Otway Basin, approximately 185 km southeast of Kingscote South Australia, 13 km south of Portland Victoria and 66 km west of Strahan Tasmania. SLR Consulting Australia Pty Ltd (SLR) has been engaged by SLB to undertake sound transmission loss modelling (STLM) for the proposed survey, in order forecast sound levels of various metrics, including peak sound pressure levels (Pk SPLs), peak to peak sound pressure levels (Pk-Pk SPLs), root-mean-square sound pressure levels (RMS SPLs), and single-pulse and cumulative sound exposure levels (SELs) at receiving locations within and adjacent to the survey area.

This report details the STLM study that has been carried out for the proposed survey, which includes the following modelling components:

- Array source modelling – modelling of the sound energy emissions from the proposed 5,265 cubic inch (CUI) Boltgun 1900LLXT/1500LL array, including its far-field signature and power spectral density (PDS);
- Short-range modelling – prediction of the received SELs at distances up to four kilometres from the source array. Short range modelling is used to assess the potential high-risk immediate noise impact to marine fauna species of interest.
- Long-range modelling – prediction of the received SELs over a range of tens to hundreds of kilometres. This modelling assesses the noise impacts to more distant sensitive marine areas; and
- Cumulative modelling – prediction of the received cumulative SELs within a 24-hour period (SEL_{24hr}) for a typical survey operation scenario.

The noise modelling results are further analysed to identify zones of impact for marine fauna species of concern based on relevant noise impact assessment criteria. The marine fauna species of concern include marine mammals, fish and turtles, fish eggs and fish larvae, plankton, scallops and lobsters. The noise effects assessed include physiological effects (physical injury/permanent threshold shift (PTS) and temporary threshold shift (TTS)) and behavioural disturbance due to either immediate impact from single airgun pulses or cumulative effects of exposure to multiple airgun pulses over a period of 24 hours.

The noise impact assessment criteria for the marine fauna species of concerns are detailed in **Section 2** of this report, and the identified relevant zones of impact are summarised in **Section 5.4** of the report.

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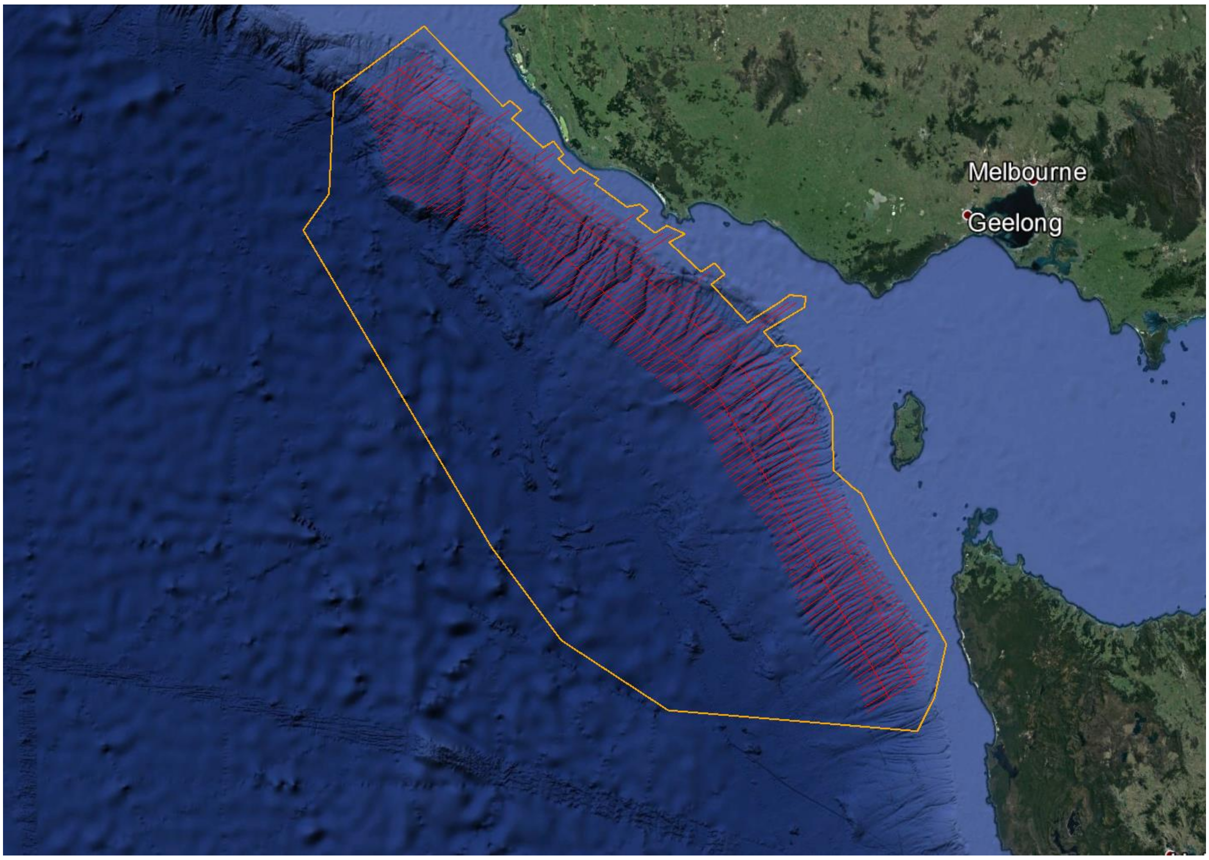
APPENDICES

1 Introduction

1.1 Project description

Schlumberger Australia Pty Limited (SLB) is proposing to acquire the Otway Basin 2D Multi-Client Marine Seismic Survey (Otway Basin 2DMC MSS). The proposed operational area and survey lines are shown in **Figure 1**.

Figure 1 The proposed Otway Basin 2DMC MSS operational area and survey lines. Brown polygon indicates the 2D survey operational area, and red polygons the proposed survey lines



SLR Consulting Australia Pty Ltd (SLR) has been engaged by SLB to undertake sound transmission loss modelling (STLM) study for the proposed survey, in order to assist with the assessment of potential noise impact on marine fauna species of interest.

This STLM study predicts received noise levels of various metrics (e.g. sound exposure levels (SELs) from single pulses, cumulative SELs from multiple pulses over 24 hours (SEL_{24hr}), peak sound pressure levels (Pk SPLs), peak-to-peak sound pressure levels (Pk-Pk SPLs) and root-mean-square sound pressure levels (RMS SPLs)) at locations within and adjacent to the survey area. These noise levels are used to estimate the threshold distances to potential sound effects on marine fauna species of interest, including marine mammals (cetaceans and pinnipeds), fish and turtles, plankton, rock lobster and scallop.

1.2 Structure of the report

This STLM study includes the following modelling components:

- Airgun source modelling, i.e. modelling of the sound energy emissions from the proposed 5,265 cubic inch (CUI) Boltgun 1900LLXT/1500LL array, including the far-field signature and its power spectral density (PSD), as well as the beam pattern of the source array.
- Short range modelling, i.e. prediction of the received noise levels over a range of four kilometres from the assumed array source locations, in order to assess the potential high-risk immediate noise impact to marine fauna species of interest.
- Long range modelling, i.e. prediction of the received noise levels over a range of two hundred kilometres from the assumed array source locations, in order to assess the potential noise impact from the survey on the relevant far-field marine sensitive areas.
- Cumulative noise exposure modelling, i.e. prediction of the cumulative SELs over a 24-hour period for receiving locations within and adjacent to the proposed survey area, to assess the potential cumulative noise impact to marine fauna species of interest.

Section 2 of the report provides relevant noise impact assessment criteria for marine fauna species of interest. **Section 3** details the modelling methodology, procedure and results for the array source modelling. **Section 4** outlines the methodologies and procedures associated with the short range and long range transmission loss modelling, as well as the cumulative noise exposure modelling. **Section 5** presents the major modelling results and the estimated zones of impact for marine fauna species of interest. **Section 6** provides discussions and summaries of the STLM study. Relevant references cited throughout the report are listed in **Section 7**.

Relevant acoustic terminologies throughout the report are presented in **Appendix A**.

2 Noise Assessment Criteria

2.1 Impact of noise on marine fauna species

The effects of noise and the distances over which effects extend depend on the acoustic characteristics of the noise (e.g. overall levels, spectral content, temporal characteristics, etc.). The potential impacts of noise on marine fauna species include mortality, physical and hearing damage, masking of communication and other biological important sounds, and alteration of behaviour (Richardson et al, 1995; Hasting and Popper, 2005). In general, underwater noise impacts on marine fauna species may be divided into two categories, behavioural impacts and physiological impacts.

2.1.1 Behavioural impacts

Behavioural responses to noise include changes in vocalisation, resting, diving and breathing patterns, changes in mother-infant relationships, and avoidance of the noise sources. Masking of biologically important sounds may interfere directly with communication and social interaction. Secondary behavioural effects such as inhibited reproduction cycles and other changes in behaviour may also occur.

2.1.2 Physiological impacts

Physiological effects of underwater noise are primarily associated with the auditory system which is likely to be most sensitive to noise. The exposure of the auditory system to a high level of noise for a specific duration can cause a reduction in the animal's hearing sensitivity, or an increase in hearing threshold. If the noise exposure is below some critical sound energy level, the hearing loss is generally only temporary, and this effect is called temporary hearing threshold shift (TTS). If the noise exposure exceeds the critical sound energy level, the hearing loss can be permanent, and this effect is called permanent hearing threshold shift (PTS).

In a broader sense, physiological impacts also include non-auditory physiological effects. Other physiological systems of marine animals potentially affected by noise include the vestibular system, reproductive system, nervous system, liver or organs with high levels of dissolved gas concentrations and gas filled spaces. Noise at high levels may cause concussive effects, physical damage to tissues and organs, cavitation or result in rapid formation of bubbles in venous system due to massive oscillations of pressure.

2.2 Marine mammals

2.2.1 Marine mammal auditory weighting functions

Marine animals do not hear equally well at all frequencies within their functional hearing range. Based on the hearing range and sensitivities, Southall et al (2007) have categorised marine mammal species (i.e. cetaceans and pinnipeds) into five hearing groups: low-frequency (LF), mid-frequency (MF), high-frequency (HF) cetaceans, phocid pinnipeds in water (PW) and otarrid pinnipeds in water (OW).

The potential noise effects on animals depend on how well the animals can hear the noise. Frequency weighting is a method of quantitatively compensating for the differential frequency response of sensory systems (Southall et al, 2007).

The NOAA technical guidance (NMFS, 2016) adopts the auditory weighting functions recommended by Finneran (2015 & 2016), which are expressed as:

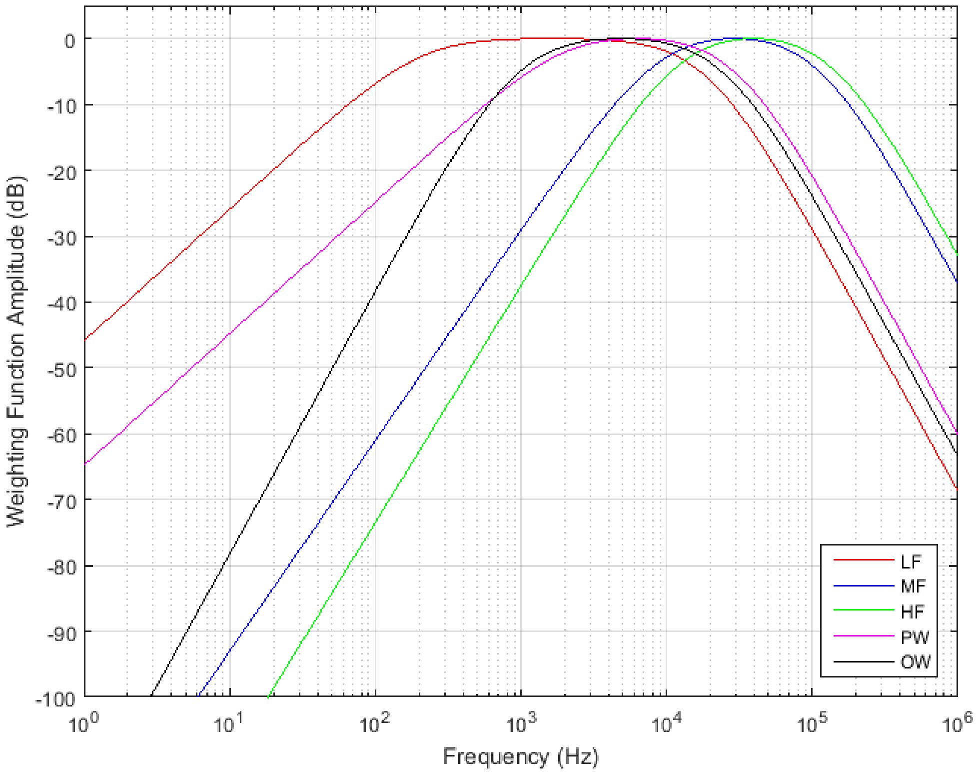
$$W(f) = C + 10log10\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\} \quad (2.1)$$

Five functional hearing groups for marine mammals in water proposed by Finneran (2015) include: low-frequency (LF), mid-frequency (MF) and high-frequency (HF) cetaceans, phocid pinnipeds in water (PW) and otarrid pinnipeds in water (OW). **Table 1** lists the auditory weighting parameters for each hearing group. The corresponding auditory weighting functions for all hearing groups are presented in. **Figure 2.**

Table 1 Parameters for the auditory weighting functions (NMFS, 2016)

Marine mammal hearing group	*a*	*b*	*f_1 (Hz)*	*f_2 (Hz)*	*C (dB)*
Low-frequency cetaceans (LF)	1.0	2	200	19,000	0.13
Mid-frequency cetaceans (MF)	1.6	2	8,800	110,000	1.20
High-frequency cetaceans (HF)	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water (PW)	1.0	2	1,900	30,000	0.75
Otarrid pinnipeds in water (OW)	2.0	2	940	25,000	0.64

Figure 2 Auditory weighting functions for low-frequency (LF), mid-frequency (MF) and high-frequency (HF) cetaceans, phocid pinnipeds in water (PW) and otarrid pinnipeds in water (OW) (NMFS, 2016)



2.2.2 Noise impact criteria for marine mammals

There have been extensive scientific studies and research efforts to develop quantitative links between marine noise and impacts on marine fauna species. For example, Southall et al (2007) have proposed noise exposure criteria associated with various sound types (e.g. pulses (e.g. piling noise) and non-pulses (e.g. vessel and dredging noise)) for certain marine mammal species (i.e. cetaceans and pinnipeds), based on review of expanding literature on marine mammal hearing and on physiological and behavioural responses to anthropogenic sounds.

NMFS (2016) propose PTS-onset and TTS-onset criteria for impulsive noise events such as seismic airgun shots, as outlined in **Table 2**, which incorporate a dual-criteria approach based on both peak sound pressure level (Peak SPL) and cumulative SEL within a 24-hour period (SEL_{24hr}).

For behavioural changes, the widely used assessment criterion for the onset of possible behavioural disruption in marine mammals is root-mean-square (RMS) SPL of 160 dB re 1µPa for impulsive noise events such as seismic survey airgun shots (NMFS, 2013), as shown in **Table 3.**

Table 2 The PTS and TTS threshold levels for individual marine mammals exposed to impulsive noise events (NMFS, 2016)

Marine mammal hearing group	PTS and TTS threshold levels – impulsive noise events			
	Injury (PTS) onset		TTS onset	
	Pk SPL, dB re 1µPa	Weighted SEL_{24hr}, dB re $1µPa^2·S$	Pk SPL, dB re 1µPa	Weighted SEL_{24hr}, dB re $1µPa^2·S$
Low-frequency (LF) cetaceans	219	183	213	168
Mid-frequency (MF) cetaceans	230	185	224	170
High-frequency (HF) cetaceans	202	155	196	140
Phocid Pinnipeds in water (PW)	218	185	212	170
Otariid Pinnipeds in water (OW)	232	203	226	188

Table 3 The behavioural disruption threshold level for individual marine mammals – impulsive noise events (NMFS, 2013)

Marine mammal hearing group	Behavioural disruption threshold levels – impulsive noise events
	RMS SPL, dB re 1µPa
All hearing groups	160

2.3 Fish, turtles, fish eggs and fish larvae

A Working Group (Popper *et al*., 2014) was established to undertake a comprehensive review of thresholds for noise exposure for fish and turtles. The resulting noise exposure criteria are providing in **Table 4**.

The behavioural threshold for turtles has been established by McCauley et al (2000) as in **Table 5,** and it has been adopted by NMFS and applied in the Arctic Programmatic Environment Impact Statement (PEIS) (NFS, 2011). The behavioural threshold for squid is based on research results from McCauley et al (2000).

Table 4 Noise exposure criteria for seismic airguns – fish, turtles, fish eggs and fish larvae (Popper et al, 2014)

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recovery injury	TTS	Masking	
Fish: no swim bladder (particle motion detection)	>219 dB SEL_{24hr}, or >213 dB Pk SPL	>216 dB SEL_{24hr} or >213 dB Pk SPL	>>186 dB SEL_{24hr}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{24hr} or >207 dB Pk SPL	203 dB SEL_{24hr} or >207 dB Pk SPL	>>186 dB SEL_{24hr}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24hr} or >207 dB Pk SPL	203 dB SEL_{24hr} or >207 dB Pk SPL	186 dB SEL_{24hr}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Sea turtles	210 dB SEL_{24hr} or >207 dB Pk SPL	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	>210 dB SEL_{24hr} or >207 dB Pk SPL	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: peak sound pressure levels (Pk SPL) dB re 1 µPa; Cumulative sound exposure level (SEL_{24hr}) dB re 1 $\mu Pa^2 \cdot s$. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Table 5 The behavioural disturbance threshold level for turtles – impulsive noise events (McCauley et al, 2000; NSF, 2011)

Type of animal	Behavioural disturbance threshold levels – impulsive noise events
	RMS SPL, dB re 1µPa
Turtles	166
Squid	156

2.4 Plankton

Recent research released by McCauley et al (2017) states that within the range from airgun passage that the abundance measures (ind. M^{-3}) of copepods and cladocerans had dropped to 50% of control abundance, the received Pk-Pk SPL was 178 dB re 1 µPa. However, the IAGC (2017) has stated that the McCauley et al (2017) paper has not been accepted by the expert scientific community.

For a comparison purpose, **Table 6** provides a summary of two sets of possible threshold values for mortal injury for plankton: one set based on McCauley et al, (2017) paper, and another set based on mortality threshold values for fish eggs and larvae from Popper et al (2014).

Table 6 Noise exposure criteria for seismic airguns – plankton (Popper et al, 2014 and McCauley et al, 2017)

Plankton	Mortality and potentially mortal injury threshold levels
Based on fish eggs and fish larvae (Popper et al, 2014)	SEL_{24hr}: >210 dB re 1µPa^2·S, or Pk SPL: >207 dB re 1 µPa
Based on recent research by McCauley et al (2017)	Pk-Pk SPL: 178 dB re 1 µPa

2.5 Scallops and lobsters

The study undertaken by Day et al (2016) has reported that exposure to airgun pulses has caused persistent physiological effects for scallops and lobsters, and increased mortality for scallops. However, no definite threshold has been established in this study.

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has publicly stated that the seafloor levels derived from Day et al (2016) should be used to assist in the assessment of potential impacts on scallops and lobsters.

Table 7 presents a set of threshold criteria for assessing potential impacts for scallops and lobsters that have been accepted by NOPSEMA, proposed by Pinzone (2017) based on the research study by Day et al (2016).

Table 7 Noise exposure criteria for potential impacts for seismic airguns – scallops and rock lobsters (Day et al, 2016)

Scallop and rock lobster	potential impacts threshold levels
Based on recent research by Day et al (2016)	Single pulse SEL: 186–190 dB re 1 µPa^2·s SEL_{24}: 192–199 dB re 1 µPa^2·s Pk-Pk SPL: 209 – 212 dB re 1 µPa

2.6 Zones of impact

Received noise levels can be predicted using known source levels in combination with models of sound propagation transmission loss between the source and the receiver locations. Zones of impact can then be determined by comparison of the predicted received levels to the noise exposure criteria.

Predicted zones of impact define the environmental footprint of the noise generating activities and indicate the locations within which the activities may have an adverse impact on marine fauna species of interest. In this report, zones of impact are defined as follows:

- For immediate impact from single pulses – the zone of impact represents the maximum horizontal distance from the array source,
- For cumulative impact from a typical survey operation scenario – the zone of impact represents the maximum perpendicular horizontal distance from an active survey line.

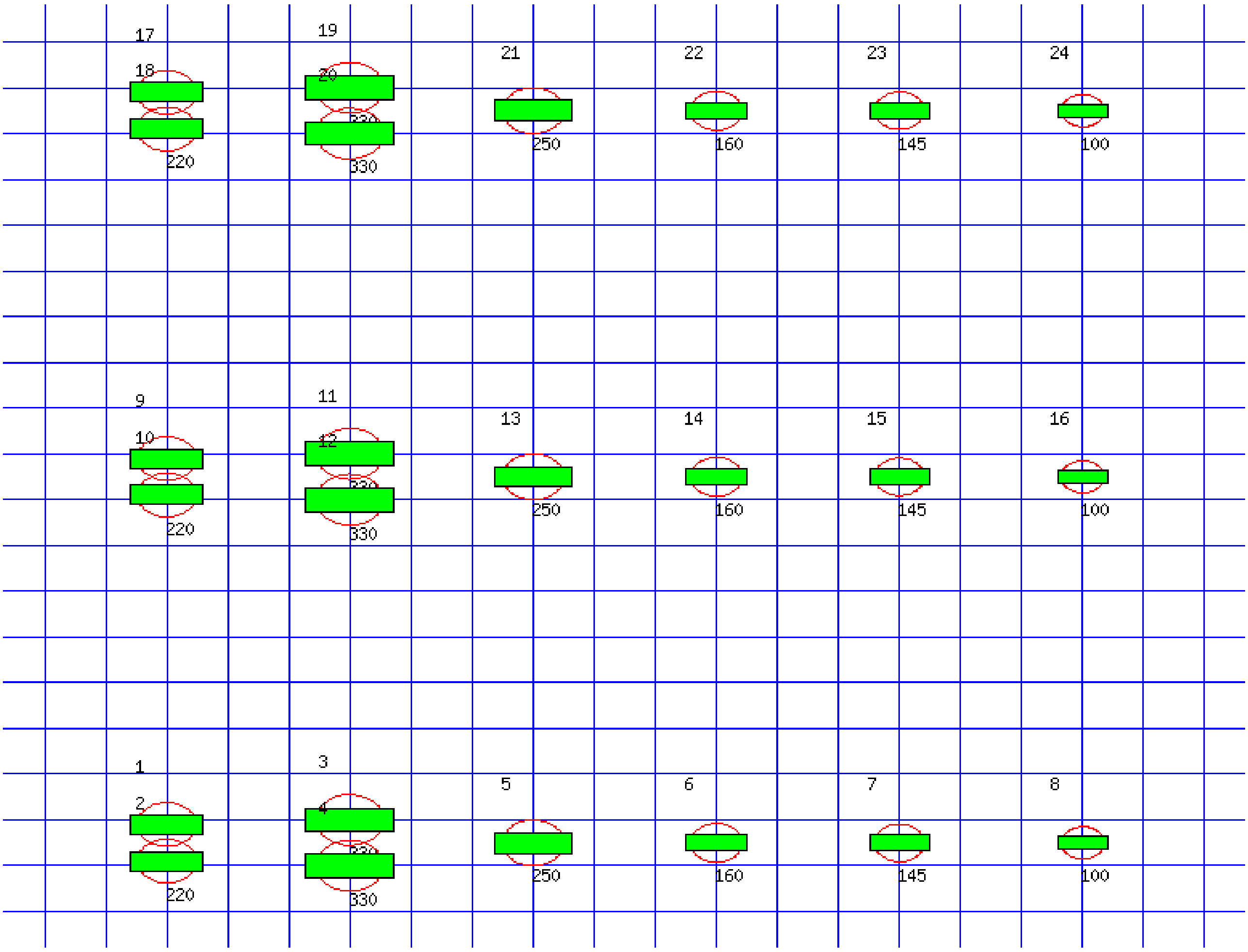
In all cases, zones of impact are conservatively determined by using the maximum predicted noise level across the water column to determine the zone of impact. Since noise levels vary with depth at any location, there will be areas in the water column within the identified zone of impact that are exposed to lower noise levels than implied by the identified zones of impact, which represent the worst case.

3 Airgun Array Source Modelling

3.1 Airgun array configuration

The airgun array proposed for this survey is the 5,265 cubic inch (CUI) Boltgun 1900LLXT/1500LL array with configuration shown in **Figure 3**. The array consists of 24 active 1900LLXT/1500LL airgun units, and has a towing depth of 7.5 m and an operating pressure of 2,000 pounds per square inch (PSI).

Figure 3 The configuration of the 5,265 CUI Boltgun 1900LLXT/1500LL airgun array



3.2 Modelling methodology

The outputs of the Boltgun 1900LLXT/1500LL airgun array source modelling include:

- A set of "notional" signatures for each of the array elements; and
- The far-field signature of the array source, including its directivity/beam patterns.

3.2.1 Notional signature

The notional signatures are the pressure waveforms of individual source elements at a standard reference distance of 1 m.

Notional signatures ae modelled using the Gundalf Designer software package (2018). The Gundalf source model is developed based on the fundamental physics of the oscillation and radiation of source bubbles as described by Ziolkowski (1970), and for an array source case, taking into account non-linear pressure interactions between source elements (Ziolkowski et al., 1982; Dragoset, 1984; Parkes et al., 1984; Vaage et al., 1984; Laws et al., 1988 & 1990).

The model solves a complex set of differential equations combining both heat transfer and dynamics, and has been calibrated against multiple measurements of both non-interacting source elements and interacting clusters for all common source types at a wide range of deployment depths.

The model has the capability to predict noise spectra with frequency range up to tens of kHz. For frequencies above 1 kHz, the modelled spectra generally follow a close to *1/f* attenuation (Landrø et al, 2011). As the noise emissions from airgun array are predominantly below hundreds of Hz, the following result section only demonstrates modelling results within frequency range below 1 kHz.

3.2.2 Far-field signatures

The notional signatures from all airguns in the array are combined using appropriate phase delays in three dimensions to obtain the far-field source signature of the array. This procedure to combine the notional signatures to generate the far-field source signature is summarised as follows:

- The distances from each individual acoustic source to nominal far-field receiving location are calculated. A 9 km receiver set is used for the current study;
- The time delays between the individual acoustic sources and the receiving locations are calculated from these distances with reference to the speed of sound in water;
- The signal at each receiver location from each individual acoustic source is calculated with the appropriate time delay. These received signals are summed to obtain the overall array far-field signature for the direction of interest; and
- The far-field signature also accounts for ocean surface reflection effects by inclusion of the “surface ghost”. An additional ghost source is added for each acoustic source element using a sea surface reflection coefficient of -1.

3.2.3 Beam patterns

The beam patterns of the acoustic source array are obtained as follows:

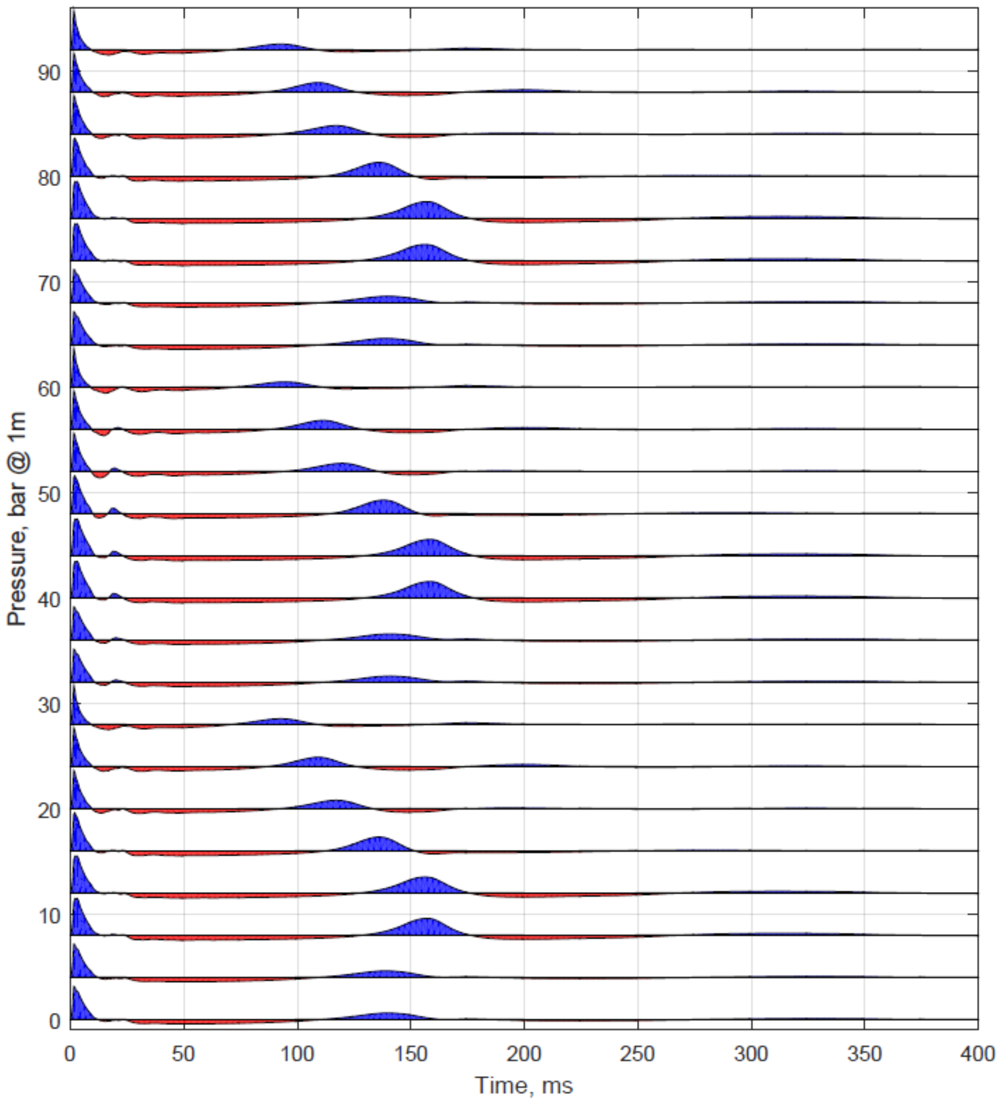
- The far-field signatures are calculated for all directions from the source using azimuthal and dip angle increments of 1-degree;
- The PSD (dB re 1 $\mu Pa^2 s/Hz$ @ 1m) for each pressure signature waveform is calculated using a Fourier transform technique; and
- The PSDs of all resulting signature waveforms are combined to form the frequency-dependent beam pattern for the array.

3.3 Modelling results

3.3.1 Notional signatures

Figure 4 shows the notional source signatures for the four airgun array elements.

Figure 4 Notional source signatures for the 5,265 CUI Boltgun 1900LLXT/1500LL airgun array

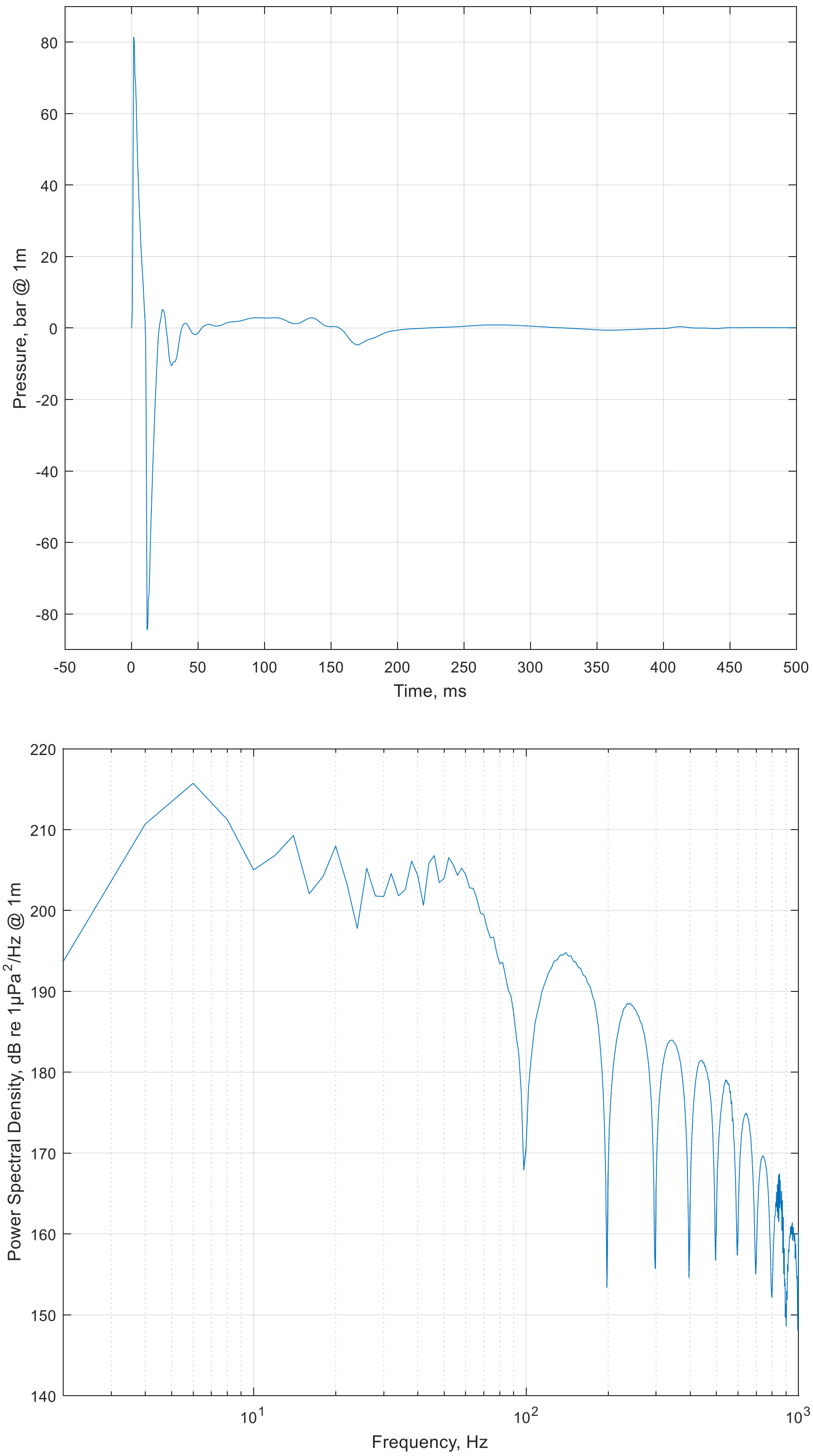


3.3.2 Far-field signature and its power spectral density

Figure 5 shows the far-field signature waveform and its power spectral density simulated by the Gundalf Designer software. The signatures are for the vertically downward direction with surface ghost included.

The source modelling result shows that the peak sound pressure level (Pk SPL) is 81.4 bar (258.5 dB re 1 µPa @ 1m), the peak to peak sound pressure level (Pk-Pk SPL) 166.0 (9.98/-8.79) bar (264.0 dB re 1 µPa) @ 1m, the root-mean-square sound pressure level (RMS SPL) 254.6dB re 1 µPa @ 1m with a 90%-energy pulse duration of 15 milliseconds, and the sound exposure level (SEL) 236.4dB re µPa^2·s @ 1m.

Figure 5 The far-field signature in vertically downward direction (top) and its power spectral density (bottom) for the 5,265 CUI Boltgun 1900LLXT/1500LL airgun array



3.3.3 Beam patterns

Array far-field beam patterns of the following three cross sections are presented in **Figure 6**:

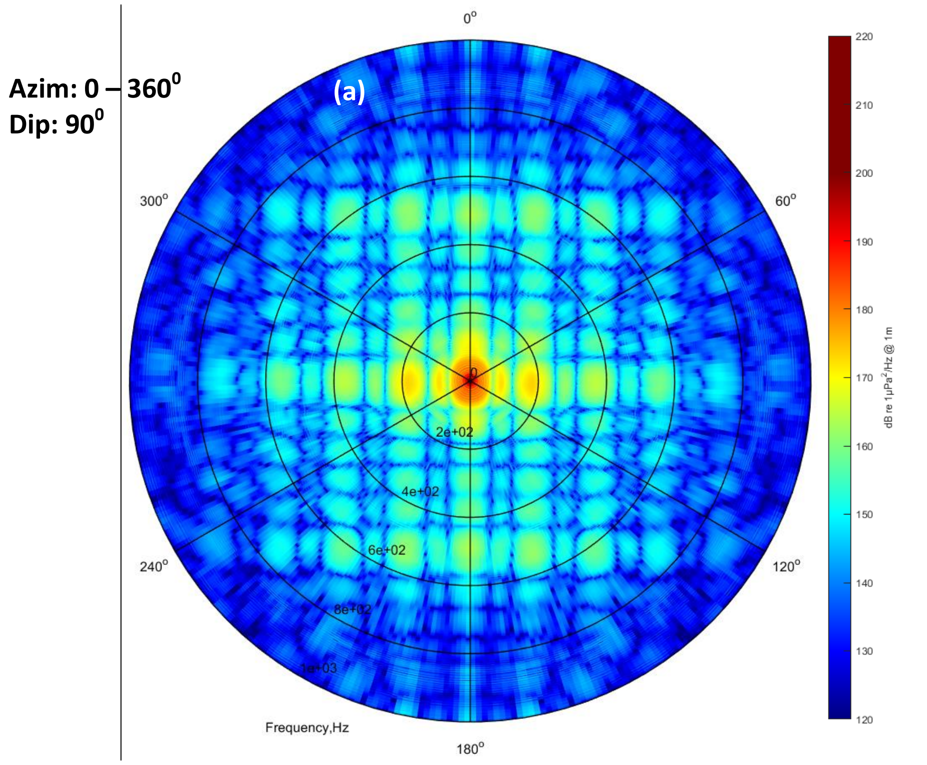
a) The horizontal plane (i.e. dip angle of 90 degrees) with azimuthal angle of 0 degree corresponding to the in-line direction;

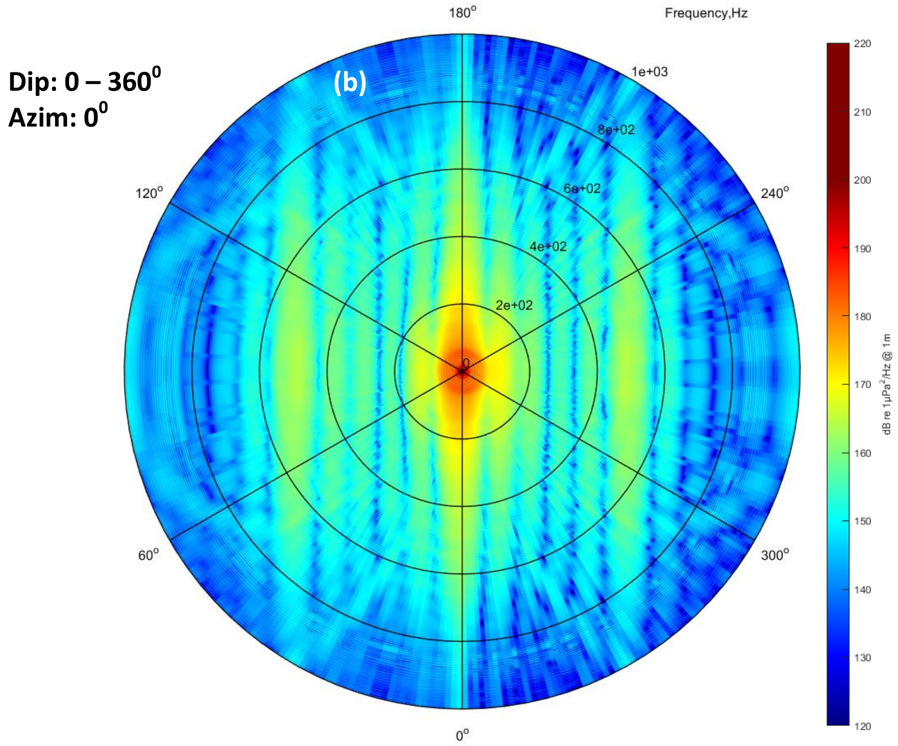
b) The vertical plane for the in-line direction (i.e. azimuthal angle of 0 degree) with dip angle of 0 degree corresponding to the vertically downward direction; and

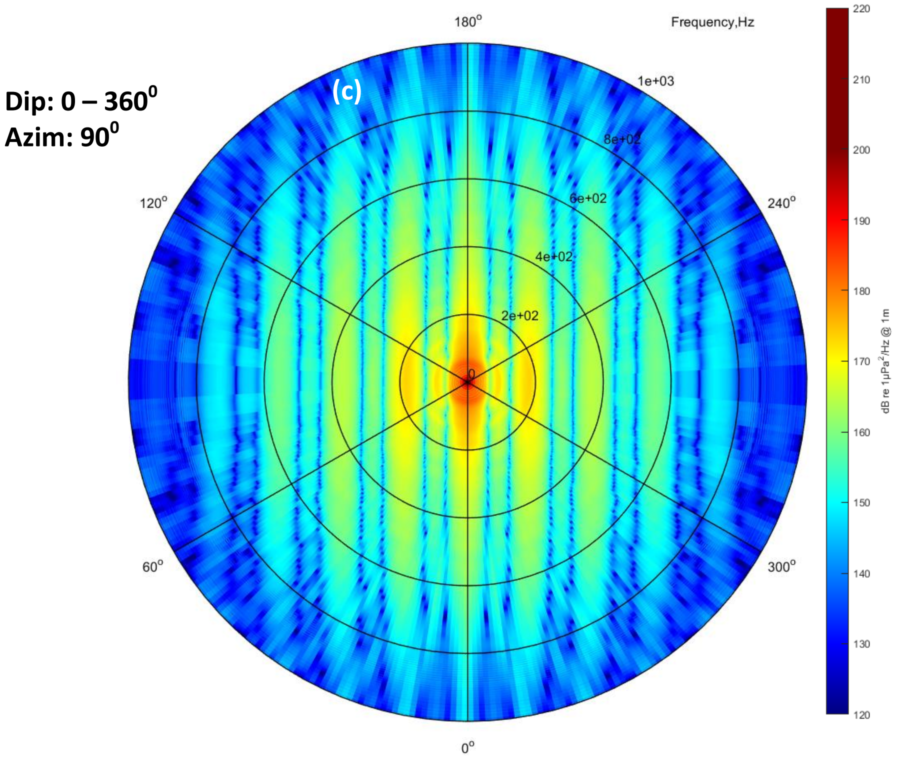
c) The vertical plane for the cross-line direction (i.e. azimuthal angle of 90 degrees) with dip angle of 0 degree corresponding to the vertically downward direction.

The beam patterns in **Figure 6** illustrate strong angle and frequency dependence of the energy radiation from the array. The beam pattern of the horizontal plane shows relatively stronger energy radiation in the cross-line direction than in the in-line direction. The beam patterns of the in-line and cross-line vertical planes have the strongest radiation in the vertical direction.

Figure 6 Array far-field beam patterns for the 5,265 CUI Boltgun 1900LLXT/1500LL airgun array, as a function of orientation and frequency. (a) - The horizontal plane with 0 degree corresponding to the in-line direction; (b) – The vertical plane for the in-line direction; (c) – The vertical plane for the cross-line direction. 0 degree dip angle corresponds to vertically downward direction




Dip: 0 – 360⁰
Azim: 0⁰
(b)
180°
Frequency,Hz
1e+03
8e+02
6e+02
4e+02
2e+02
0
120°
240°
60°
300°
0°
220
210
200
190
180
170
160
150
140
130
120
dB re 1μPa²/Hz @ 1m


Dip: 0 – 360⁰
Azim: 90⁰
(c)
180°
Frequency,Hz
1e+03
8e+02
6e+02
4e+02
2e+02
0
120°
240°
60°
300°
0°
220
210
200
190
180
170
160
150
140
130
120
dB re 1μPa²/Hz @ 1m

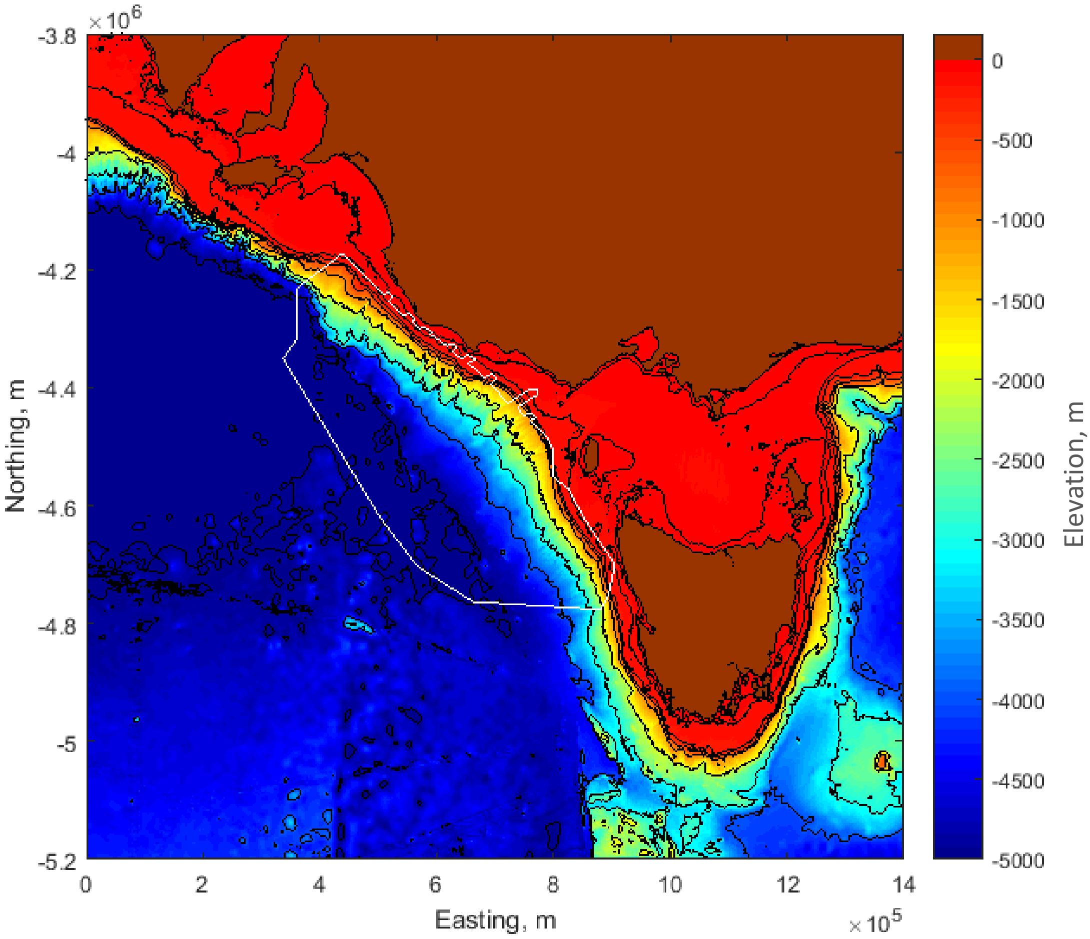
4 TRANSMISSION LOSS MODELLING

4.1 Modelling input parameters

4.1.1 Bathymetry

The bathymetry data used for the sound propagation modelling were obtained from the Australian Bathymetry and Topography Grid dataset with a resolution of 9 arc second (0.0025° or ~250m at the equator) (Whiteway, 2009). The bathymetric imagery within and surrounding the operational area of the proposed survey with a resolution of 250 m is presented in **Figure 7**.

Figure 7 The bathymetric imagery overlaying the survey operational area. The coordinate system is based on Lambert Conic Projection. White polygon shows the operational area of the proposed survey

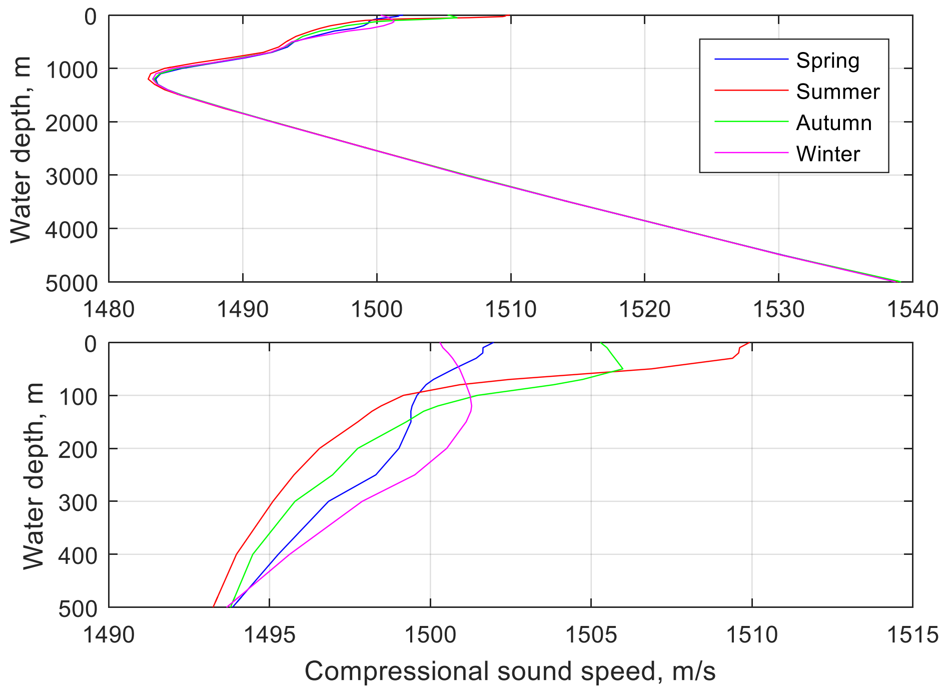


4.1.2 Sound speed profile

Temperature and salinity data required to derive the sound speed profiles were obtained from the World Ocean Atlas 2009 (WOA09) (Locarnini et al., 2010; Antonov et al., 2010). The hydrostatic pressure needed for calculation of the sound speed based on depth and latitude of each particular sample was obtained using Sanders and Fofonoff's formula (Sanders and Fofonoff, 1976). The sound speed profiles were derived based on Del Grosso's equation (Del Grosso, 1974).

Figure 8 presents the typical sound speed profiles for four Southern Hemisphere seasons within the Otway Basin. The figure demonstrates that the most significant distinctions for the profiles of four seasons occur within the mixed layer near the surface. The spring and summer seasons have downwardly refracting near-surface profiles, with the summer profile having the stronger downwardly refracting feature. Both the autumn and winter seasons exhibit a surface duct, with the profile in the winter season having a stronger and deeper surface duct than that in the autumn season. Due to the stronger surface duct within the profile, it is expected that the winter season will favour the propagation of sound from a near surface acoustic source array. In descending order, the autumn, spring and summer seasons are expected to have relatively weaker sound propagation for a near-surface acoustic source array.

Figure 8 Typical sound speed profiles within Otway Basin for different Southern Hemisphere seasons. Top panel shows profiles in deep water region, bottom panel shows profiles in the continental shelf area



4.1.3 Seafloor geoacoustic model

The majority of the western and southern continental shelves of Australia are composed of calcarenite which is a type of limestone (Duncan et al. 2009). The calcarenite seabed material has elastic wave speed slightly less than the sound speed in water, which leads to higher attenuation at low grazing angles, and is generally regarded as acoustically absorptive.

Duncan et al (2013) has proposed a detailed seafloor geoacoustic model consisting of calcarenite layers of various formations, based on a comprehensive study for the continental shelf area off Bass Strait and within Otway Basin. This geoacoustic model has been adopted for this modelling study.

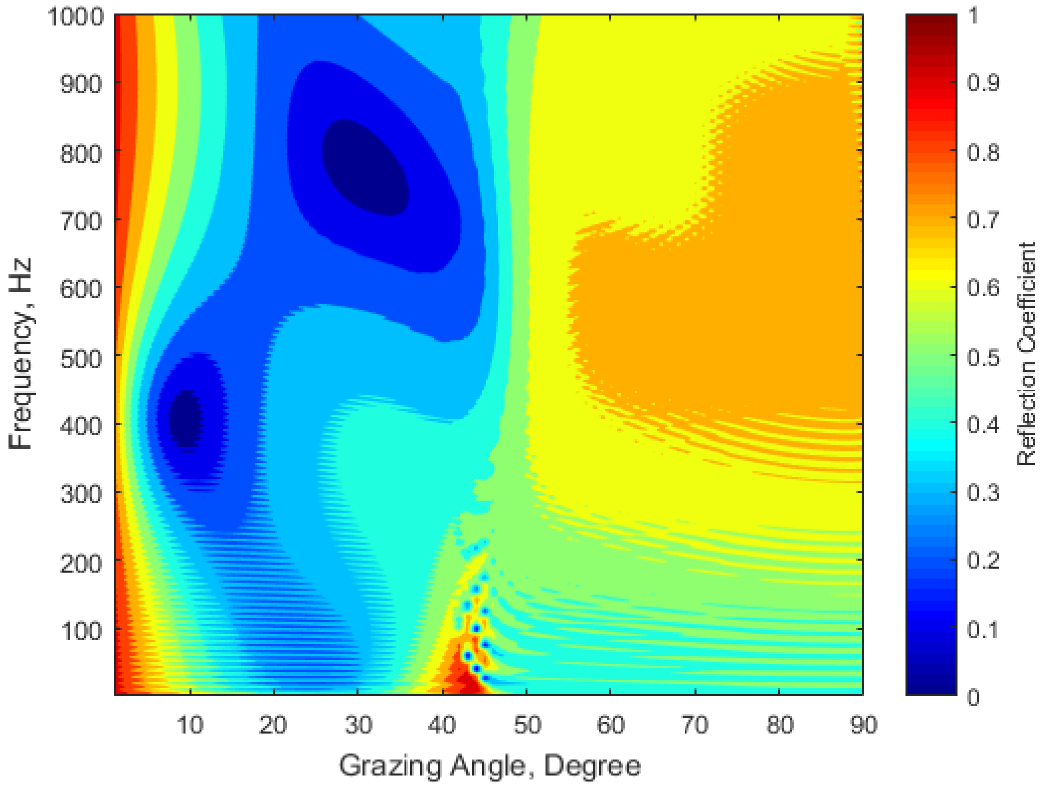
Table 8 presents geoacoustic parameters for the seafloor geoacoustic model as in Duncan et al (2013), and **Figure 9** shows the reflection coefficient variations with grazing angle and frequency for the proposed seafloor geoacoustic model, calculated using the plane-wave reflection coefficient program (Porter, 2007). As can be seen in the figure, the reflection coefficient demonstrates strong frequency dependence, with overall higher attenuation at lower grazing angles due to the elastic characteristics of the calcarenite layers. The thin cap rock (well-cemented calcarenite) layer leads to higher attenuation as the frequency increases, and essentially works as a low-pass filter at low frequencies (Duncan et al, 2013).

The elastic seafloor geoacoustic model as in **Table 8** can be approximated based on a fluid model for the low grazing angle range without consideration of the shear wave component, by compensating the significant attenuation at low grazing angles with higher compressional wave attenuations. Therefore, the equivalent fluid seafloor model can be applied only to far-field sound field modelling where the low grazing angle reflections are expected to dominate the sound propagation.

Table 8 Geoacoustic parameters for the proposed seafloor model (Duncan et al, 2013)

Seafloor Materials	Thickness, m	Density, ρ, (kg.m^{-3})	Compressional Wave		Shear Wave	
			Speed, c_p, (m.s^{-1})	attenuation, α_p, (dB/λ)	Speed, c_s, (m.s^{-1})	attenuation, α_s, (dB/λ)
Well-cemented calcarenite	1	2200	2600	0.2	1200	0.4
Slightly to semi-cemented sand/calcarenite	100	1900	2100	0.12	550	0.25
Semi-cemented sand/calcarenite	900	1900	2200	0.12	650	0.25
Basement (rock)	∞	2700	3800	0.1	1900	0.2

Figure 9 Reflection coefficient variations with grazing angle and frequency for the geo-acoustic model



4.2 Detailed modelling methodologies and procedures

The sub-sections below describe the modelling methodologies and procedures for predicting received SELs and noise levels in other relevant acoustic metrics (i.e. Peak SPLs, Peak-Peak SPLs and RMS SPLs) for a single shot from the 5,265 cubic inch (CUI) Boltgun 1900LLXT/1500LL array, as well as for the cumulative SELs within a 24-hour period for an assumed typical survey scenario.

4.2.1 Short range modelling

4.2.1.1 Modelling methodology and procedure

Short range modelling is proposed to model received SELs in relatively close proximity to the airgun source, with consideration of the near field effect of the sound field. As such, the predictions for the short range case are modelled by adding or reconstructing the received signal waveforms from individual airgun source units within the array.

The wavenumber integration modelling algorithm SCOOTER (Porter, 2010) is used to calculate the transfer functions (both amplitudes and phases) between sources and receivers. SCOOTER is a finite element code for computing acoustic fields in range-independent environments. The method is based on direct computation of the spectral integral, and is capable of dealing with an arbitrary layered seabed with both fluid and elastic characteristics.

The following procedures have been followed to calculate received SELs for short range cases:

1. The modelling algorithm SCOOTER is executed for frequencies from 1 Hz to 1 kHz, in 1 Hz increments. The source depth is taken to be the array depth of 7.5 m. A receiver grid of 1 m in range (maximum range 4.0 km) and 1 m in depth is applied for the selected receivers. For each gridded receiver, the received SEL is calculated by following steps 2) – 5);
2. The range from the source to each receiver is calculated, and the transfer function between the source and the receiver is obtained by interpolation of the results produced by modelling algorithm SCOOTER in Step 1). This interpolation involves both amplitude and phase of the signal waveform in frequency domain;
3. The complex frequency domain signal of the notional signature waveform for each source element is calculated via Fourier Transform, and multiplied by the corresponding transfer function from Step 2) to obtain the frequency domain representation of the received signal from the source element;
4. The waveform of received signal from the array source is reconstructed via Inverse Fourier Transform. The received signal waveforms from all airgun sources in the array are summed to obtain the overall received signal waveform; and
5. The signal waveform is squared and integrated over time to obtain the received SEL value. Alternatively, the SEL value can also be calculated via integration of the energy power density (ESD) over frequency in Step 3).

4.2.1.2 Modelling scenarios

The modelling inputs for the short range modelling case, such as sound speed profile and seabed geoacoustic models, has been detailed in **Section 4.1**. To analyse the received SEL variations with water depth changes, modelling has been undertaken for eight water depth input cases covering the depth ranges over the entire survey area (i.e. 50m, 100m, 200m, 400m, 800m, 1600m, 3200 and 4800m).

4.2.2 Long range modelling

4.2.2.1 Modelling methodology and procedure

The long range modelling generally involves complex and variable environmental factors (such as sound speed profiles and bathymetric variations) along an extended range of sound propagation environment, and requires an efficient modelling prediction algorithm with reasonable accuracy. Therefore, the modelling prediction for the long range case is carried out using the far-field source levels of octave frequency bands and their corresponding transmission loss calculations.

The fluid parabolic equation (PE) modelling algorithm RAMGeo (Collins, 1993) is used to calculate the transmission loss between the source and the receiver. RAMGeo is an efficient and reliable PE algorithm for solving range-dependent acoustic problems with fluid seabed geo-acoustic properties.

The received sound exposure levels are calculated following the procedure as below:

1) One-third octave source levels for each azimuth to be considered are obtained by integrating the horizontal plan source spectrum over each frequency band, these levels are then corrected to SELs;

2) Transmission loss is calculated using RAMGeo at one-third octave band central frequencies from 8 Hz to 1 kHz, with a maximum range of 200 km and at 5 degree azimuth increments. The bathymetry variation along each modelling track is obtained via interpolation from the bathymetry dataset;

3) The one-third octave source SEL levels and transmission loss are combined to obtained the received SEL levels as a function of range, depth and frequency;

4) The overall received SEL levels are calculated by summing all frequency band SEL levels.

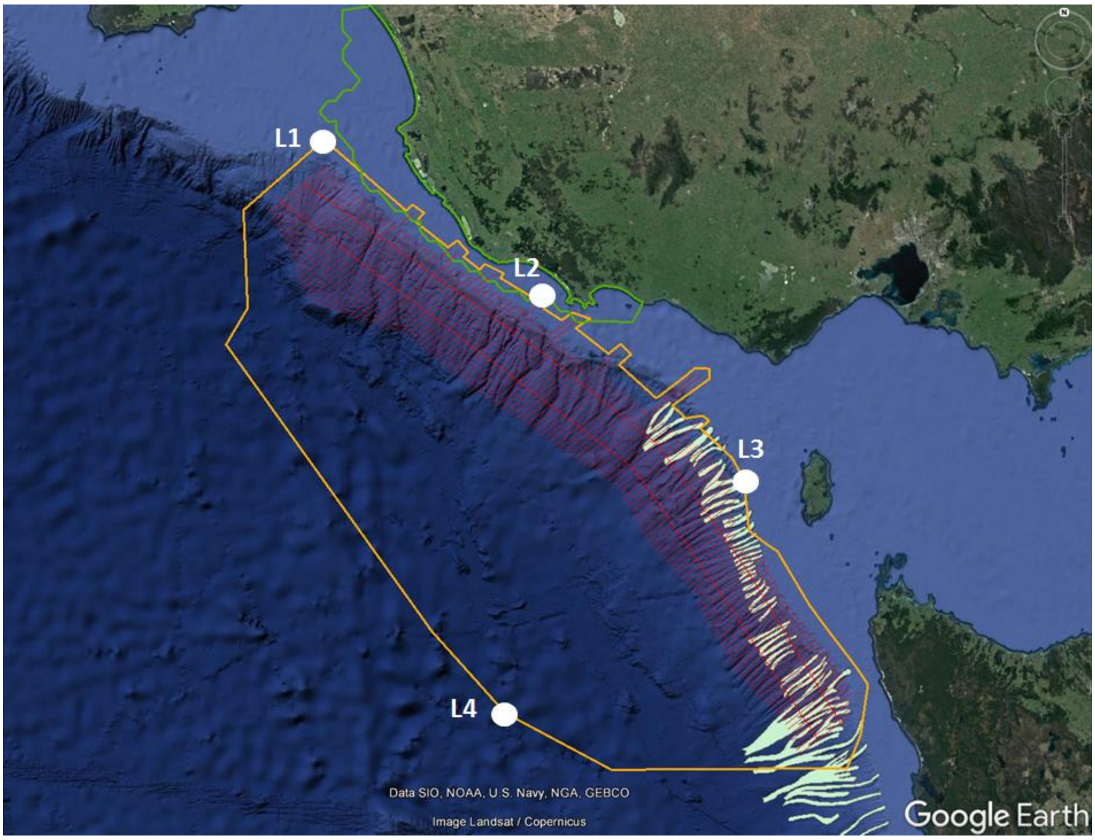
4.2.2.2 Modelling scenarios

Four long range modelling scenarios are proposed for the 5,265 cubic inch (CUI) Boltgun 1900LLXT/1500LL array. The source locations as in **Table 9** and shown in **Figure 10** are selected for the long range modelling.

Table 9 Details of the selected single source location for the long range modelling

Source Location	Water Depth, m	Coordinates [Easting, Northing]	Locality
L1	76	[4.3849 x 10^5, - 4.1726 x 10^6]	Northernmost point of the Operational Area, adjacent to Bonney Coast Upwelling marine sensitive area
L2	80	[6.2864 x 10^5, -4.32651x 10^6]	Northeast point of the Operational Area, close to shore and within Bonney Coast Upwelling marine sensitive area
L3	132	[7.9872x 10^5, -4.50469 x 10^6]	East point of the Operational Area, adjacent to West Tasmania Canyons and exposed to Bass Strait
L4	5,295	[5.6758 x 10^5, -4.7036 x 10^6]	Southwest point of the Operational Area, deep water region

Figure 10 The selected four long range modelling source locations (L1 – L4). Brown polygon indicates the survey operational area, red polygons the proposed survey lines, green polygon the Bonney Coast Upwelling marine sensitive area and grey areas the West Tasmania Canyon sensitive areas



4.2.3 Cumulative SEL modelling

4.2.3.1 Modelling methodology and procedure

The cumulative SEL accounts for the total acoustic energy received from all seismic impulses within a specific period of exposure (i.e. 24 hours). There will be thousands of survey shots during a typical survey operation within a 24-hour period, and, it is not practical to perform sound modelling for every survey shot in an efficient manner. However, the propagation environments for a set of consecutive survey shots are similar, and therefore one propagation modelling could to be performed as representative for the set group. The sound field for the representative survey shot then could be adjusted for the rest of the survey shots within the set group accounting for their source positions.

The cumulative SELs (unweighted and weighted) are modelled based on the proposed steps as below:

1. The received SELs at individual grid locations (a 50-m grid size for this study) from individual representative survey shot considered (one in every ten shots for this study) is modelled based on the long range modelling methodology and procedure as detailed in Section **4.2.2.1**, and then the results are adjusted for the rest of survey shots based on their shot locations;
2. The SEL_{24hr} at individual receiving grid locations are obtained by summing SEL contribution from all survey shots within a 24-hour period for the typical survey operation scenario considered;

3. For weighted SEL_{24hr} for individual marine mammal hearing groups, the source spectra are adjusted accounting for the frequency weighting functions for individual hearing groups (as in **Table 1**), and the weighted SEL_{24} for individual hearing groups to be obtained by repeating the first two steps as above;
4. For high frequency energy component which is important for marine mammals with high frequency hearing range, the source spectra and propagation modelling are extended up to 10 kHz, with the source spectra having $1/f$ attenuation for frequencies above 1 kHz (Landrø et al, 2011), so that the high frequency energy component to be included for the weighted SEL_{24} predictions.

4.2.3.2 Modelling scenario

It has been advised that the proposed survey has the following survey schedule:

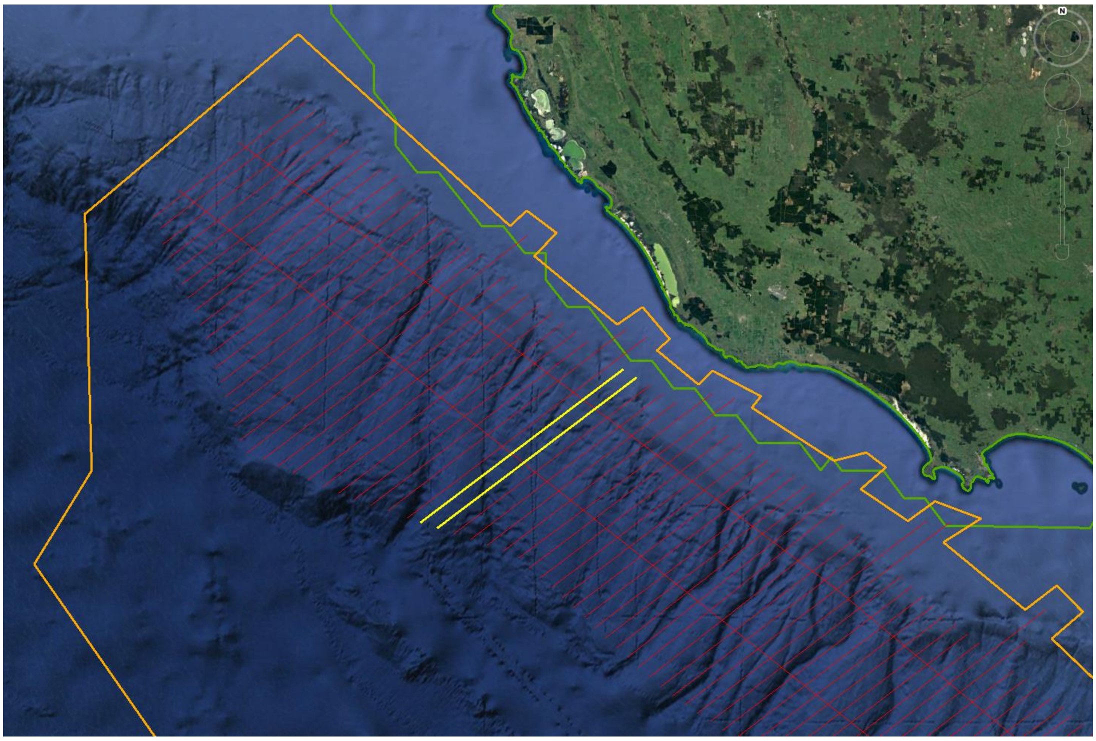
- Minimum survey shot interval along the survey lines of 9.75 seconds (25 m spacing with vessel speed of 5.0 knots);
- Maximum number of shots per day 6,640;
- Average survey line lengths around 91 km and two lines to be acquired within 24 hours.

Based on the above survey schedule, two survey lines as displayed in **Figure 11** are selected as a representative survey scenario within a 24-hour period, considering their representative water depth coverage and the line lengths. More details for the two survey lines are listed in **Table 10**.

Table 10 Details of the selected single source location for the long range modelling

Survey Line	North point coordinates [Easting, Northing]	Length, km	Locality
North	[5.4554 x 10^5, - 4.2939 x 10^6]	89.5	Northern section of the survey, adjacent to Bonney Coast Upwelling marine sensitive area
South	[5.4996 x 10^5, - 4.2970 x 10^6]	86.5	

Figure 11 The selected two survey lines (yellow polygons) representing a typical 24-hour survey scenario



4.2.4 Pk SPLs, Pk-Pk SPLs and RMS SPLs – estimate methodology from modelled SELs

For received individual signals emitted from impulsive sources such as seismic airguns, the differences between the SEL and other sound parameters, such as the Pk SPL/Pk-Pk SPL/RMS SPL, are expected to be greatest at the source location, and then gradually decrease with receiving locations further away from the source location. This is due to the following effects:

- Theoretically, the airgun pulse goes through increasing waveguide distortion effects (e.g. dispersion, interference effects, seafloor and surface reflections, differences of time arrivals, etc.) with increasing range from the source, which impact predominantly on temporal characteristics of the pulse (e.g. lower peak/peak-peak level, extended pulse duration, etc.) rather than the energy based metric levels.
- The above statement is reliably supported by numerous theoretical and empirical research studies, e.g. the relevant seismic survey signal modelling and measurement studies (e.g. Austin et al, 2013, Matthews and MacGillivray, 2013, Galindo-Romero et al, 2015, McCauley et al, 2000 & 2016) show that the differences between the three temporal parameters (i.e. Pk SPL, Pk-Pk SPL and RMS SPL) and SEL are increasingly larger at the receiver closer to the source location.

SEL and Pk SPL/ Pk-Pk SPL

As presented in **Section 3.3.2**, the differences between the Pk SPL/Pk-Pk and SEL of the far-field signature of the 5,265 cubic inch (CUI) Boltgun 1900LLXT/1500LL array (at a reference distance of 1 m from the centre of the array) are 22.1 dB and 29.6 dB respectively. These values are taken as the conversion factors applied to the SELs for calculating the received Pk SPLs and Pk-Pk SPLs over the receiving range close to the source location. This approach is regarded as conservative for estimating relevant near-field acoustic parameters based on SEL predictions.

SEL and RMS SPL

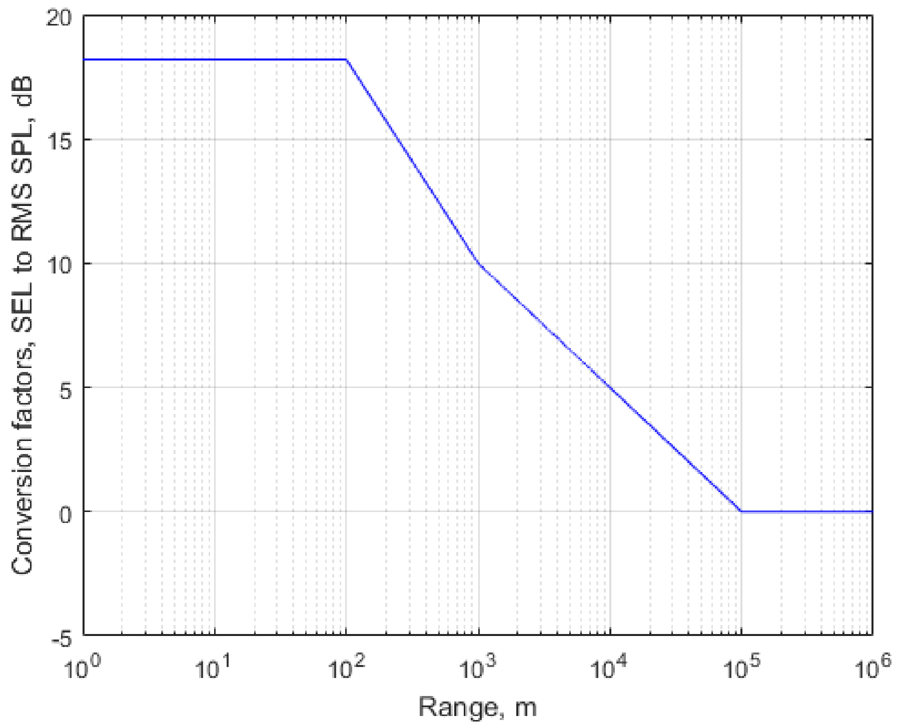
Previous empirical studies demonstrate that at relatively close distances from the airgun sources (within 1.0 km), the difference between SELs and RMS SPLs could be between 10 dB to 15 dB (Austin et al, 2013, McCauley et al, 2000,). The differences could drop to under 5 dB when the distances are close to 10 km (Austin et al, 2013). The differences are expected to drop further with the increasing distances beyond 10 km (Simon et al, 2018).

For this project, the RMS SPLs were estimated using the following conversion factors to be applied to the modelled SELs within different distance ranges. These conversion factors are conservatively estimated based on the source array modelling results and above previous measurement results:

- 0 – 100m, a conversion factor of 18.2 dB. This is the difference between RMS SPL and SEL of the far-field signature of the 5,265 cubic inch (CUI) Boltgun 1900LLXT/1500LL array as modelled in **Section 3.3.2**.
- 100 – 1,000m, conversion factors 18.2 dB to 10 dB, following a logarithmic trend with distance;
- 1,000 – 10,000m, conversion factors 10 dB to 5 dB, following a logarithmic trend with distance;
- 10,000 – 100,000m, conversion factors 5 dB to 0 dB, following a logarithmic trend with distance;
- > 100,000m, a conversion factor of 0 dB.

The SEL to RMS SPL conversion factors as a function of horizontal ranges from source array are demonstrated in **Figure 12** as below.

Figure 12 SEL to RMS SPL conversion factors as a function of horizontal ranges from source array



4.3 Model validation

The accuracy of an airgun array sound field modelling depends on the suitability and accuracy of the airgun array source model and the transmission loss model, as well as the realism of the parameters defining the sound propagation environment, including the bathymetry, seafloor geo-acoustics and sound speed profiles (DOC, 2016).

The following model validation exercises have been undertaken previously in regards to the airgun array source model, short range model and long range model that have been used in this modelling study:

- The source modelling software Gundalf has been calibrated against various datasets of near-field recorded signatures, and has been verified against other airgun array source signature models (Ainslie et al, 2016);
- The short range model and long range model have been validated from a few underwater acoustic measurement programs undertaken by independent third parties, with good agreements between modelled and measured results being reported (e.g. Simon et al (2018) and Allan, T. (personal communication, 2018)).

5 MODELLING RESULTS

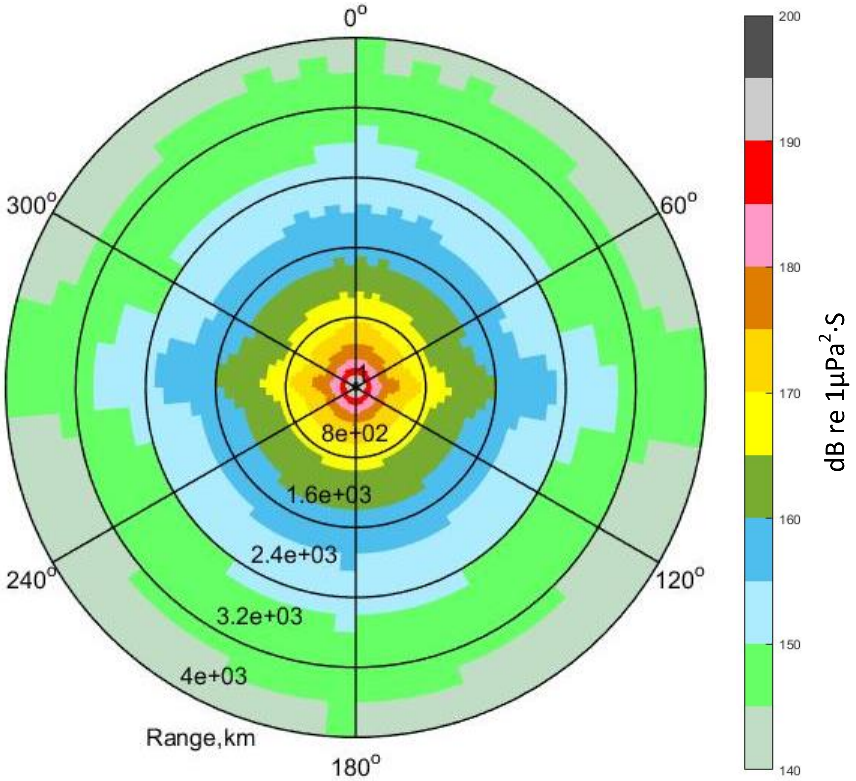
This report section presents the modelling results in regards to the three STLM components, i.e. short range modelling, long range modelling and cumulative noise exposure modelling.

5.1 Short range modelling

The received SELs from the 5,265 CUI Boltgun 1900LLXT/1500LL array have been modelled for eight water depth cases (i.e. 50m, 100m, 200m 400m, 800m, 1600m, 3200m, and 4800m).

Taking the 100-m water depth case as an example, **Figure 13** shows the maximum received SELs across the water column for a single survey shot as a function of azimuth (0 – 360°) and near-field horizontal range (0 – 4km) from the centre of the array for the water depth of 100m. The figure illustrates slightly higher SELs at certain directions, particularly along the cross-line directions, as a result of the directivity of the source array.

Figure 13 The predicted maximum SELs across the water column as a function of azimuth and horizontal range from the centre of the array. 0 degree azimuth corresponds to the in-line direction. The modelling scenario is for the 5,265 CUI Boltgun 1900LLXT/1500LL array at the survey location with a water depth of 100m



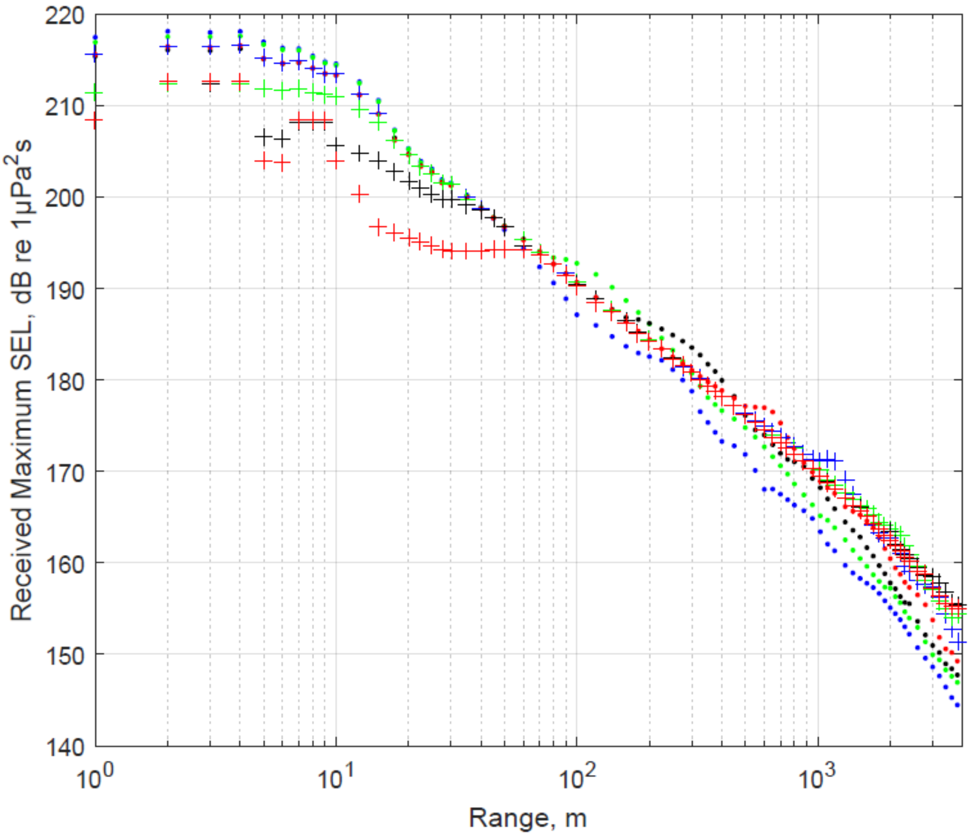
The scatter plot of the predicted maximum SELs across the water column for all azimuths as a function of horizontal range (0 – 4 km) from the source array are displayed in **Figure 14** for all eight water depth cases.

It is noted from the figure:

- At horizontal distances very close to the array centre (<60m), the maximum received SELs decrease with increasing water depths. This is due to the weaker acoustic energy reflection from the seabed when water depths are higher.

- At horizontal distances further away from the array centre, lower maximum received SELs are predicted for shallower water depths. This is due to the fact that for a relatively far-field sound propagation, the interaction between sound and seafloor increases as the water depth decreases, particularly with the presence of downward refraction sound speed profiles and acoustically absorptive limestone seabed as demonstrated in **Section 4.1.2** and **Section 4.1.3** respectively.

Figure 14 The predicted maximum SELs across the water column for all azimuths as a function of range (0 – 4 km) from the source locations with water depths of 50m (blue '.'), 100m (green '.'), 200m (black '.'), 400m (red '.'), 800m (blue '+'), 1600m (green '+'), 3200m (black '+') and 4800m (red '+')



5.2 Long range modelling

Figure 15 to **Figure 18** show the contour images of the predicted maximum SELs received at locations up to 200 km from the four long range source locations L1 to L4 respectively, overlaying the local bathymetry contours.

As can be seen from the four figures, the received noise levels at far-field locations vary at different angles and distances from the source locations. This directivity of received levels is due to a combination of the directivity of the source array, and propagation effects caused by bathymetry and sound speed profile variations.

For the source locations L1 – L3 with relatively shallower water depths, the sound fields are predicted to experience strong acoustic attenuation along shallow water environment, particularly for the upslope bathymetry profile, as shown in the top panel in **Figure 19**, which causes strong interaction between the sound signal and seabed. The sound fields towards deep water region as shown in the bottom panel in **Figure 19**, however, are predicted to experience much less attenuation due to the presence of the surface duct within the speed profile which traps much of the acoustic energy (more than the deep water SOFAR channel in this case).

For the source location L4 within the deep water region, the sound field demonstrates a strong convergence-zone propagation feature, as shown in the maximum SEL horizontal contours in **Figure 18** and one vertical sound field transect in **Figure 20**. The convergence-zone propagation occurs because the sound emitted from the near-surface source forms a downward-directed beam, and after following a deep refracted path in the ocean, reappears near the surface to create a zone of high sound intensity (convergence or focusing) at a distance of tens of kilometres from the source (Jensen et al, 2011). The convergence is repetitive in range, and the convergence zone range (i.e. between high intensity regions) for this case is approximately 6km.

Figure 15 Modelled maximum SEL (maximum level across water column) contour for source location L1 to a maximum range of 200km, overlaying with bathymetry contour lines

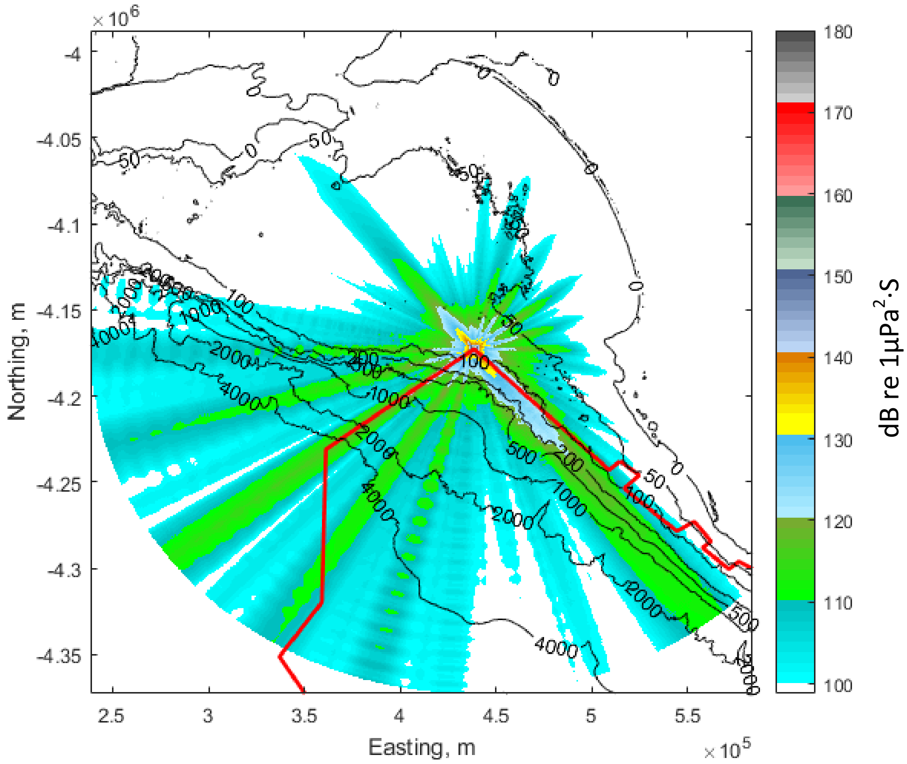


Figure 16 Modelled maximum SEL (maximum level across water column) contour for source location L2 to a maximum range of 200km, overlaying with bathymetry contour lines

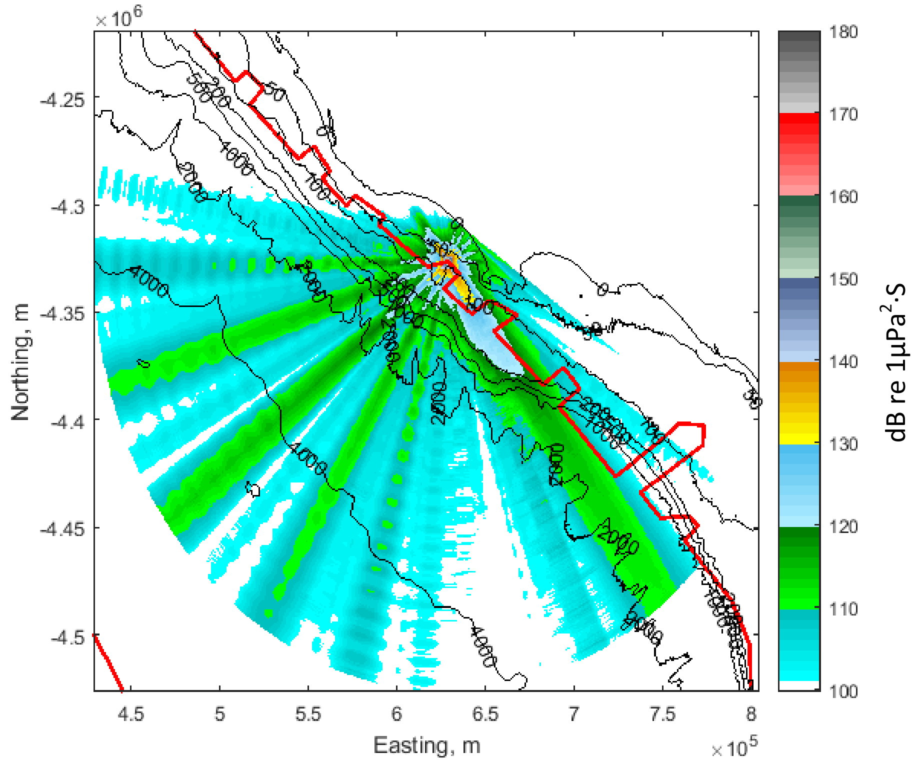


Figure 17 Modelled maximum SEL (maximum level across water column) contour for source location L3 to a maximum range of 200km, overlaying with bathymetry contour lines

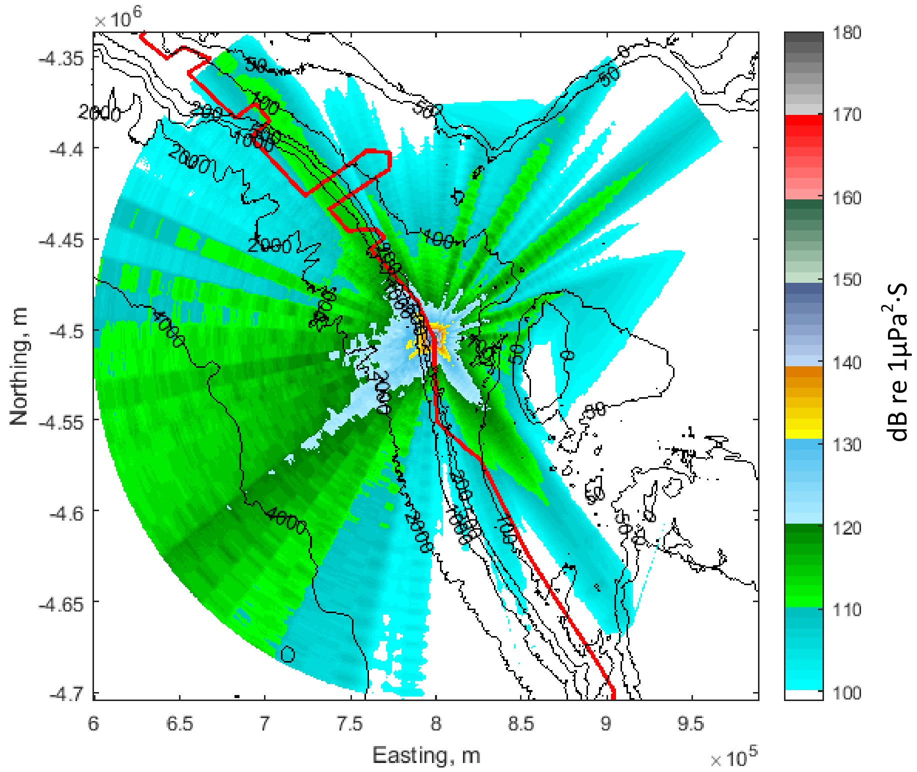


Figure 18 Modelled maximum SEL (maximum level across water column) contour for source location L4 to a maximum range of 200km, overlaying with bathymetry contour lines

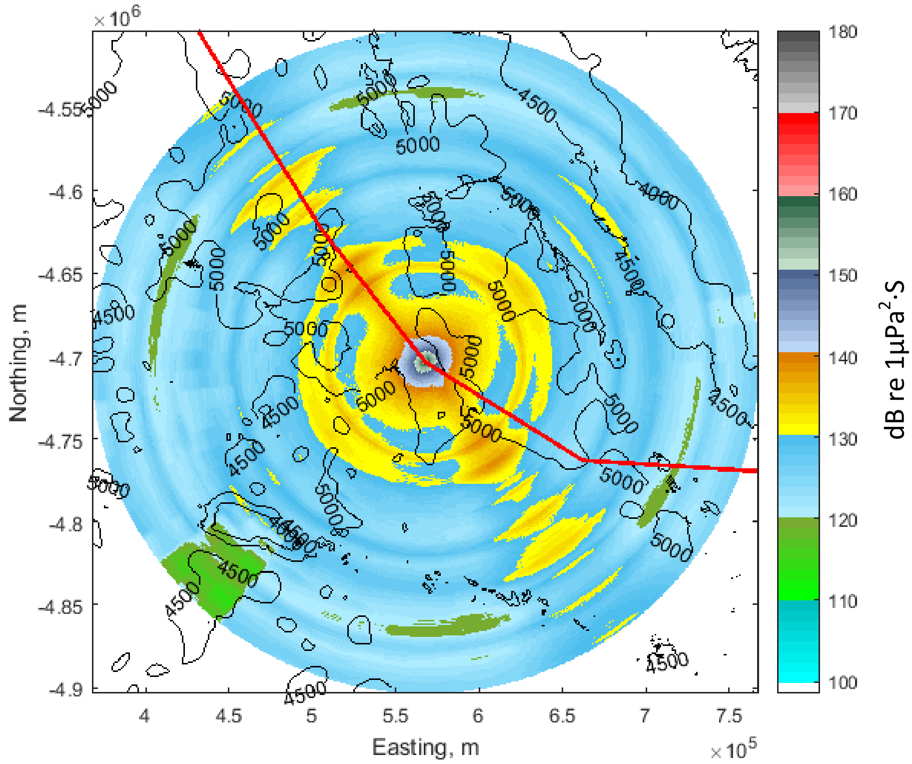


Figure 19 Modelled SELs vs range and depth along the propagation path towards shallower water (top) and towards deeper water (bottom) from the source location L1. Black line shows the seabed depth

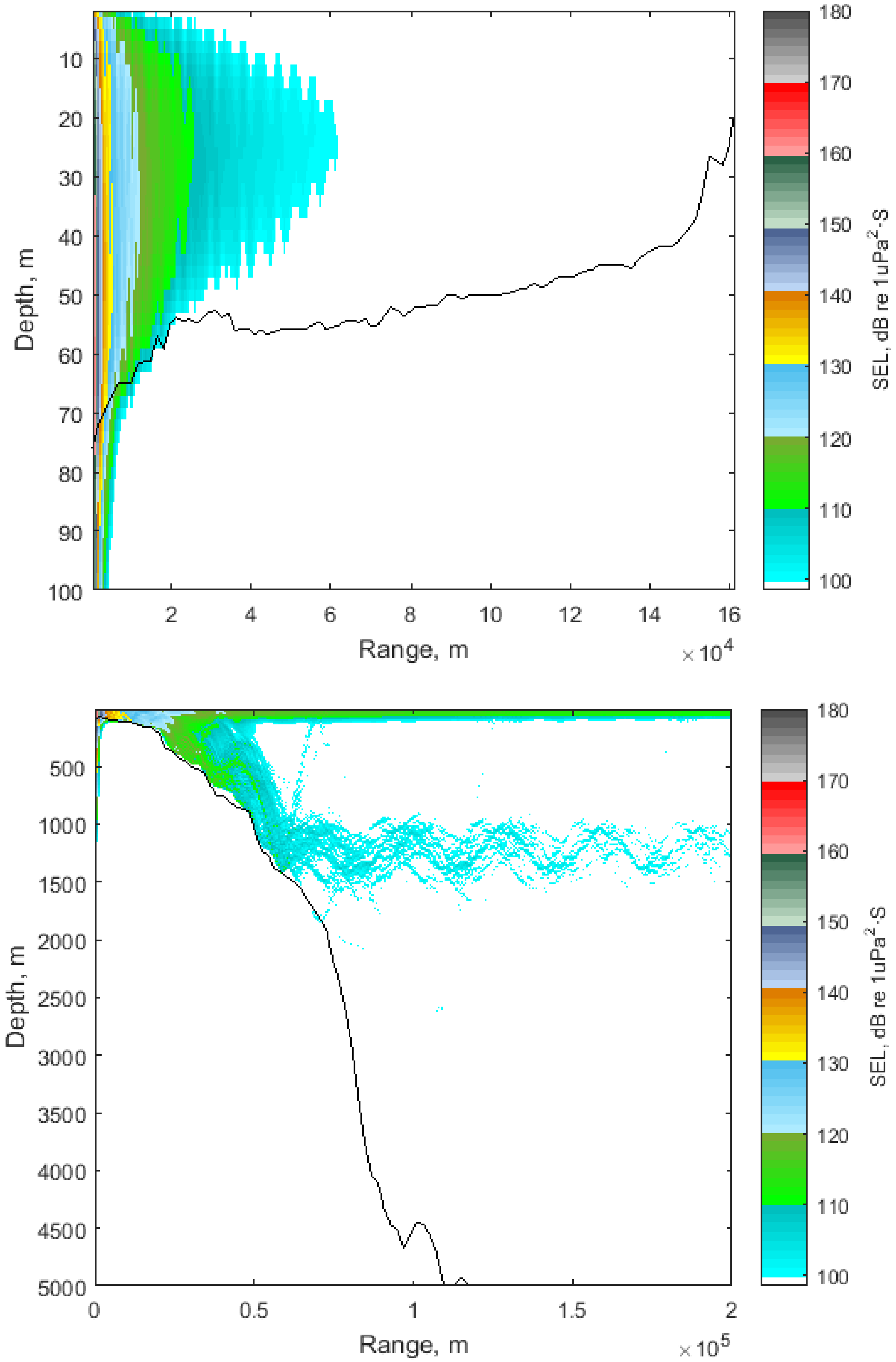
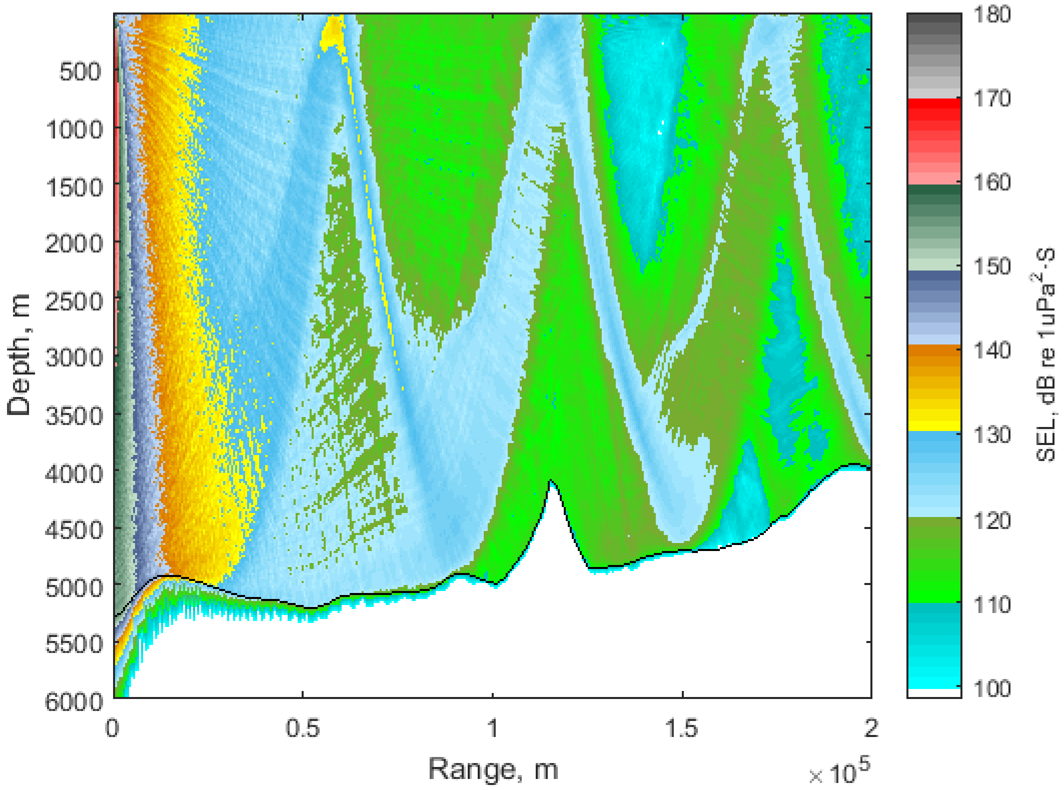


Figure 20 Modelled SELs vs range and depth along the propagation path towards east direction from the source location L4. Black line shows the seabed depth variation



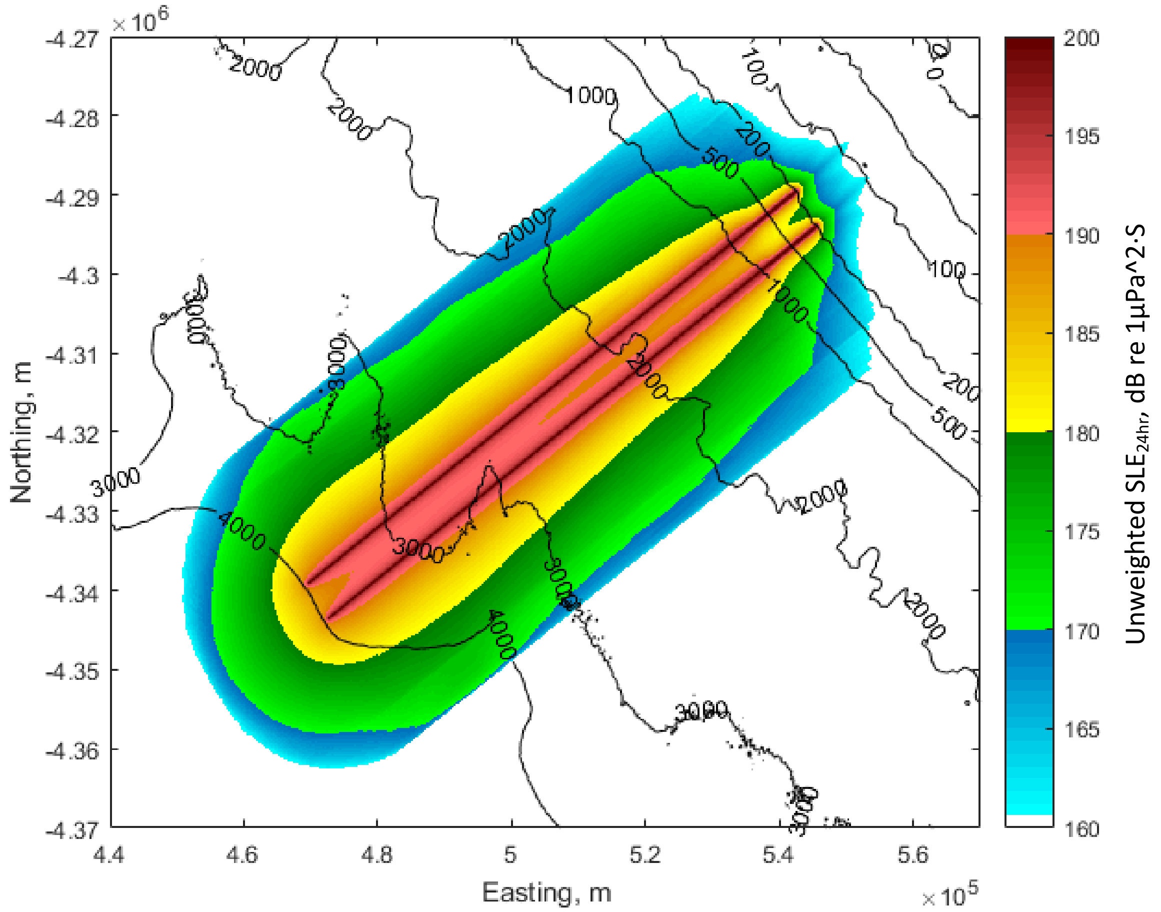
5.3 Cumulative SEL modelling

As presented from the short range modelling results in **Section 5.1**, sound exposure level from a survey shot at a distance of 1.0 km is up to 30 dB lower than a survey shot at a close distance of 25 m from the receiving location. However, with the receiving location perpendicularly further away from the survey lines, the distance differences between survey shots become smaller, and the sound exposure contributions from adjacent multiple shots along the survey lines become more significant compared with the survey shots closer to the survey lines. Based on this consideration, cumulative modelling is carried out for a modelling area within a 20-km zone around the survey lines and with a 50-m grid size.

The cumulative SEL modelling has been carried out for a typical 24-hour survey operation scenario as described in **Section 4.2.3.2**, based on the modelling methodology and procedure as laid out in **Section 4.2.3.1**, for unweighted SEL_{24} case and weighted SEL_{24} cases with frequency weighting functions of different marine mammal hearing groups applied.

The modelled unweighted SEL_{24hr} contour map for the typical survey operation scenario within a 24-hour period is presented in **Figure 21**. As can be seen from the figure, the contours change in line with water depth variations, and the exposure levels between the survey lines are higher due to the high contributions from survey shots along both survey lines.

Figure 21 The predicted maximum unweighted SEL_{24hr} across the water column for a typical survey scenario



5.4 Zones of impact

Based on the noise modelling prediction results presented above, the zones of impact (i.e. maximum horizontal threshold distance) for marine fauna species of interest are summarized in the following sub sections below.

5.4.1 Zones of impact – immediate exposure from single pulses

The table below outlines the predicted maximum SELs and the estimated Pk SPLs, Pk SPLs, Pk-SPLs and RMS SPL across the water column for all azimuths as a function of horizontal distance from the source array for two water depth cases (50m and 4,800m) as examples, based on the short range SEL modelling results as in **Section 5.1** and relevant estimate approach as in **Section 4.2.4**.

Table 11 The maximum SELs, Pk SPLs, Pk-Pk SPLs and RMS SPL across the water column for all azimuths as a function of distance from the source array for two water depth cases (50m and 4,800m)

Horizontal distance from the source array, m	The predicted maximum levels across the water column for all azimuths - 50m and 4,800m water depth cases							
	SEL, dB re 1 μPa^2·s		Pk SPL, dB re 1μPa		Pk-Pk SPL, dB re 1μPa		RMS SPL, dB re 1μPa	
	50m	4,800m	50m	4,800m	50m	4,800m	50m	4,800m
5	217	212	239	234	247	242	235	230
10	215	204	237	226	245	234	233	222
20	205	196	227	218	235	226	223	214
50	197	194	219	217	227	224	215	212
80	191	193	213	215	221	223	209	211
100	187	190	209	212	217	220	205	208
200	183	184	205	206	213	214	199	200
500	172	176	194	198	202	206	185	189
800	166	172	188	194	196	202	177	183
1,000	164	170	186	192	194	200	174	180
2,000	155	163	177	185	185	193	164	172
4,000	145	155	167	177	175	185	152	162

The zones of impact based on per-pulse SEL, Pk SPL, Pk-Pk SPL and RMS SPL metrics are estimated and presented in **Table 12** for PTS and TTS effects for marine mammals, **Table 13** for fish, turtles, fish eggs and fish larvae, **Table 14** for behavioural disturbance for marine mammals, turtles and squid, **Table 15** for plankton, and **Table 16** for scallops and rock lobsters.

As a result of the modelled level variations under different water depth cases as described in **Section 5.1**, the zones are estimated as a range in horizontal distance from the source array. The upper ranges of the impact zones are generally from the deepest water depth case (i.e. 4.800m) when the zones are larger than 60m from the source array. For the zones closer to the source array, the upper ranges of the zones are from the shallowest water depth case (i.e. 50m).

Marine mammal physiological effects

Due to the high level of impulsive signal emissions from the array source, marine mammals are predicted to experience a permanent auditory threshold shift (PTS) at close proximity to the source array due to the immediate exposure to individual pulses. Based on zones of impact estimated Pk-SPL metric criteria as in **Table 12**, marine mammals of all hearing groups except high-frequency cetaceans are predicted to experience PTS effect within approximately 50m from the source array at all assessed water depth scenarios. The zones of PTS effect for high frequency cetaceans are predicted to range 275m from the array source at shallow water depth of 50m and up to 400m at deeper water depth scenarios.

The zones of a temporary auditory threshold shift (TTS) due to a single pulse exposure for marine mammals of all hearing groups except high-frequency cetaceans are predicted to be within approximately 150m from the source array at all assessed water depth scenarios. The zones of TTS effect for high frequency cetaceans are predicted to range 380m to 760m from the array source for all water depth scenarios assessed.

The zones of behavioural disturbance for marine mammals of all hearing groups caused by the immediate exposure to individual pulses are predicted to be 2.5km – 4.5km from the array source, as presented in **Table 14**, for all eight water depth scenarios considered.

Table 12 Zones of immediate impact from single pulses for PTS and TTS – marine mammals

Marine mammal hearing group	Zones of impact – maximum horizontal distances from source to impact threshold levels			
	Injury (PTS) onset		TTS onset	
	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m
Low-frequency (LF) cetaceans	219	45 - 50	213	80 - 130
Mid-frequency (MF) cetaceans	230	8 - 16	224	12 - 27
High-frequency (HF) cetaceans	202	275 - 400	196	380 - 760
Phocid Pinnipeds (PW) (Underwater)	218	12 - 55	212	80 - 140
Otariid Pinnipeds (OW) (Underwater)	232	8 - 12	226	10 - 22

Fish, turtles, fish eggs and fish larvae physiological effects

As presented in **Table 14**, the zones of potential injuries for fish species with swim bladder, turtles and fish eggs and fish larvae are predicted to range 380m to 760m from the array source for all water depth scenarios assessed. However, fish species without swim bladders have higher injury impact thresholds, and therefore smaller zones of potential injuries within 130m from the array source for all water depth scenarios assessed.

Table 13 Zones of immediate impact from single pulses for mortality and recovery injury– fish, turtles, fish eggs and fish larvae

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels			
	Mortality and potential mortal injury		Recovery injury	
	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m
Fish: no swim bladder (particle motion detection)	> 213	75 - 130	>213	75 - 130
Fish: swim bladder is not involved in hearing (particle motion detection)	>207	130 - 250	>207	130 - 250
Fish: swim bladder involved in hearing (primarily pressure detection)	>207	130 - 250	>207	130 - 250
Sea turtles	>207	130 - 250	-	-
Fish eggs and fish larvae	>207	130 - 250	-	-

Note: a dash indicates the threshold is not applicable.

Marine mammal, turtle and squid behavioral responses

The zones of behavioural disturbance for marine mammals, turtles and squid caused by the immediate exposure to individual pulses are presented in **Table 14**, across the range of all eight water depth scenarios considered.

Table 14 Zones of immediate impact from single pulses for behavioural disturbance – marine mammals, turtles and squid

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels	
	Behavioural disturbance	
	Criteria - RMS SPL, dB re 1µPa	Maximum threshold distance, m
Marine mammals	160	2,500 – 4,500
Turtles	166	1,700 – 3,000
Squid	156	3,200 – 5,800

Plankton physiological effects

As presented in **Table 15**, based on Pk SPL impact criteria for fish eggs and fish larvae (Popper et al, 2014), the zones of mortality and potential mortal injury for plankton caused by the immediate exposure to individual pulses are predicted to be within 250m from the array source for all water depth scenarios considered. However, if estimated based on the reported impact threshold of pk-pk SPL 178 dB re 1 µPa from the recent research by McCauley et al (2017), the impact zones are predicted to extend to the range of 2.7km – 4.5km for all water depth scenarios considered.

Table 15 Zones of immediate impact from single pulses for mortality and potential mortal injury– Plankton

Plankton	Zones of impact – maximum horizontal distances from source to impact threshold levels	
	Mortality and potential mortal injury	
	Criteria - Pk SPL/Pk-Pk dB re 1µPa	Maximum threshold distance, m
Based on fish eggs and fish larvae (Popper et al, 2014)	Pk SPL: >207 dB re 1 µPa	130 - 250
Based on recent research by McCauley et al (2017)	Pk-Pk SPL: 178 dB re 1 µPa	2,700 – 4,500

Scallops and rock lobsters zones of potential impact

The zones of potential impact for scallops and rock lobsters caused by the immediate exposure to individual pulses are predicted to be 120m - 220m from the array source based on per-pulse SEL metric criteria, and 240m – 360m based on Pk-Pk SPL metric criteria respectively for all water depth scenarios considered.

Table 16 Zones of potential immediate impact from single pulses – scallops and rock lobsters

Scallop and rock lobster	Zones of impact – maximum horizontal distances from source to impact threshold levels	
	Potential impact	
	Criteria – SEL/Pk-Pk SPL dB re 1 µPa^2·s/dB re 1µPa	Maximum threshold distance, m
Based on recent research by Day et al (2016)	Per-pulse SEL: 186 dB re 1 µPa^2·s	120 - 220
	Pk-Pk SPL: 209 dB re 1 µPa	240 - 360

5.4.2 Zones of impact – cumulative exposure from multiple pulses

As described in **Section 5.3**, the cumulative sound fields in unweighted SEL_{24hr} and weighted SEL_{24hr} with relevant frequency weighting functions applied are modelled based on one typical 24-hour survey operation scenario.

The zones of cumulative impact (i.e. the maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels) are estimated based on the above modelling results **Table 17** presents the cumulative PTS and TTS effects for marine mammals, **Table 18** the cumulative mortality, injury and TTS effects for fish, turtle, fish egg and fish larvae, **Table 19** the cumulative mortality and mortal injury for plankton, and **Table 20** the potential cumulative impact for scallops and rock lobsters.

Cumulative impacts for marine mammals

Among marine mammals of all five hearing groups, low-frequency cetaceans have the highest zones of PTS and TTS impact, as can be seen in **Table 17**. The zones of PTS impact are predicted to range 450m to 1.2km from the adjacent survey lines for the typical 24-hour survey operation scenario considered, and the zones of TTS impact are predicted to be slightly beyond 5km from the adjacent survey lines.

The cumulative PTS criteria SEL_{24hr} are predicted not to be exceeded for either mid-frequency cetaceans or otarriid pinnipeds in water, but the cumulative TTS criteria SEL_{24hr} to be slightly exceeded, with zones of impact around 10m from the adjacent survey lines.

The cumulative PTS criteria SEL_{24hr} are predicted to be slightly exceeded for both high-frequency cetaceans and Phocid pinnipeds in water, with zones of impact within 20m from the adjacent survey lines. For high-frequency cetaceans the zones of TTS impact are predicted to range 500m to 1.0km, and for phocid pinnipeds in water 200m to 500m from the adjacent survey lines for the typical 24-hour survey operation scenario considered.

Table 17 Zones of cumulative impact from multiple pulses for PTS and TTS – marine mammals

Marine mammal hearing group	**Zones of impact – maximum** horizontal perpendicular distances **from assessed survey lines to cumulative impact threshold levels**			
	Injury (PTS) onset		**TTS onset**	
	Criteria – Weighted SEL_{24hr} dB re 1 $\mu Pa^2 \cdot s$	Maximum threshold distance, m	Criteria – Weighted SEL_{24hr} dB re 1 $\mu Pa^2 \cdot s$	Maximum threshold distance, m
Low-frequency (LF) cetaceans	183	450 – 1,200	168	>5,000
Mid-frequency (MF) cetaceans	185	-	170	10
High-frequency (HF) cetaceans	155	20	140	500 – 1,000
Phocid pinnipeds in water (PW)	185	10	170	200 - 500
Otariid pinnipeds in water (OW)	203	-	188	10

Note: a dash indicates the threshold is not reached.

Cumulative impacts for fish, turtles, fish eggs and fish larvae

As presented in **Table 18**,the zones of potential mortal injuries for fish species with and without swim bladder, turtles and fish eggs and fish larvae are predicted to be within 50m from the adjacent survey lines for the typical 24-hour survey operation scenario considered. For recoverable injury, the zones of impact are predicted to be 10m from the adjacent survey lines for fish without swim bladder, and 150m for fish with swim bladder. The zones of TTS effect for fish species with and without swim bladders are predicted to be 1.0km to 3.5km from the adjacent survey lines for the typical 24-hour survey operation scenario considered.

Table 18 Zones of cumulative impact from multiple pulses for mortality and recovery injury– fish, turtles, fish eggs and fish larvae

Type of animal	Zones of impact – maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels					
	Mortality and potential mortal injury		Recoverable injury		TTS	
	Criteria - SEL_{24hr} dB re 1 µPa^2·s	Maximum threshold distance, m	Criteria - SEL_{24hr} dB re 1 µPa^2·s	Maximum threshold distance, m	Criteria - SEL_{24hr} dB re 1 µPa^2·s	Maximum threshold distance, m
Fish: no swim bladder (particle motion detection)	219	10	216	10	186	1,000 - 3,500
Fish: swim bladder is not involved in hearing (particle motion detection)	210	30	203	150	186	1,000 – 3,500
Fish: swim bladder involved in hearing (primarily pressure detection)	207	50	203	150	186	1,000 – 3,500
Sea turtles	210	30	-	-	-	-
Fish eggs and fish larvae	210	30	-	-	-	-

Note: a dash indicates the threshold is not applicable.

Cumulative impacts for plankton

The zones of mortality and potential mortal injury for plankton caused by the cumulative exposure to multiple pulses are predicted to be within 30m from the adjacent survey lines for the typical 24-hour survey operation scenario considered as shown in **Table 19**.

Table 19 Zones of cumulative impact from multiple pulses for mortality and potential mortal injury – Plankton

Plankton	Zones of impact – maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels	
	Mortality and potential mortal injury	
	Criteria – SEL_{24hr}, dB re 1 µPa^2·s	Maximum threshold distance, m
Based on fish eggs and fish larvae (Popper et al, 2014)	210	30

Cumulative impacts for scallops and rock lobsters

The zones of potential impact for scallops and rock lobsters caused by the cumulative exposure to multiple pulses are predicted to be 350m – 1,25m from the adjacent survey lines for the typical 24-hour survey operation scenario considered, as shown in **Table 20**.

Table 20 Zones of potential cumulative impact from multiple pulses – scallops and rock lobsters

Scallop and rock lobster	Zones of impact – maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels	
	Potential impact	
	Criteria – $SEL_{24hr,}$ dB re 1 µPa^2·s	Maximum threshold distance, m
Based on recent research by Day et al (2016)	192	350 – 1,250

5.4.3 Discussions

Combined zones of impact from either immediate or cumulative exposure

As detailed in **Section 2**, dual metric criteria (i.e. per-pulse impact criteria Pk SPL and cumulative exposure impact criteria SEL_{24hr}) are required to be applied to PTS and TTS impact for marine mammals, and mortality and recovery injury for fish, turtles, fish eggs and fish larvae. The combined threshold distance for each impact effect is considered as the maximum threshold distances estimated from either metric criteria being applied.

For marine mammals, the combined zones of impact of all five hearing groups based on estimated results in **Table 12** and **Table 17** are presented in **Table 21**. As can be seen, the cumulative noise exposure results in extended zones of PTS and TTS impact for low-frequency cetaceans, and zones of TTS impact for high frequency cetaceans and phocid pinnipeds in water.

The combined zones of mortal and recoverable injury impact for fish species are the zones of impact estimated based on immediate impact criteria Pk SPL as in **Table 13**.

It should be noted that the cumulative exposure level at certain location is modelled based on the assumption that the animals are constantly exposed to the survey airgun noise at a fixed location over the entire 24-hour period. However, in reality marine fauna species, particularly marine mammals and fish species assessed in this study would not stay in the same location for the entire period. Therefore, the zones of impact assessed for marine mammals and fish species represent the worst case consideration.

Table 21 Combined zones of impact from single/multiple pulses for PTS and TTS – marine mammals

Marine mammal hearing group	Combined zones of impact – maximum horizontal distances to either Pk SPL or cumulative SEL threshold levels			
	Injury (PTS) onset		TTS onset	
	Criteria applied - Pk SPL, dB re 1 µPa / Weighted SEL_{24hr} dB re 1 µPa^2·s	Maximum threshold distance, m	Criteria applied - Pk SPL, dB re 1 µPa / Weighted SEL_{24hr} dB re 1 µPa^2·s	Maximum threshold distance, m
Low-frequency (LF) cetaceans	183 Weighted SEL_{24hr}	450 – 1,200	168 Weighted SEL_{24hr}	>5,000
Mid-frequency (MF) cetaceans	230 Pk SPL	<16	224 Pk SPL	<27
High-frequency (HF) cetaceans	202 Pk SPL	20	196/140 Pk SPL/Weighted SEL_{24hr}	380 – 1,000
Phocid pinnipeds in Water (PW)	218 Pk SPL	<55	183 Weighted SEL_{24hr}	200 - 500
Otariid pinnipeds in water (OW)	232 Pk SPL	<12	226 Pk SPL	<22

For plankton, the combined zones of impact are the same as the zones of immediate impact estimated based on immediate effect criteria of Pk-Pk SEL as in **Table 19**. For scallops and lobsters, the combined zones of potential impact are the zones of impact estimated based on cumulative impact of criteria SEL_{24hr} as in **Table 20**.

6 Summary

SLB proposes to undertake a 2D marine seismic survey in the Otway Basin, approximately 185 km southeast of Kingscote SA, 13 km south of Portland VIC and 66 km west of Strahan TAS. SLR has undertaken STLM for the proposed survey, in order forecast SELs and other relevant parameters at receiving locations within and adjacent to the survey area.

This report details the STLM study that has been carried out for the proposed survey, which includes the following modelling components:

- Array source modelling – modelling the sound emissions from individual airguns making up the acoustic array, to determine overall array source level and directivity characteristics;
- Short-range modelling – prediction of the received SELs at distances out to four kilometres. Short range modelling is used to assess the potential high-risk immediate noise impact to marine fauna species of interest.
- Long-range modelling – prediction of the received SELs over a range of tens to hundreds of kilometres. This modelling assesses the noise impacts to more distant sensitive marine areas; and
- Cumulative modelling – prediction of the received SELs accumulated due to repeated moving source impulses over a 24 hour period, including infill scenarios.

The noise modelling demonstrates that over the water depth range of 50m – 4800m within the survey area, noise propagates over greater distances as the water depth increases. The noise modelling results have been used to identify zones of impact for marine mammals and other species of concern based on relevant noise impact assessment criteria.

Zones of impact have been evaluated for physiological effects and behavioural disturbance, due to the immediate impact from single airgun pulses, as well as the cumulative effects of exposure to multiple airgun pulses over a period of 24 hours.

7 References

Ainslie, M. A., Laws, R. M., and Sertlek, H. O., International Airgun Modelling Workshop: Validation of source signature and sound propagation models – Dublin (Ireland), 16 July 2016 – problem description, IEEE J. Ocean. Eng., to be published.

Antonov, J. I., Seidov, D., Boyer, T. P., Locarnini, R. A., Mishonov, A. V., Garcia, H. E., Baranova, O. K., Zweng, M. M., and Johnson, D. R., 2010, World Ocean Atlas 2009, Volume 2: Salinity. S. Levitus, Ed. NOAA Atlas NESDIS 69, U.S. Government Printing Office, Washington, D.C., 184 pp.

Austin, M., McCrodan, A., Wladichuk, J., 2013, Marine mammal monitoring and mitigation during Shell's activities in the Chukchi Sea, July–September 2013: Draft 90-Day Report. (Chapter 3) *In* Reider, H. J., L. N. Bisson, M. Austin, A. McCrodan, J. Wladichuk, C. M. Reiser, K.B. Matthews, J.R. Brandon, K. Leonard, et al, (eds.). *Underwater Sound Measurements*. LGL Report P1272D–2. Report from LGL Alaska Research Associates Inc., Anchorage, AK, USA, and JASCO Applied Sciences, Victoria, BC, Canada, for Shell Gulf of Mexico, Houston, TX.

Day, R.D., McCauley, R.M. Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., Institute for Marine and Antarctic Studies, 2016, Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries, University of Tasmania, Hobart, October. CC BY 3.0.

Del Grosso, V. A., 1974, New equation for the speed of sound in natural waters (with comparisons to other equations), J. Acoust. Soc. Am. 56: 1084-1091.

DOC (Ed), 2016, Report of the Sound Propagation and Cumulative Exposure Models Technical Working Group, Marine Species and Threats, Department of Conservation, Wellington, New Zealand, 59p.

Dragoset, W. H., 1984, A comprehensive method for evaluating the design of airguns and airgun arrays, 16th Annual Proc. Offshore Tech. Conf. 3: 75-84.

Duncan, A. J., Gavrilov, A., and Li, F., 2009, Acoustic propagation over limestone seabeds, in Acoustics 2009: Research and Consulting, Proceedings Australasian Acoustical Societies' Conference, edited by T.McMinn, Adelaide, Australia, 23–25 November 2009, p. 6.

Duncan, A. J., Gavrilov, A. N, McCauley R. D., and Parnum, I., 2013, Characteristics of sound propagation in shallow water over an elastic seabed with a thin cap-rock layer, J. Acoust. Soc. Am., 134(1), 207-215.

Finneran, J. J., 2015, Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores, San Diego: SSC Pacific.

Finneran, J. J., 2016, Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposure to underwater noise, Technical Report, 49 pp.

Galindao-Romero, M., Lippert, T. and Gavrilov, A., 2015, Empirical prediction of peak pressure levels in anthropogenic impulsive noise. Part I: Airgun arrays signals. J. Acoust. Soc. Am. 138 (6), December: EL540-544.

Gundalf Designer, Revision AIR8.1n, 30 March 2018, Oakwood Computing Associates Limited. (https://www.gundalf.com/).

Hamilton, E. L., 1980, Geoacoustic modelling of the sea floor, J. Acoust. Soc. Am. 68: 1313:1340.

IAGC, 2017, IAGC: Plankton Study Speculative and Needs Better Data, A WWW document accessed at https://globenewswire.com/news-release/2017/06/22/1027751/0/en/IAGC-Plankton-Study-Speculative-and-Needs-Better-Data.html.

Pinzone, G., 2017, CarbonNet Pelican 3D Marine Seismic Survey (3DMSS) Environmental Plan (EP) Summary, Rev1, Department of Economic Development, Jobs, Transport and Resources, Victoria State Government.

Jensen, F. B., Kuperman, W. A., Porter, M. B. and Schmidt, H., 2011, Computational Ocean Acoustics, Springer-Verlag New York.

Landrø, M., Amundsen, L., and Barker, D., 2011, High-frequency signals from air-gun arrays, Geophysics, vol. 76, pp. Q19–Q27.

Laws, R. M., Parkes, G. E., and Hatton, L., 1988, Energy-interaction: The long-range interaction of seismic sources, Geophysical Prospecting, 36: 333-348.

Laws, M., Hatton, L. and Haartsen, M., 1990, Computer Modelling of Clustered Airguns, First Break, 8(9): 331-338.

Li, B. and Hall, M.V., 2012, The loss mechanisms of plane-wave reflection from the seafloor with elastic characteristics, *Proceedings of Acoustics 2012 Fremantle*, 21-23 November 2012, Fremantle, Australia.

Locarnini, R. A., Mishonov, A. V., Antonov, J. I., Boyer, T. P., Garcia, H. E., Baranova, O. K., Zweng, M. M., and Johnson, D. R., 2010, World Ocean Atlas 2009, Volume 1: Temperature. S. Levitus, Ed. NOAA Atlas NESDIS 68, U.S. Government Printing Office, Washington, D.C., 184 pp.

Matthews, M. N. and Macgillivray, A. O., 2013, Comparing modeled and measured sound levels from a seismic survey in the Canadian Beaufort Sea, Proceedings of meetings on acoustics Acoustical Society of America, 2 – 7 June 2013, Montreal, Canada.

McCauley, R. D., Duncan, A. J., Gavrilov, A. N. and Cato, D. H., 2016, Transmission of marine seismic survey, air gun array signals in Australian waters. Proceedings of ACOUSTICS 2016, 9-11 November 2016, Brisbane, Australia.

McCauley R. D., Fewtrell J., Duncan A. J., Jenner, C., Jenner M. N., Penros J. D., Prince R. I. T., Adhitya A., Murdoch J. and McCabe K., 2000, Marine Seismic Surveys: Analysis and Propagation of Air Gun Signals, and Effects of Exposure on Humpback Whales, Sea Turtles, Fishes and Squid. Prepared for the APPEA. CMST, Curtin University.

McCauley, R. D., Day, R. D., Swadling, K. M., Fitzgibbon, Q. P., Watson, R. A., and Semmens, J. M., 2017, Widely used marine seismic airgun operations negatively impact zooplankton, Nature Ecology & Evolution 1, 0195. | DOI: 10.1038/s41559-017-0195.

National Marine Fisheries Services (NMFS), 2016, Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustics Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Administration, U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 pp.

National Marine Fisheries Services (NMFS), 2013, Marine mammals: Interim Sound Threshold Guidance (webpage), National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.
http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

National Science Foundation (NSF) (U.S.), U.S. Geological Survey, and National Oceanic and Atmospheric Administration (NOAA) (U.S.), 2011, *Final Programmatic Environmental Impact Statement/Overseas, Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey*, National Science Foundation, Arlinton, VA.

Parkes, G. E., Ziolkowski, A. M., Hatton L. and Haugland T., 1984, The signature of an airgun array: computation from near-field measurements – practical considerations, Geophysics, 49: 105-111.

Popper A. N., Hawkins A. D., Fay R. R., Mann D. A., Bartol S., Carlson T. J., Coombs S., Ellison W. T., Gentry R. L., Halworsen M. B., Lokkeborg S., Rogers P. H., Southall B. L., Zeddies D. G. and Tavolga W. N., 2014, ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

Porter, M., 2010, Acoustics Toolbox in Ocean Acoustics Library (http://oalib.hlsresearch.com/).

Richardson W. J., Charles R. G. J., Charles I. M. and Denis H. T, 2013, Marine mammals and noise: Academic press.

Saunders, P. M. and Fofonoff, N. P., 1976, Conversion of pressure to depth in the ocean, Deep-Sea Res. 23: 109-111.

Simon, C., Matthew, P. and David, P., 2018, Results of deployment of acoustic monitoring equipment for Taranaki Ltd for 2018 Māui 4D Seismic Survey, Report No. PM-18-Shell-Report 3 Results of acoustic equipment deployment 2018 Māui 4D MSS-v1.1.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C. Jr., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J., Tyack, P., 2007, Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33(4), 411-521.

Vaage, S., Strandness, S. and Utheim, T., 1984, Signatures from single airguns, Geophysical Prospecting, 31: 87-97.

Ziolkowski, A. M., Parkes, G. E., Hatton, L. and Haugland, T., 1982, The signature of an airgun array: computation from near-field measurements including interactions, Geophysics, 47: 1413-1421.

Ziolkowski, A. M., 1970, A method for calculating the output pressure waveform from an airgun, Geophys.J.R.Astr.Soc., 21: 137-161.

Whiteway, T. G., 2009, Australian Bathymetry and Topography Grid, June 2009, Geoscience Australia Record 2009/21. 46pp.

APPENDIX A

Acoustic Terminology

Sound Pressure	A deviation from the ambient hydrostatic pressure caused by a sound wave
Sound Pressure Level (SPL)	The logarithmic ratio of sound pressure to the reference pressure. The reference pressure underwater is P_{ref} = 1 µPa
Root-Mean-Square Sound Pressure Level (RMS SPL)	The mean-square sound pressure is the average of the squared pressure over the pulse duration. The root-mean-square sound pressure level is the logarithmic ratio of the root of the mean-square pressure to the reference pressure. Pulse duration is taken as the duration between the 5% and the 95% points on the cumulative energy curve
Peak Sound Pressure Level (Peak SPL)	The peak sound pressure level is the logarithmic ratio of the peak pressure over the impulsive signal event to the reference pressure
Peak-to-Peak Sound Pressure Level (Peak-Peak SPL)	The peak-to-peak sound pressure level is the logarithmic ratio of the difference between the maximum and minimum pressure over the impulsive signal event to the reference pressure
Sound Exposure Level (SEL)	SEL is a measure of energy. Specifically, it is the dB level of the time integral of the squared instantaneous sound pressure normalised to a 1-s period
Power Spectral Density (PSD)	PSD describes how the power of a signal is distributed with frequency
Source Level (SL)	The acoustic source level is the level referenced to a distance of 1m from a point source
1/3 Octave Band Levels	The energy of a sound split into a series of adjacent frequency bands, each being 1/3 of an octave wide
Sound Speed Profile	A graph of the speed of sound in the water column as a function of depth

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New Zealand
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APPENDIX B

List of Stakeholders SLB have Engaged with

Stakeholders Engaged	
Department or Agency of the Commonwealth	
1	Australian Fisheries Management Limited (AFMA)
2	Australian Fisheries Management Limited (AFMA) – Petroleum Sector
3	Australian Fisheries Management Limited (AFMA) – Southeast Trawl Sector
4	Commonwealth Fisheries Association
5	Department of Agriculture & Water Resources
6	Parks Australia – Director of National Parks
7	Department of Defence
8	GeoScience Australia
9	Shipping Australia
Department or Agency of the State	
10	Bass Coast Shire Council, Victoria
11	Borough of Queenscliffe, Victoria
12	Burnie City Council – Tasmania
13	CarbonNet – Victoria State Govt, Economic Development, Jobs, Transport, Resources
14	Central Coast Council – Tasmania
15	Circular Head Council – Tasmania
16	City of Port Lincoln
17	Colac Otway Shire Council, Victoria
18	Conservation Council SA
19	Corangamite Shire Council, Victoria
20	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Gippsland Basin Activities (DEDJTR)
21	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Incident Reporting
22	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Otway Basin Activities
23	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Petroleum
24	Department of Environment, Land, Water and Planning (Victoria) DELWP
25	Department of Primary Industry, Parks, Water and Environment (DPIPWE) (Tasmania)
26	Department of State Growth – Tasmania
27	District Council of Lower Eyre Peninsula (DCLEP)
28	Flinders Ports – SA
29	Glenelg Shire Council, Portland, Victoria
30	Huon Valley Council – Tasmania
31	Kangaroo Island Council
32	King Island Council
33	Mornington Peninsula Shire Council, Victoria
34	Moyne Shire Council, Victoria
35	Parks Victoria
36	Primary Industries and Regions SA PIRSA/SARDI

Stakeholders Engaged	
37	Regional Development Australia, Whyalla and Eyre Peninsula (RDAWEP)
38	South Gippsland Shire Council, Victoria
39	Surf Coast Shire Council, Victoria
40	Tourism Tasmania
41	Waratah Wynyard Council – Tasmania
42	Warrnambool City Council, Victoria
43	Wellington Shire Council, Victoria
44	West Coast Council – Tasmania
45	Victorian Fisheries Authority
Relevant Persons	
46	3D Oil
47	Abalone Council of Australia
48	Alissa Enterprises Pty Ltd (Innes)
49	Anz Fishing Company Pty Ltd
50	Austar Fishing Pty Ltd
51	Australian Fishing Enterprises Pty. Ltd.
52	Australian Southern Bluefin Tuna Industry Association (ASBFTIA)
53	Australian Tuna Fisheries Pty Ltd
54	Australian Wildcatch Fishing
55	B Tunnage Fishing Pty Ltd
56	Blaslov Fishing Pty Ltd
57	Claudarah Pty Ltd
58	Corporate Alliance Enterprises Pty Ltd
59	C R & A Lavalle Pty Ltd
60	Cull Fisheries Pty Ltd
61	Dewebb Pty Limited
62	Eastern Tuna and Billfish Fishery – Tuna Australia
63	F & H Trawling Co. Pty. Limited
64	Fina K Pty. Ltd.
65	Fishan Pty. Ltd.
66	Friend Fishing Pty. Ltd.
67	Gabo Bay Pty Ltd
68	Gail Jeanette Pty Limited
69	Galaxy Fishing Co. Pty. Ltd.
70	Gazak Holdings Pty Ltd
71	George Town Seafoods Pty Ltd
72	Guillot Enterprises (L.E.) Pty. Ltd.
73	Hagfish Australia Pty Ltd
74	Hefem Trawl Pty Ltd

Stakeholders Engaged	
75	Hursey & Sons Pty. Ltd.
76	Ironnet Pty. Limited
77	J & N Jarvis Pty Ltd
78	Ka Olver Pty Ltd
79	Lyenna Proprietary Limited
80	Mahina Bay Fishing Co Pty Ltd
81	Marellen Pty Ltd
82	Marnikol Fisheries Pty. Ltd.
83	Muollo Fishing Pty Limited
84	Mures Fishing Pty. Ltd.
85	Nautical Fishing (Nsw) Pty Limited
86	Nautilus Fishing Pty Ltd
87	Nina Fishing Pty Ltd
88	Pescatore Di Mare Pty Ltd
89	Raptis Fishing Licences Pty Ltd
90	Rhylan Fishing Pty Ltd
91	Richey Fishing Co Pty Ltd
92	Rockfish 1 Pty Limited
93	Sanpool Fisheries Pty. Ltd.
94	Sarin Marine Farm Pty Ltd
95	Scallop Fishermen's Association of Tasmania
96	Seafood Industry Australia
97	Seafood Industry Victoria (SIV)
98	Shark Gillnet and Shark Hook Sector – Sustainable Shark Fishing Inc.
99	Silver Phoenix Holdings Pty Ltd
100	Skipjack Tuna Fisheries
101	Slidell Pty. Ltd.
102	Small Pelagic Fishery – Small Pelagic Fishery Industry Association
103	South Australian Rock Lobster Fishery (SARLF)
104	South East Trawl Fishing Association (SETFIA)
105	South Eastern Professional Fishermans Association (SEPFA)
106	Southern Bluefin Tuna Fishery
107	Southern Rock Lobster Limited (SRL)
108	Southern Sea Eagles Pty Ltd
109	Southern Shark Industry Alliance Inc.
110	Southern Squid Jig - Commonwealth Fisheries Association
111	Southern Zone Abalone Fishery
112	Southlander Fisheries Pty Ltd
113	St Antonios Nominees Pty Ltd

Stakeholders Engaged	
114	Sustainable Shark Fishing Association
115	T & Dp Guarnaccia Pty Ltd & Hunt Morrey Pty Ltd
116	Tasmanian Rock Lobster Fisherman's Association (TRLFA)
117	Tasmanian Seafood Industry Council (TSIC)
118	Three Friends Fishing Company Pty Limited
119	Toberfish Pty. Ltd.
120	Tony's Tuna International Pty Ltd
121	Trinsand Fisheries Pty Ltd
122	Tullaberga Fishing Pty Limited
123	Tweed Bait Pty. Ltd
124	Uptop Fisheries Pty Ltd
125	Victorian Giant Crab Fishery
126	Victorian Rock Lobster Fishery
127	Victorian Rock Lobster Fishery – Eastern Zone
128	Victorian Scallop Fisherman's Association
129	Wellington Cape Pty Ltd
130	Wildcatch Fisheries SA Inc. (WFSA)
Any other Persons considered relevant	
131	Aegir Divers
132	[redacted]
133	Allways Dive Expeditions
134	[redacted]
135	Apollo Bay Fishing & Adventure Tours
136	[redacted]
137	Aquability
138	[redacted]
139	Australian Marine Conservation Society (AMCS)
140	Australian Diving Instruction
141	[redacted]
142	Bagout Fishing Charters - Portland
143	Bass Strait Aquatic Club
144	[redacted]
145	Blue Whale Study
146	Boating Industry Association (BIA)
147	[redacted]
148	[redacted]
149	[redacted]
150	[redacted]
151	Cetacean Biological Sciences – Flinders University

Stakeholders Engaged	
152	Charter Boat Fishery – SA
153	[redacted]
154	[redacted]
155	[redacted]
156	Dive Adventures
157	Daktari Sports
158	Dive and Dive
159	Dive Victoria
160	Dive Works Subea Solutions
161	Diveline Aus
162	Diving and Marine Services
163	Elstone Diving Services
164	Extreme Watersport
165	Geelong Dive Centre (Divein2Scuba)
166	[redacted]
167	[redacted]
168	Go Dive Launceston
169	Gone Fishing Charters
170	Industrial Divers
171	[redacted]
172	[redacted]
173	[redacted]
174	[redacted]
175	[redacted]
176	[redacted]
177	[redacted]
178	[redacted]
179	[redacted]
180	[redacted]
181	[redacted]
182	[redacted]
183	Macs Diving Services Pty Ltd
184	[redacted]
185	[redacted]
186	Matthew Hunt Fishing Charters
187	[redacted]
188	[redacted]
189	[redacted]
190	[redacted]

Stakeholders Engaged	
191	Neptune Diving Services Melbourne
192	[redacted]
193	Ocean Divers
194	[redacted]
195	[redacted]
196	[redacted]
197	[redacted]
198	[redacted]
199	Peninsula Dive School
200	[redacted]
201	[redacted]
202	[redacted]
203	Petuna Sealord Deepwater Fishing Pty Limited (PSDF)
204	[redacted]
205	Professional Diving Services
206	[redacted]
207	Proline Charters - Sorrento
208	RecFish – SA
209	Red Hot Fishing Charters
210	Reel Time Fishing Charters
211	Rip Charters
212	[redacted]
213	[redacted]
214	[redacted]
215	[redacted]
216	[redacted]
217	Salty Dog Charters
218	[redacted]
219	[redacted]
220	Scuba Culture
221	Scuba Life
222	Seals by Sea Tours (Cape Bridge)
223	Sharkmen Charters
224	[redacted]
225	Snorkel & Dive Safari
226	Southern Coast Charters
227	Southern Divers
228	Southwest charters - Portland
229	[redacted]

Stakeholders Engaged	
230	Surf-n-Fish
231	[redacted]
232	TasFish
233	The SCUBA Doctor
234	The Wilderness Society (SA) Inc.
235	[redacted]
236	University of Tasmania
237	VRFish – Victorian Recreational Fishers
238	Warrnambool Diving & Firearms
239	WaterMaarQ
240	[redacted]
241	Academy of Scuba
242	[redacted]
243	[redacted]
244	[redacted]

APPENDIX C

Full Unedited Correspondence Between SLB and Stakeholders

Sensitive information – content removed.

APPENDIX D

Meeting Minutes and Memos

Sensitive information – content removed.

APPENDIX E

Information Packs

Schlumberger

Otway Basin Marine Seismic Survey

Schlumberger proposes to undertake a two dimensional (2D) marine seismic survey (MSS) in Commonwealth waters adjacent to South Australia (SA), Victoria (VIC) and Tasmania (TAS). The survey area is located 185 km south east of Kingscote (SA), 13 km south of Portland (VIC) and 66 km west of Stahan (TAS). Water depths in the survey area range from 0 to 6,000 m, although the vessel will be restricted to water depths >30 m at all times.

The proposed seismic activity area encompasses a few permit areas in Otway Basin (Figure 1 and Figure 2). Operational area coordinates, petroleum operator permit areas, significant features and their proximity to the proposed seismic operational area are outlined in Table 1.

This area experiences rough metocean conditions and to ensure safety and efficiency, it is proposed the survey be undertaken during the calmer months of November 2018 to May 2019. The survey is not expected to take more than 100 days of continuous activity, but due to adverse weather, potential stakeholder activities and vessel availability, a maximum activity window of 150 days is proposed to allow flexibility and to avoid any potential sensitivities identified during the stakeholder engagement. This maximum activity window will not consist of continuous survey days.

The Environment Plan (EP) will be compiled to encompass the period of November to May.

PROPOSED ACTIVITY

Offshore seismic surveying is used to improve the understanding of subsurface geology in marine environments.

During 2D MSSs, seismic data is acquired using a purpose-built seismic survey vessel towing an acoustic source array and a single hydrophone cable, also known as a streamer. The streamer can be up to 12 km long to adequately record the necessary information. Both the source and streamer are towed beneath the surface, (Figure 3). Acoustic energy from the source array is detected by the streamer and recorded on board the seismic vessel. The recorded signals are then processed to provide information about the structure and composition of geological formations below the seabed.

When recording the data, the seismic vessel traverses the survey area along a series of pre-determined sail lines at a speed of approximately 4-5 knots (7-9 km/h). During the seismic survey, the power of acoustic emissions can be altered to provide low-power 'soft start' or 'fauna alert' procedures, and during vessel turning at the end of each sail line, or during any maintenance operations.

A support vessel may work with the seismic vessel to assist in warning other vessels that may have entered the seismic vessel's exclusion zone and to support the overall operations (i.e. provide food and supplies to the seismic vessel).

COMMUNICATION COMMITMENTS

Schlumberger are committed to maintaining regular communication with all relevant stakeholders and shall work with the community in a transparent manner.

As part of this initial consultation Schlumberger invites feedback on the proposed activities. Details of consultation will be provided to the National Offshore Petroleum Safety and Environment Management Authority (NOPSEMA) in accordance with EP procedures.

Due to the nature of seismic survey operations, the timing and location of the activity is prone to minor changes. To eliminate confusion, Schlumberger commits to notifying stakeholders of schedule location and vessel details as they are confirmed. If you wish to receive these notifications, or wish to receive specific information regarding this survey, please advise in response to this package as soon as possible.

ENVIRONMENTAL PERFORMANCE

Any key potential environmental impacts and risks associated with the proposed survey activities will be temporary and localised, including potential disturbance to navigation and shipping activities and isolated disturbance to marine mammals and fishing activities.

Schlumberger are committed to working with all interested parties to ensure risks are identified and reduced to as low as reasonably practicable (ALARP) before activities begin. This will include detailed impact assessments and the adoption of appropriate impact mitigation measures that will be documented in the EP.

NOPSEMA reviews each project specific EP in accordance with the requirements of the Offshore Petroleum Greenhouse Gas (Environment) Regulations 2009.

YOUR FEEDBACK

As indicated above, the seismic survey is subject to Commonwealth Government regulatory approval and Schlumberger seeks your feedback on the proposed activities. Schlumberger is currently seeking initial feedback about this proposed activity before making a formal submission to NOPSEMA. Please be aware any feedback will be communicated to NOPSEMA, as required under Commonwealth legislation.

If you would like to comment on the survey or would like additional information, please make contact as soon as possible. Schlumberger are arranging meetings with local stakeholders the week of 10th September to discuss the project in more detail. If you would like a meeting please confirm your availability prior to this date.

Best Regards,
Kunal Mishra

Schlumberger Australia Pty Ltd:
Level 5 256 St Georges Terrace
Perth WA, 6000
(08) 9420 4800
Email: environment@slb.com

Figure 1: Location map of proposed operational area key features

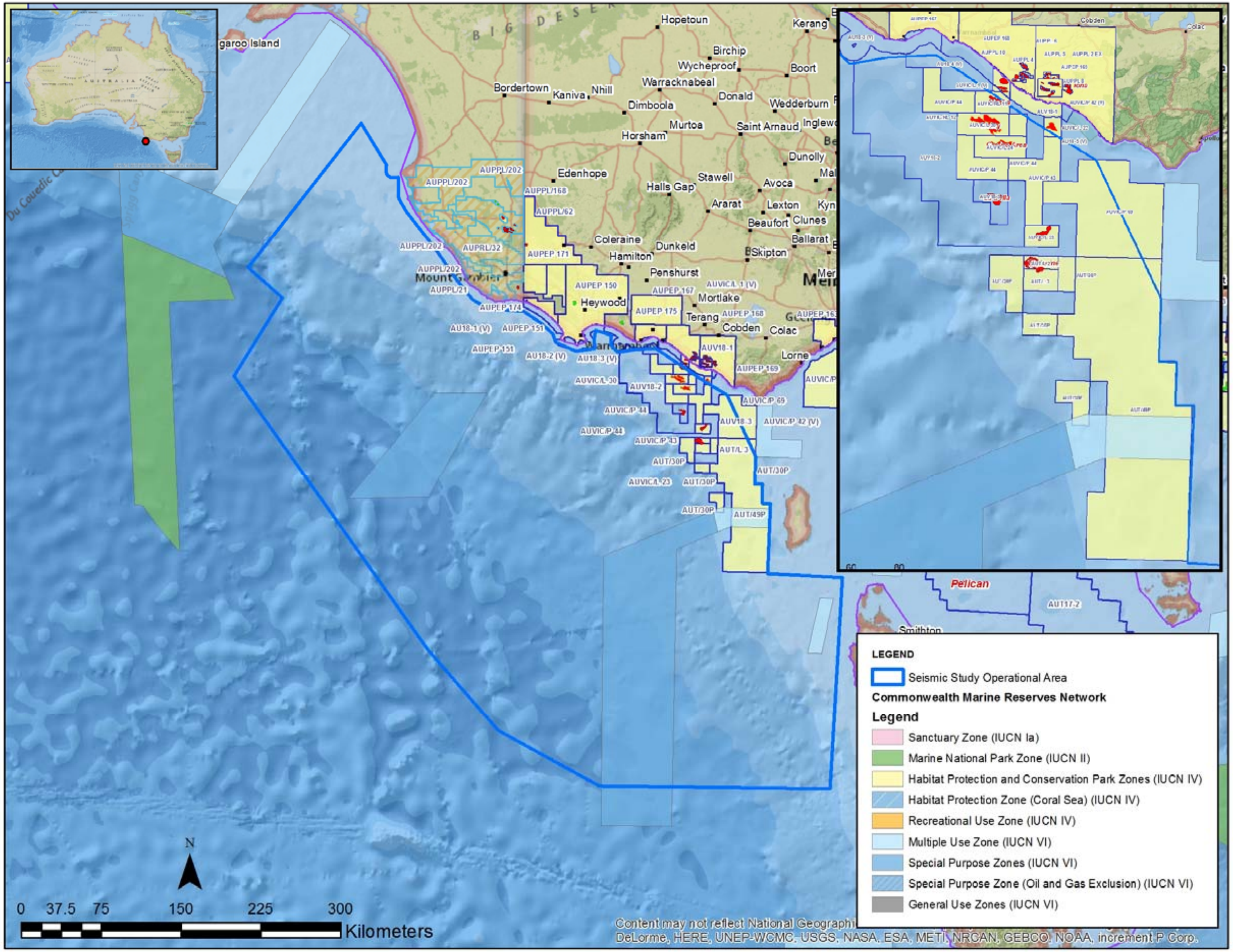


Figure 2: Location map of proposed operational area and Petroleum Titles

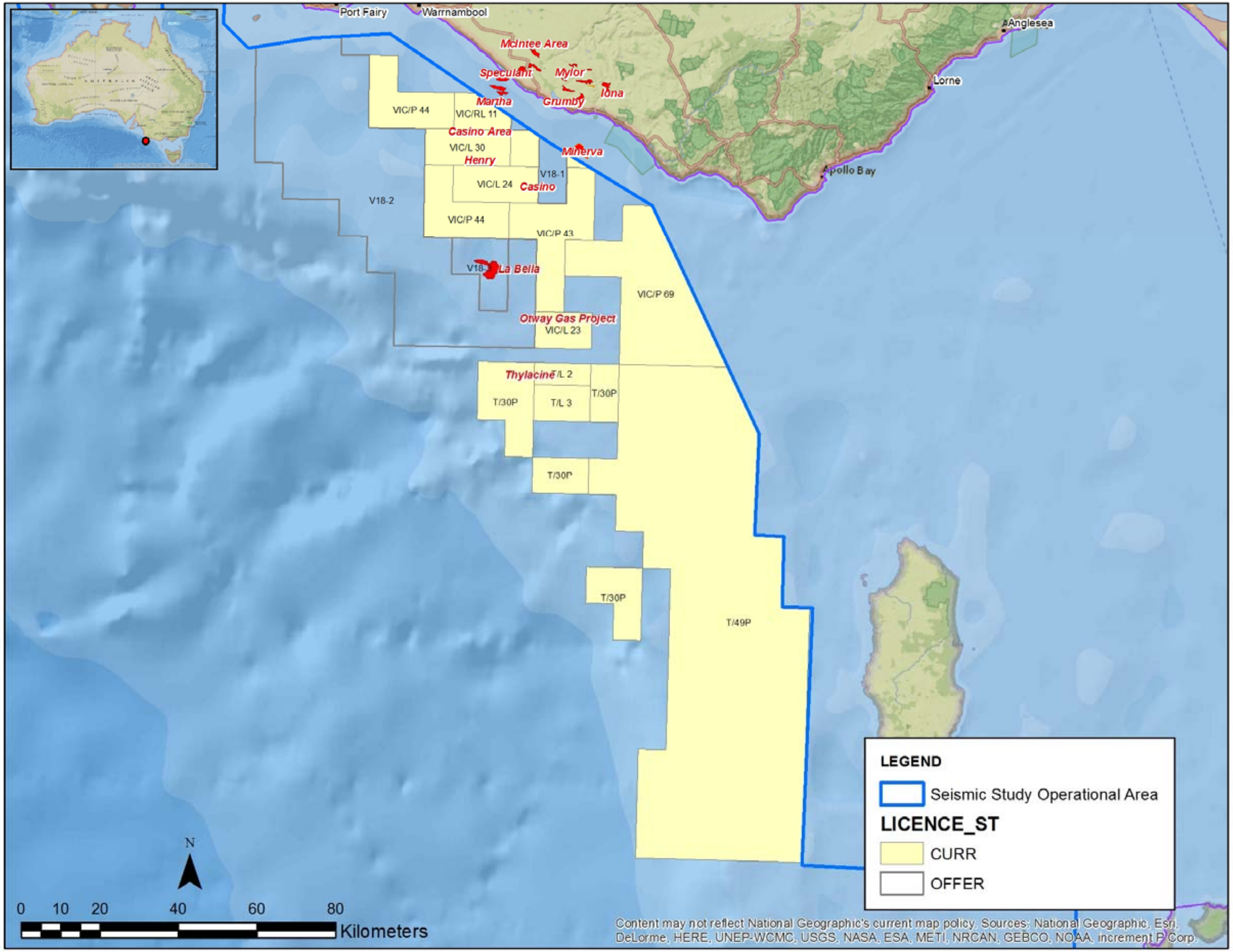


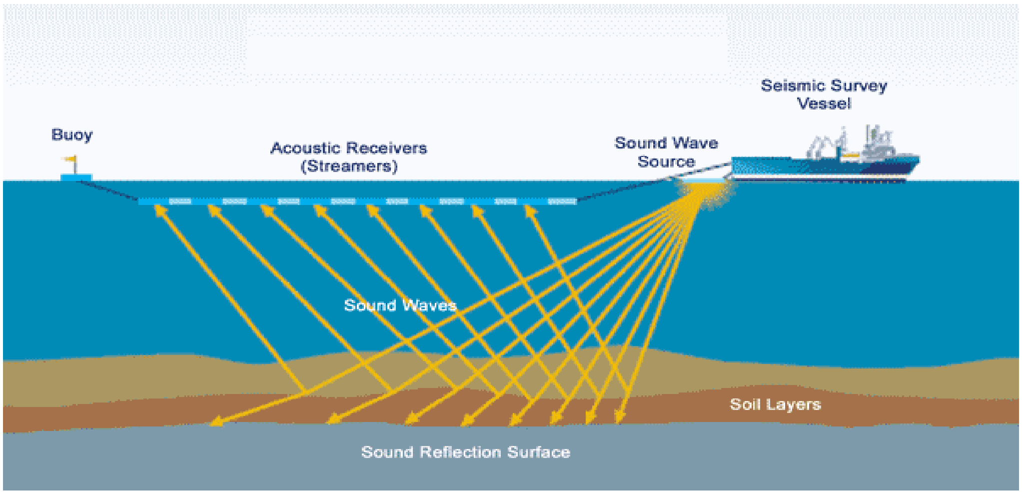
Table 1: Coordinates of the proposed operational area, permits which overlap the operational area and distances to key regional features

X	Y	X	Y	X	Y	X	Y
368748.21	5906789.35	524672.30	5756874.00	621510.10	5743447.00	568704.60	5331417.00
372514.12	5904312.01	527363.10	5748888.00	662621.70	5715433.00	473543.90	5383679.00
379289.68	5904411.28	546264.60	5740564.00	688407.90	5699644.00	406667.80	5460057.00
379573.18	5884559.56	564120.80	5743508.00	715711.70	5641393.00	224623.80	5717347.00
387184.76	5871568.80	563399.30	5751382.00	714527.70	5615513.00	270416.40	5790841.00
411816.59	5840181.69	564706.60	5760098.00	722080.30	5615163.00	237914.30	5819698.00
434175.09	5807654.75	569300.60	5759101.00	721562.50	5597202.00	344109.40	5955570.00
448856.86	5789066.90	579658.90	5755628.00	729310.70	5596975.00	368258.80	5916499.00
464429.25	5780278.71	578972.80	5746227.00	726620.50	5531290.00	367665.80	5910997.00
497082.17	5778450.00	585515.00	5739767.00	796980.80	5527483.00	368748.30	5906789.00
513459.68	5767038.97	601346.60	5742412.00	785340.80	5328515.00		

Permits within Operational area	VIC/P43, T/30P, T/49P, T/L 2, T/L 3, VIC/L 22, VIC/L 23, VIC/L 24, VIC/L 30, VIC/RL 11, VIC/L 44 and VIC/L 69

Relative proximity of key regional features to the operational area	Feature	Distance
	Nelson – Special Purpose Zone (IUCN VI)	Intersect Area
	Zeehan – Special Purpose Zone (IUCN VI) & Multi Use Zone	Intersect Area
	Franklin – Multi Use Zone (IUCN VI)	Intersect Area
	Apollo – Multi Use Zone (IUCN VI)	1 km east
	Boags – Multi Use Zone (IUCN VI)	100 km east
	Murray – Marine National Park Zone (IUCN II)	40 km west
	Murray – Multi Use Zone (IUCN VI)	45 km west

Figure 3: Schematic of typical 2D geophysical survey



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Kunal Mishra

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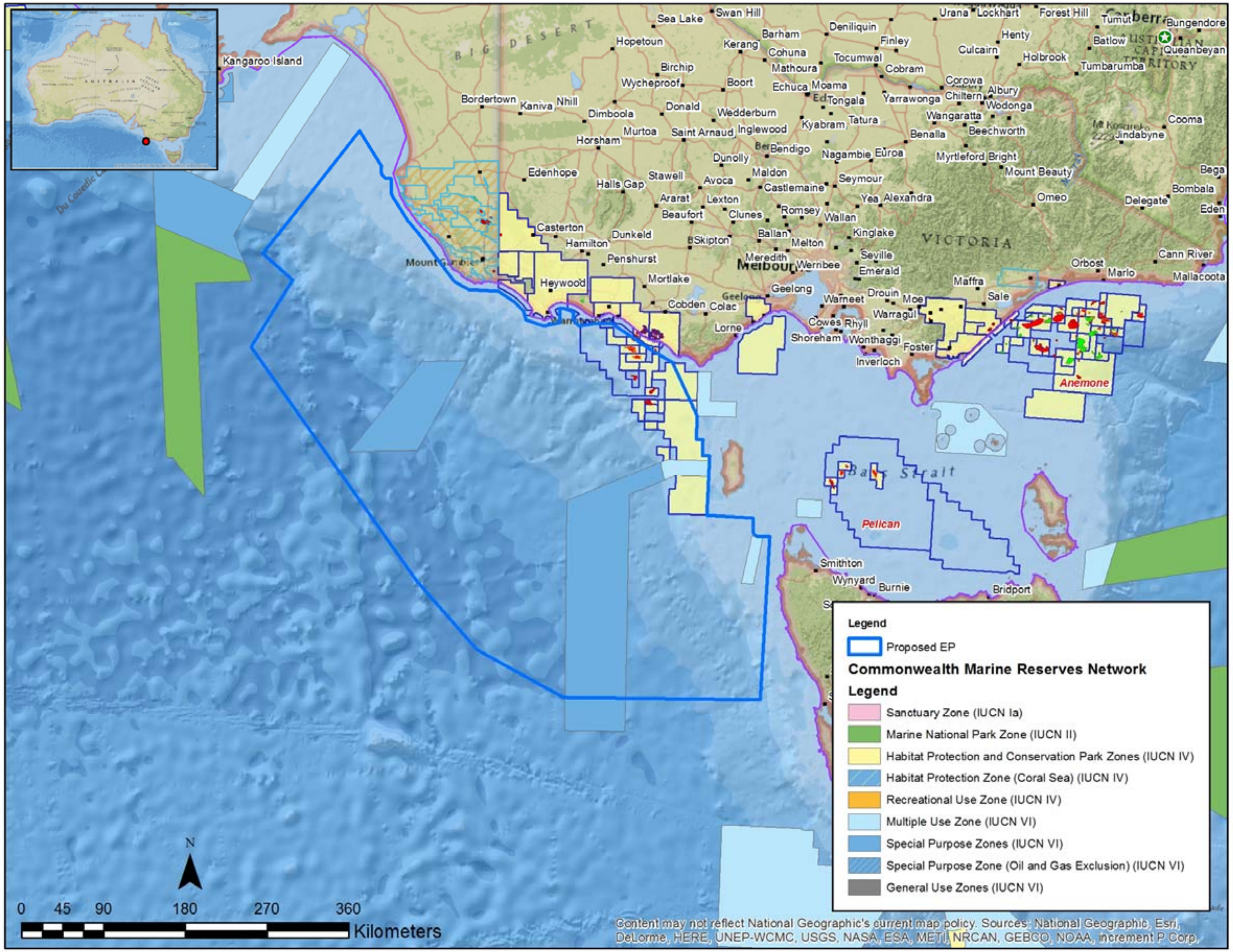
Figure 1: Location map of proposed operational area key features



Schlumberger

Figure 2: Location map of proposed operational area and Petroleum Titles

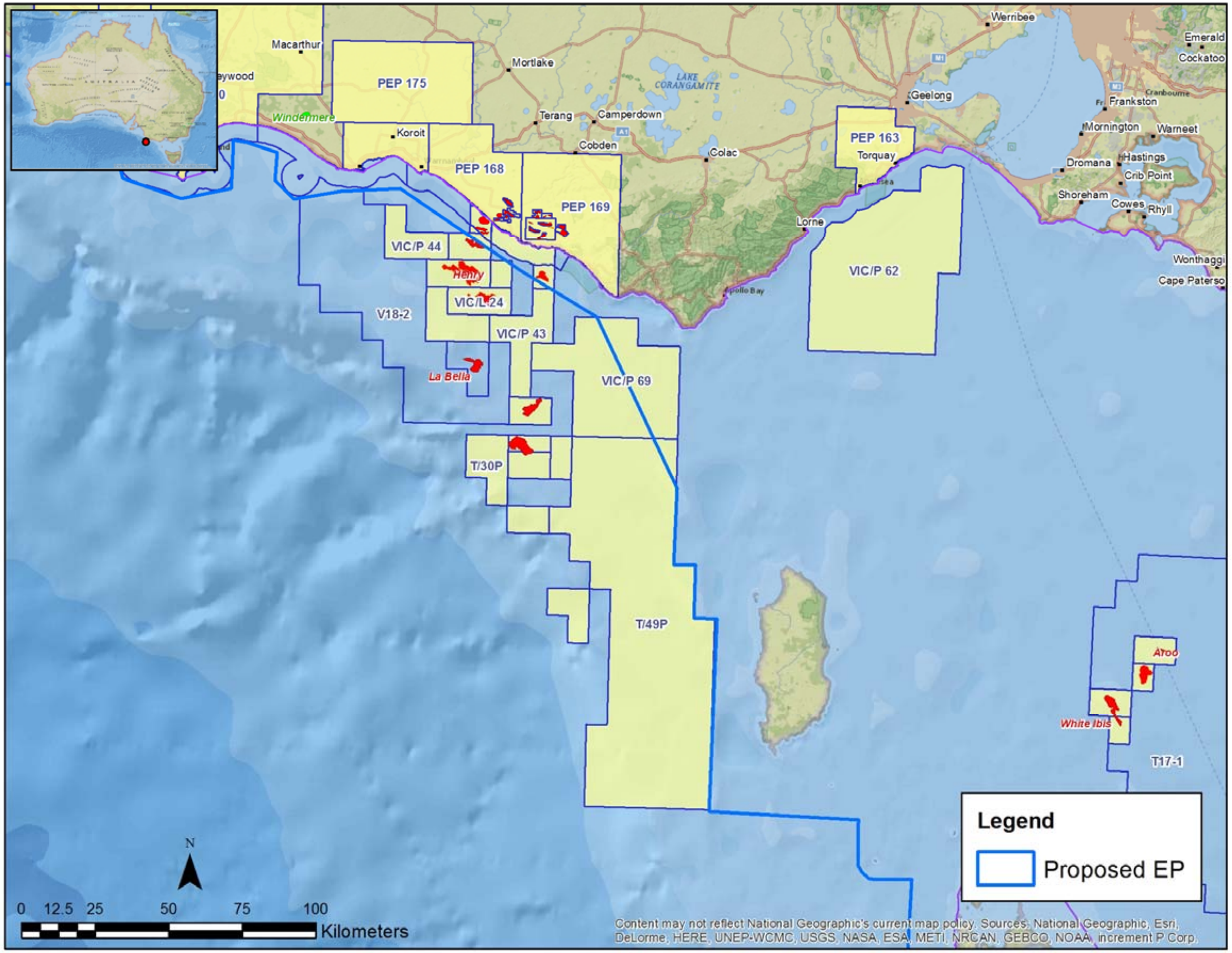


Table 1: Coordinates of the proposed operational area, permits which overlap the operational area and distances to key regional features

Long	Lat	Long	Lat	Long	Lat	Long	Lat
139.525376	-36.9759	141.282307	-38.3359	142.869947	-38.6948	144.489516	-40.5234
139.563095	-37.008	141.312085	-38.4263	143.170578	-38.8319	144.452971	-42.1435
139.637335	-37.0144	141.54	-38.4869	143.503357	-39.35	141.831756	-42.1664
139.643398	-37.1776	141.734881	-38.4544	143.49795	-39.5833	140.682048	-41.6982
139.831111	-37.4268	141.736821	-38.396	143.585927	-39.5845	139.890164	-41.0053
139.979467	-37.5692	141.740658	-38.3062	143.585927	-39.7463	137.835737	-38.6497
140.251524	-37.8762	141.792706	-38.3135	143.676346	-39.7463	138.385257	-38.0011
140.417135	-38.0447	141.911569	-38.344	143.667939	-40.3382	138.025988	-37.7325
140.594167	-38.1246	141.904774	-38.4287	144.265966	-40.3484	139.25863	-36.5326
140.966702	-38.1418	141.980504	-38.4863	144.271605	-40.4848	139.521569	-36.8883
141.153816	-38.2446	142.161613	-38.4609	144.287066	-40.5076		

Permits within Operational area	VIC/P43, T/30P, T/49P, T/L 2, T/L 3, VIC/L 22, VIC/L 23, VIC/L 24, VIC/L 30, VIC/RL 11, VIC/L 44 and VIC/L 69

	Feature	Distance
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	Boags – Multi Use Zone (IUCN VI)	100 km east
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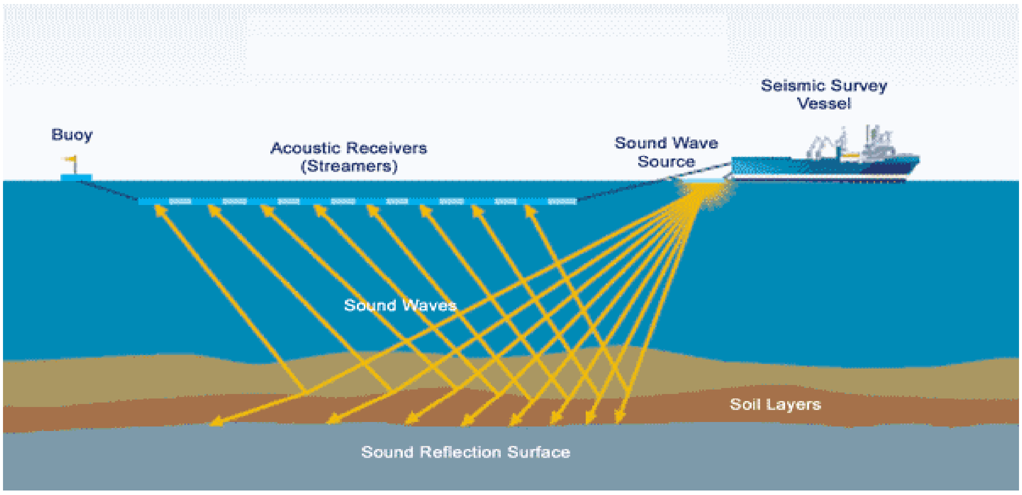
	Murray – Multi Use Zone (IUCN VI)	45 km west

Figure 3: Schematic of typical 2D geophysical survey



Otway Basin Marine Seismic Survey

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Operational area coordinates, petroleum operator permit areas, significant features and their proximity to the proposed seismic operational area are outlined in Table 1. In developing the operational area, a 15 km buffer has been applied around the proposed survey lines in most cases.

This area experiences rough metocean conditions and to ensure safety and efficiency, it is proposed the survey be undertaken during the calmer months of December 2018 to May 2019. The survey is expected to require no more than 100 days of continuous activity, but due to adverse weather, potential stakeholder activities and vessel availability, a maximum activity window of 150 days is proposed to allow flexibility and to avoid any potential sensitivities identified during the stakeholder engagement. This maximum activity window will not consist of continuous survey days.

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PROPOSED ACTIVITY

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To minimise survey duration, geophysical data would be acquired 24 hours a day. Each 2D line is about 90 kilometres long and it takes approximately 11 hours to complete each line. Data only needs to be acquired once. More than 90% of the acquisition is in water depths >200m, with the shallowest line only touching the 50m depth contour, located 12 kilometres from shore.

A support vessel will work with the seismic vessel to assist in warning other vessels that have entered the area of operations and to support the overall operations, such as providing food and supplies.

COMMUNICATION COMMITMENTS

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Figure 1: Location map of proposed operational area key features

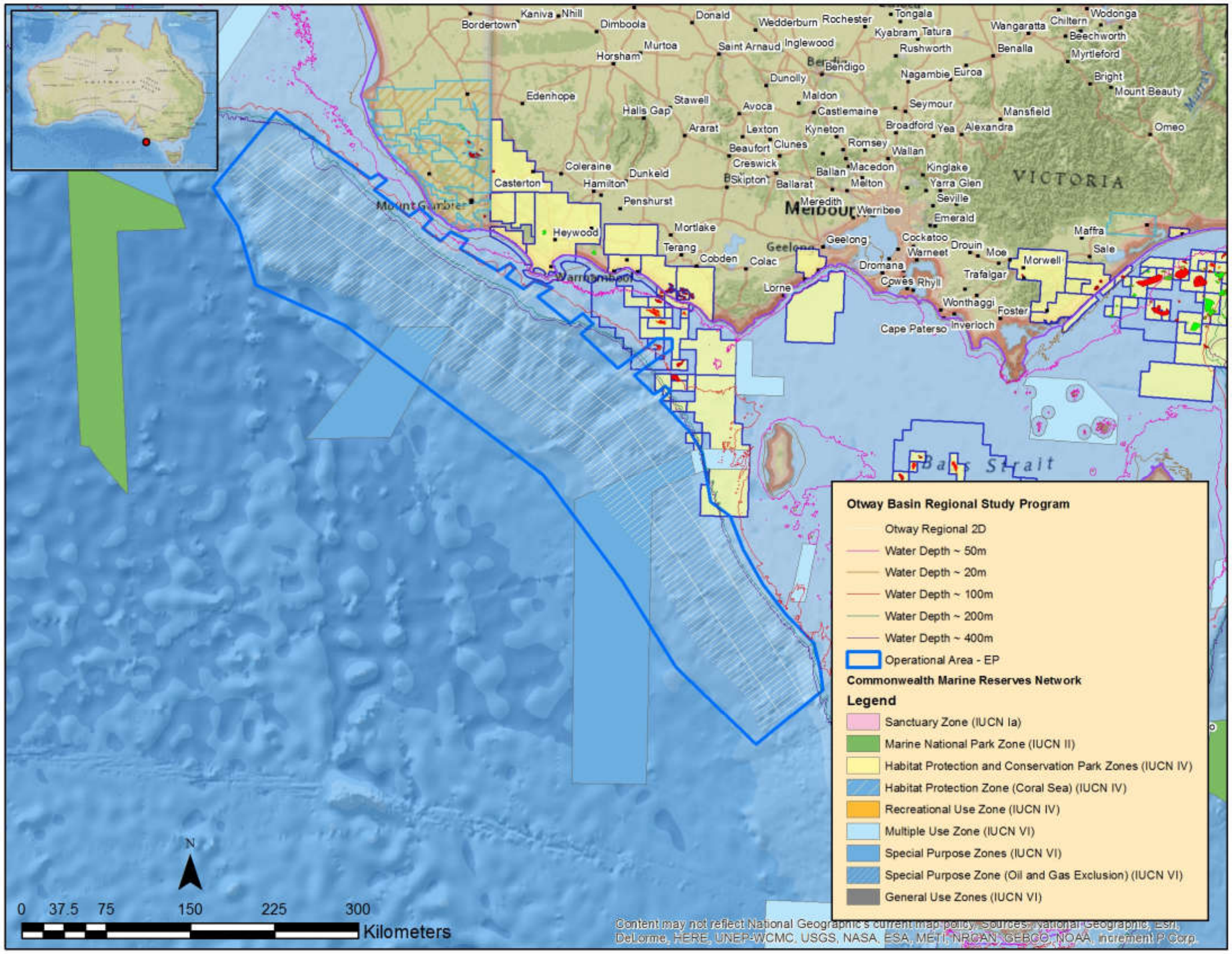

Table 1: Coordinates of the proposed operational area, permits which overlap the operational area and distances to key regional features

S No	Long	Lat	S No	Long	Lat
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2	139.92	-37.65	30	142.45	-39.21
3	139.79	-37.72	31	142.66	-39.36
4	140.14	-37.94	32	142.71	-39.33
5	140.25	-37.87	33	142.78	-39.30
6	140.37	-37.96	34	142.83	-39.33
7	140.27	-38.03	35	142.73	-39.41
8	140.46	-38.14	36	143.04	-39.66
9	140.56	-38.07	37	143.17	-39.82
10	140.73	-38.14	38	143.27	-40.22
11	140.66	-38.21	39	143.48	-40.33
12	141.04	-38.38	40	143.63	-40.59
13	141.17	-38.33	41	143.85	-40.87
14	141.22	-38.36	42	144.10	-41.10
15	141.12	-38.43	43	144.41	-41.33
16	141.31	-38.53	44	144.49	-41.52
17	141.42	-38.47	45	144.53	-41.70
18	141.60	-38.52	46	143.83	-42.15
19	141.45	-38.59	47	142.94	-41.55
20	141.79	-38.80	48	142.36	-40.86
21	141.91	-38.72	49	141.51	-40.02
22	142.02	-38.80	50	139.47	-38.81
23	141.90	-38.89	51	138.57	-38.47
24	142.28	-39.16	52	138.41	-38.00
25	142.58	-38.98	53	138.16	-37.68
26	142.68	-38.92	54	138.82	-37.09
27	142.83	-38.92	55	139.75	-37.63
28	142.83	-39.00	56	139.84	-37.60

Permits within Operational area	T/30P, and T/49P

Relative proximity of key regional features to the operational area	Feature	Distance
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	Zeehan – Special Purpose Zone (IUCN VI) & Multi Use Zone	Intersect Area
	Franklin – Multi Use Zone (IUCN VI)	1 km east
	Apollo – Multi Use Zone (IUCN VI)	58 km east
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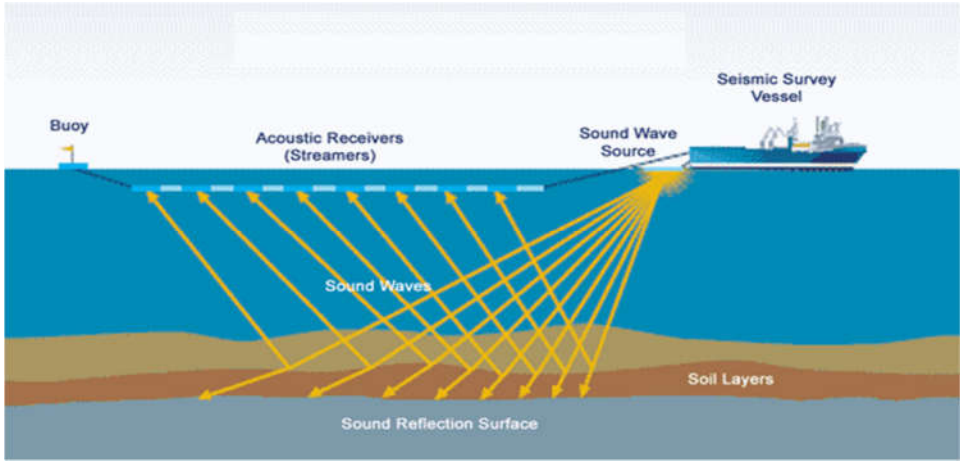
Figure 2: Schematic of typical 2D geophysical survey



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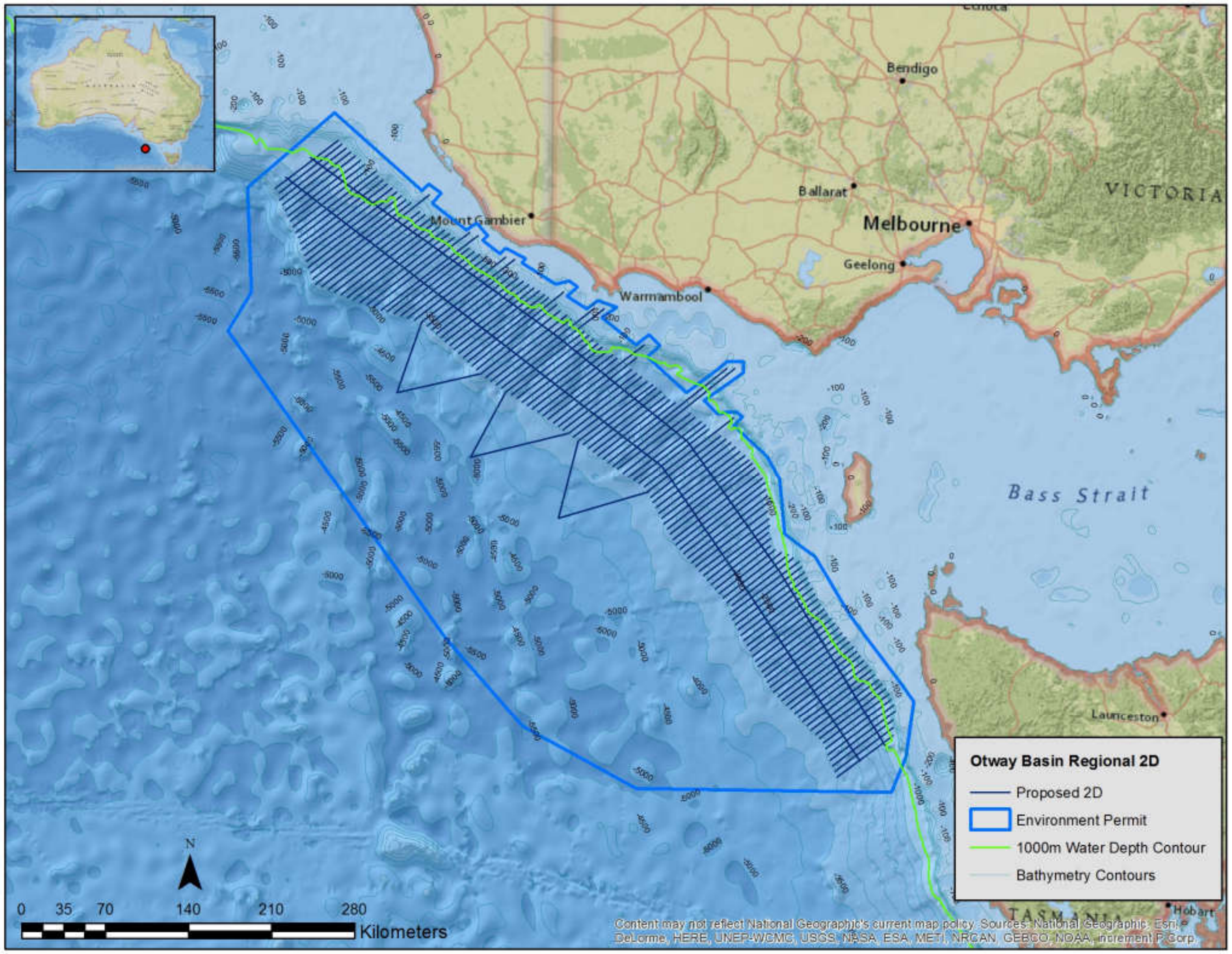

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9	140.53	-38.07	37	143.21	-39.80
10	140.72	-38.15	38	143.27	-40.22
11	140.68	-38.18	39	143.48	-40.33
12	141.01	-38.35	40	143.58	-40.38
13	141.14	-38.32	41	143.94	-40.81
14	141.22	-38.36	42	144.14	-41.00
15	141.12	-38.43	43	144.47	-41.31
16	141.31	-38.53	44	144.62	-41.45
17	141.42	-38.47	45	144.56	-41.87
18	141.60	-38.52	46	144.43	-42.14
19	141.45	-38.59	47	141.83	-42.16
20	141.79	-38.80	48	140.67	-41.69
21	141.91	-38.72	49	139.90	-41.02
22	142.02	-38.80	50	137.84	-38.65
23	141.90	-38.89	51	138.08	-38.37
24	142.28	-39.16	52	138.07	-37.57
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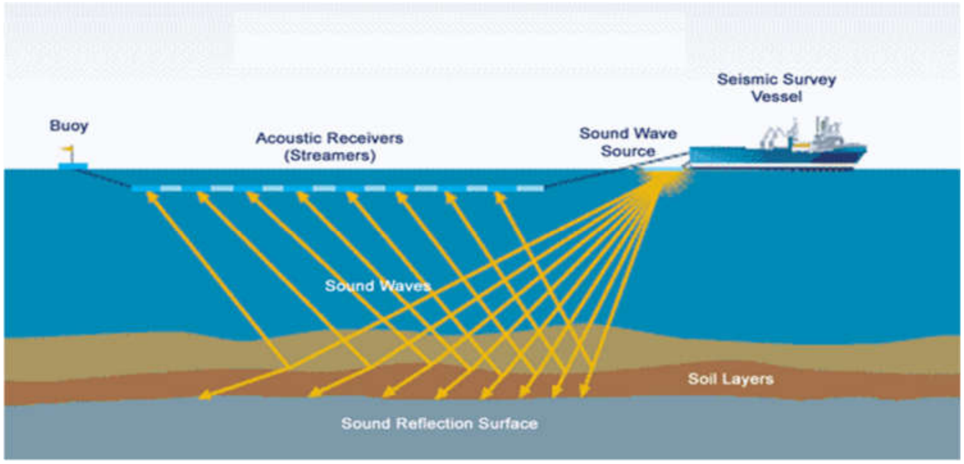

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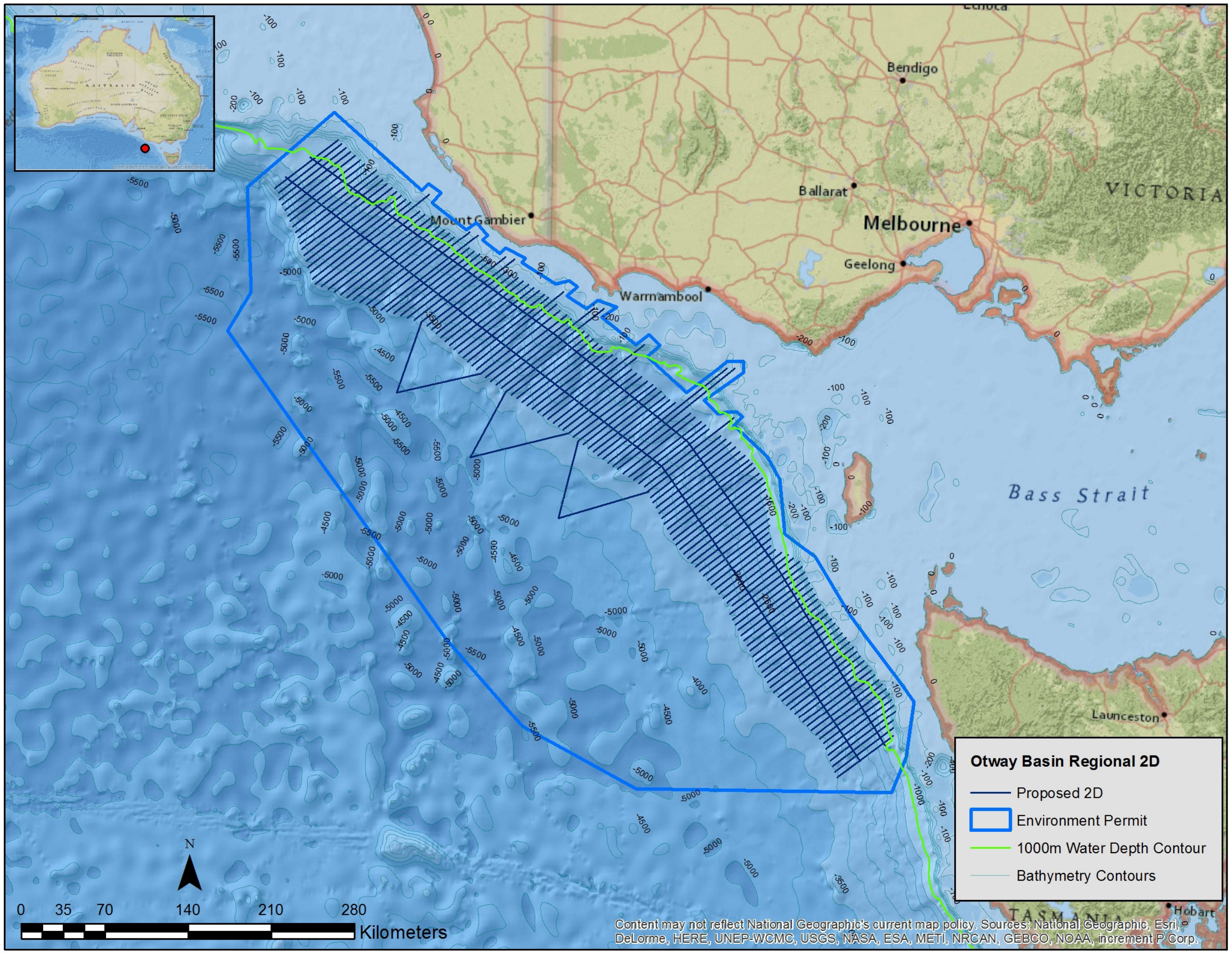

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9	140.53	-38.07	37	143.21	-39.80
10	140.72	-38.15	38	143.27	-40.22
11	140.68	-38.18	39	143.48	-40.33
12	141.01	-38.35	40	143.58	-40.38
13	141.14	-38.32	41	143.94	-40.81
14	141.22	-38.36	42	144.14	-41.00
15	141.12	-38.43	43	144.47	-41.31
16	141.31	-38.53	44	144.62	-41.45
17	141.42	-38.47	45	144.56	-41.87
18	141.60	-38.52	46	144.43	-42.14
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20	141.79	-38.80	48	140.67	-41.69
21	141.91	-38.72	49	139.90	-41.02
22	142.02	-38.80	50	137.84	-38.65
23	141.90	-38.89	51	138.08	-38.37
24	142.28	-39.16	52	138.07	-37.57
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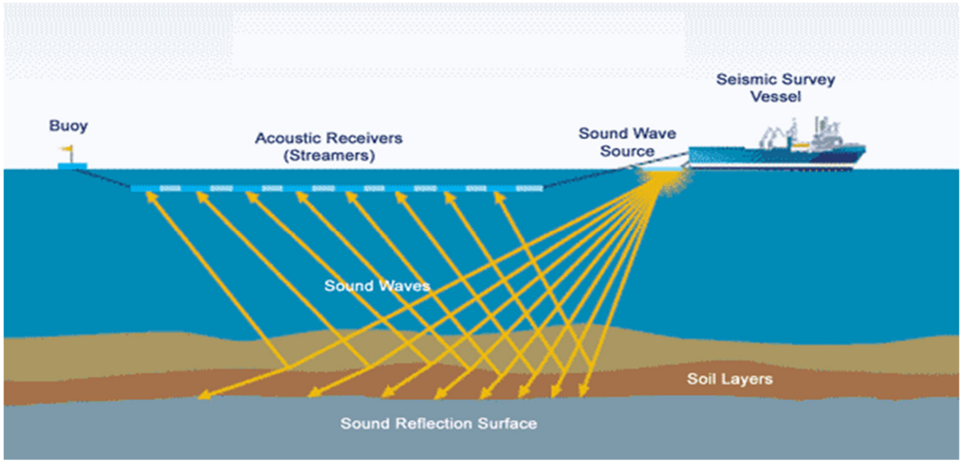

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Due to the nature of seismic survey operations, the timing and location of the activity are prone to minor changes. To eliminate confusion, Schlumberger commits to notifying stakeholders of schedule location and vessel details as they are confirmed. This will be supported by 48-hour lookaheads and notification provided to relevant stakeholders during operations. If you wish to receive these notifications, or specific information regarding this survey, please advise in response to this package as soon as possible.

Following submission of the EP to NOPSEMA, stakeholder engagement will continue throughout the EP review period and survey acquisition to ensure everyone is kept informed and to minimise potential for disruption to any ongoing activities in the area.

ENVIRONMENTAL PERFORMANCE

Schlumberger is committed to working with all interested parties to ensure risks are identified and reduced to as low as reasonably practicable (ALARP) before activities begin. Latest technology in sound modelling will be used to understand emitted sound levels for the survey across different parts of the operational area. This will include detailed impact assessments and the adoption of appropriate mitigation measures that will be documented in the EP.

There will be Marine Fauna Observers (MFOs) onboard who will monitor precaution zones, observation zones, and low power zones in accordance with EPBC Act during daylight hours. There will also be Passive Acoustic Monitoring (PAM) 24hours a day to monitor for marine mammals in the vicinity of survey vessel. Mitigation measures will be implemented to minimize any potential for disturbance to marine mammals during the survey

NOPSEMA reviews each project-specific EP in accordance with the requirements of the Offshore Petroleum Greenhouse Gas (Environment) Regulations 2009 before any approvals to the proposed survey can be made.

Schlumberger has a reputation for the highest standards of environmental protection in environmentally sensitive areas.

YOUR FEEDBACK

As indicated above, Schlumberger is seeking feedback about this proposed activity before making a formal submission to NOPSEMA. The proposed seismic survey is subject to Commonwealth Government regulatory approval and any feedback will be communicated to NOPSEMA, as required under Commonwealth legislation.

If you would like to comment on the survey or would like additional information, please contact us as soon as possible. Schlumberger is arranging meetings with local stakeholders towards the end of November to discuss the project in more detail. If you would like a meeting please confirm your availability prior to this date.

Best Regards,
Kunal Mishra

Schlumberger Australia Pty Ltd:
Level 5 256 St Georges Terrace
Perth WA, 6000(08) 9420 4800
Email: environment@slb.com

Schlumberger

Figure 1: Location map of proposed operational area key features

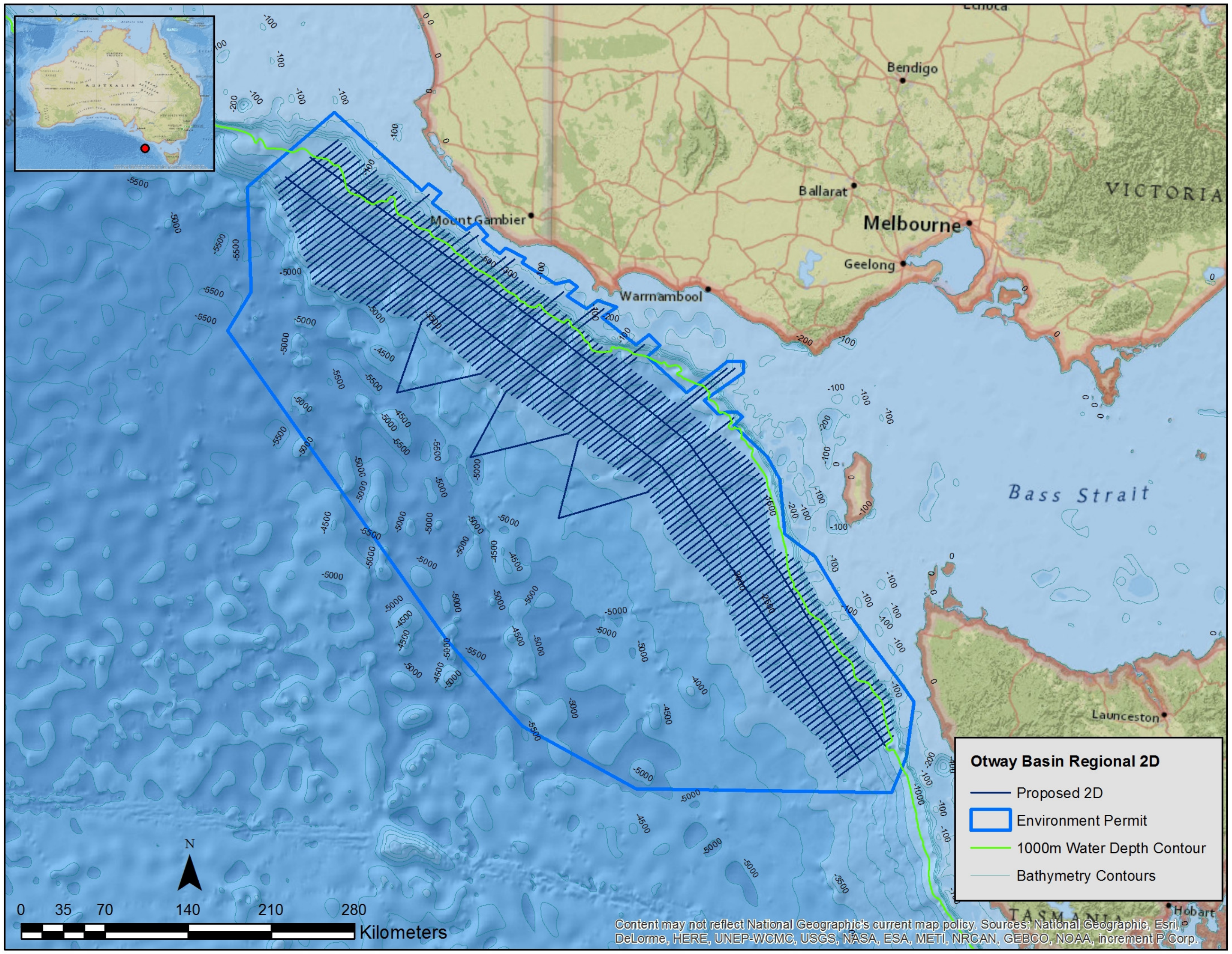


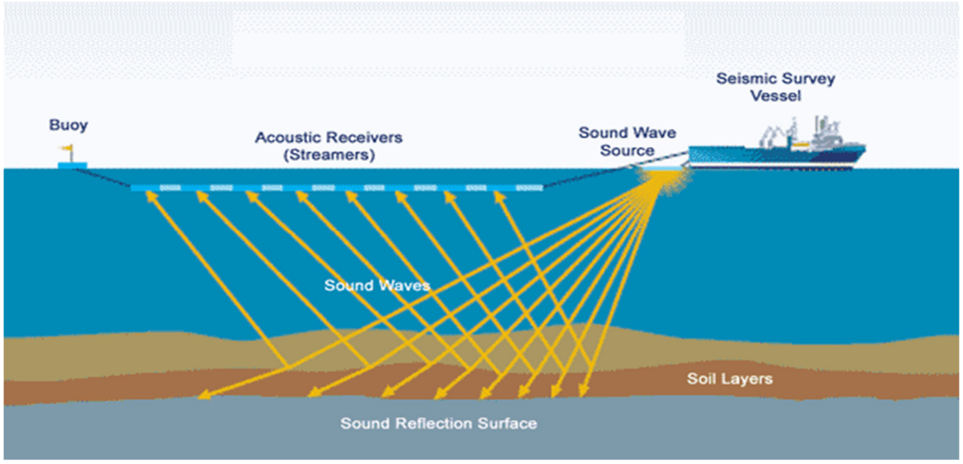
Table 1: Coordinates of the proposed operational area, permits which overlap the operational area and distances to key regional features

S No	Long	Lat	S No	Long	Lat
1	139.80	-37.58	29	142.67	-39.09
2	139.92	-37.65	30	142.45	-39.21
3	139.83	-37.72	31	142.59	-39.32
4	140.15	-37.93	32	142.67	-39.30
5	140.25	-37.87	33	142.78	-39.30
6	140.36	-37.97	34	142.83	-39.33
7	140.31	-38.01	35	142.75	-39.40
8	140.47	-38.11	36	143.08	-39.63
9	140.53	-38.07	37	143.21	-39.80
10	140.72	-38.15	38	143.27	-40.22
11	140.68	-38.18	39	143.48	-40.33
12	141.01	-38.35	40	143.58	-40.38
13	141.14	-38.32	41	143.94	-40.81
14	141.22	-38.36	42	144.14	-41.00
15	141.12	-38.43	43	144.47	-41.31
16	141.31	-38.53	44	144.62	-41.45
17	141.42	-38.47	45	144.56	-41.87
18	141.60	-38.52	46	144.43	-42.14
19	141.45	-38.59	47	141.83	-42.16
20	141.79	-38.80	48	140.67	-41.69
21	141.91	-38.72	49	139.90	-41.02
22	142.02	-38.80	50	137.84	-38.65
23	141.90	-38.89	51	138.08	-38.37
24	142.28	-39.16	52	138.07	-37.57
25	142.58	-38.98	53	138.91	-37.02
26	142.68	-38.92	54	139.74	-37.63
27	142.83	-38.92	55	139.80	-37.58
28	142.83	-39.00			

Permits within Operational area	T/30P, and T/49P

Relative proximity of key regional features to the operational area	Feature	Distance
	Nelson – Special Purpose Zone (IUCN VI)	Intersect Area
	Zeehan – Special Purpose Zone (IUCN VI) & Multi Use Zone	Intersect Area
	Franklin – Multi Use Zone (IUCN VI)	0.3 km east
	Apollo – Multi Use Zone (IUCN VI)	58 km east
	Boags – Multi Use Zone (IUCN VI)	115 km east
	Murray – Marine National Park Zone (IUCN II)	38 km west
	Murray – Multi Use Zone (IUCN VI)	45 km west

Figure 2: Schematic of typical 2D geophysical survey



Schlumberger

Otway Basin Marine Seismic Survey

Schlumberger proposes to undertake a two-dimensional (2D) marine seismic survey in Otway Basin, in Commonwealth waters adjacent to South Australia (**SA**), Victoria (**VIC**) and Tasmania (**TAS**). The operational area is 92,000 km^2 located 190 km south east of Kingscote SA, 18 km south of Portland VIC and 241 km northwest of Strahan TAS. Water depths in the survey area range from 50 to 5,600 m, with 98% of the survey lines in water depths greater than 200 m (**Figure 1**).

Coordinates for the Operational Area are outlined in **Table 1**. In developing the Operational Area, a 15 km buffer has been applied around the proposed survey lines in most cases.

The Operational Area experiences rough metocean conditions, and to ensure safety and efficiency, it is proposed the survey is undertaken during the calmer months of January 2019 to May 2019. The survey is expected to require no more than 100 days of continuous activity, but a maximum activity window of 150 days is proposed to allow flexibility for weather and logistics, and to avoid any potential sensitivities identified during the stakeholder engagement. This maximum activity window will not consist of continuous survey days. The Environment Plan (**EP**) is being prepared for the entire year to fully understand the entire marine environment in this area.

PROPOSED ACTIVITY

Offshore seismic surveying is used to improve the understanding of subsurface geology in marine environments.

During 2D marine surveys, seismic data is acquired using a purpose-built seismic survey vessel towing an acoustic source array and a single hydrophone cable, also known as a streamer. Streamers are towed with a tail buoy, radar reflectors and lights to mark the end of the array. The streamer will be up to 11 km long to adequately record the necessary information.

Both the source and streamer are towed beneath the surface, (**Figure 2**). Acoustic energy from the source array is detected by the streamer and recorded on board the vessel. The recorded signals are then processed to provide information about geological formations below the seabed.

When recording the data, the seismic vessel traverses the survey area along a series of predetermined sail lines at a speed of approximately 4-5 knots (7-9 km/h). The level of acoustic emissions can be adjusted to provide low-power 'soft start' or 'fauna alert' procedures, at any point during the survey or maintenance operations.

To minimise survey duration, geophysical data will be acquired 24 hours a day. Each 2D line is about 90 kilometres long and will take approximately 11 hours to complete. Data for a pre-determined line only needs to be acquired once, and the survey vessel will not need to collect data in that area again. *More than 90% of the acquisition is in water depths greater than 1,000m, with the shallowest line located 12 kilometres from shore and deeper than 50m.*

A support vessel will work with the seismic vessel to assist in communicating with other vessels that have entered the area of operations and to support the overall operations, such as providing food and supplies.

There has been extensive planning for the proposed survey through the EP development, with feedback being incorporated to minimize potential for disturbance to the surrounding environment. Due to time constraints, the original scope of the operational area was reduced by 73,000 km^2 to ensure the survey's primary objectives can be achieved safely and efficiently, whilst avoiding peak fishing activity in December. The reduction includes the removal of 2,700 linear km from the southernmost extent of the proposed program.

Schlumberger

COMMUNICATION COMMITMENTS

Schlumberger is committed to maintaining regular communication with all relevant stakeholders throughout the duration of the survey and works with communities in a transparent manner.

As part of this continuous consultation, Schlumberger invites feedback on the proposed activities. Details of all consultation received will be provided to the National Offshore Petroleum Safety and Environment Management Authority (**NOPSEMA**) in accordance with EP procedures.

Due to the nature of seismic survey operations, the timing and location of the activity are prone to minor changes. To ensure clarity, Schlumberger commits to notifying stakeholders of schedule location and vessel details as they are confirmed. This will be supported by 48-hour lookaheads and notification provided to relevant stakeholders during operations. If you wish to receive these notifications, or specific information regarding this survey, please advise in response to this package as soon as possible.

Following submission of the EP to NOPSEMA, stakeholder engagement will continue throughout the EP review period and survey acquisition to ensure everyone is kept informed and to minimise potential for disruption to any ongoing activities in the area.

ENVIRONMENTAL PERFORMANCE

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There will be two dedicated Marine Mammal Observers (**MMOs**) onboard who will monitor precaution zones, observation zones, and low power zones during daylight hours in accordance with the Environment Protection and Biodiversity Conservation Act. There will also be Passive Acoustic Monitoring **(PAM)** 24 hours a day to monitor for whales in the vicinity of survey vessel. Mitigation measures will be implemented to minimize any potential for disturbance to whales during the survey.

NOPSEMA reviews each project-specific EP in accordance with the requirements of the Offshore Petroleum Greenhouse Gas (Environment) Regulations 2009 before any approvals to the proposed seismic survey can be made.

Schlumberger has a reputation for the highest standards of environmental protection in environmentally sensitive areas and will implement these procedures for the duration of this proposed survey.

YOUR FEEDBACK

As indicated above, Schlumberger is seeking feedback about this proposed activity before making a formal submission to NOPSEMA and some questions have been provided below. The proposed survey is subject to Commonwealth Government regulatory approval and any feedback will be communicated to NOPSEMA, as required under Commonwealth legislation. We intend to lodge the EP to NOPSEMA shortly so please get in touch if you have any questions or comments.

If you would like to comment on the survey or would like additional information, please contact us as soon as possible. If you would like to meet with us to discuss the survey further or raise any concerns you have in relation to your fishing activities, please get in touch with me at the contact details below.

Questions on proposed Otway Basin 2D Seismic Survey

- Do you fish in the proposed Operational Area?
- What fish species do you target between months of January and April each year
- What method of fishing do you use?
- What depth range do you fish for your target species?

Best regards,
Kunal Mishra

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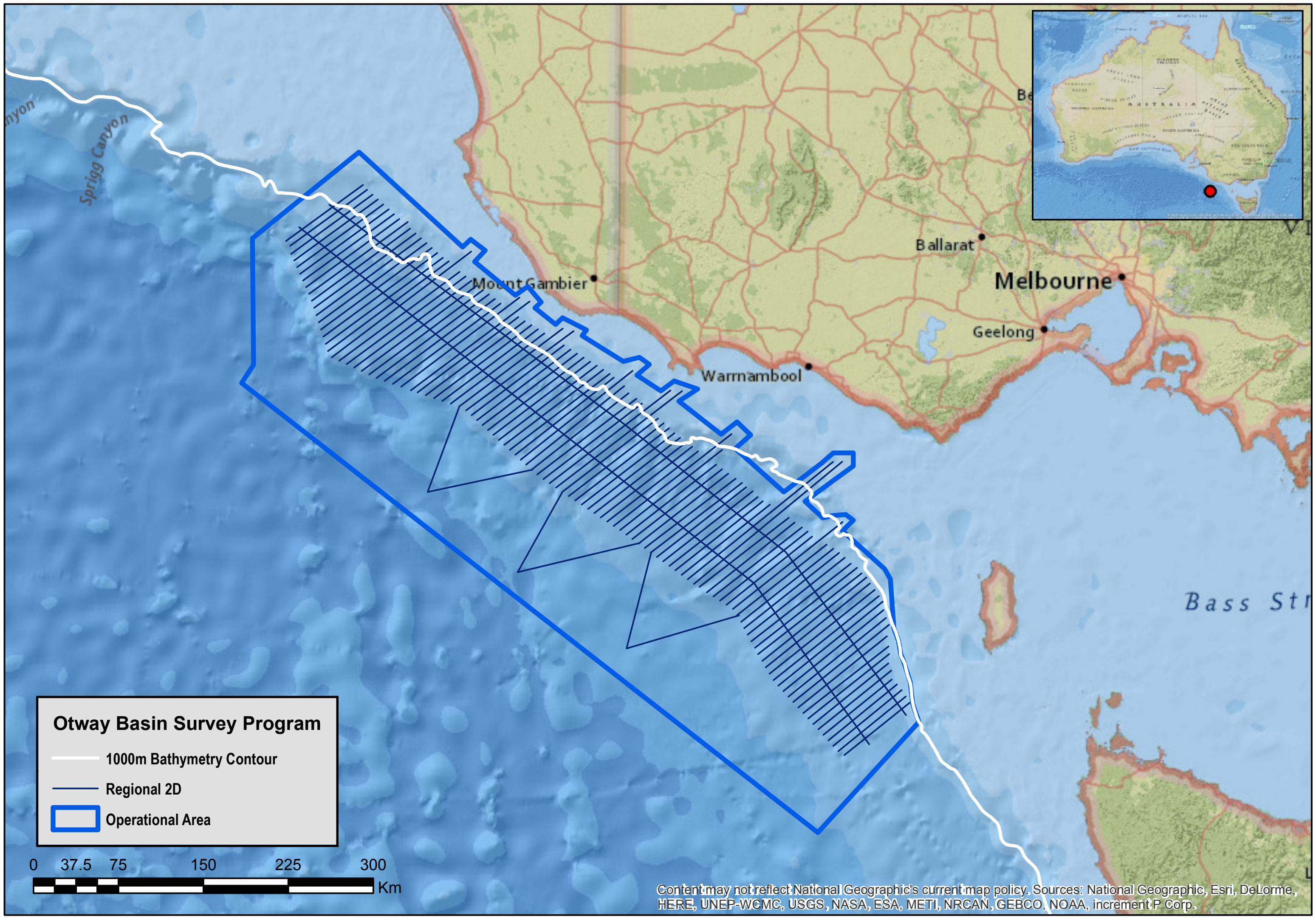
Figure 1: Location map of revised operational area



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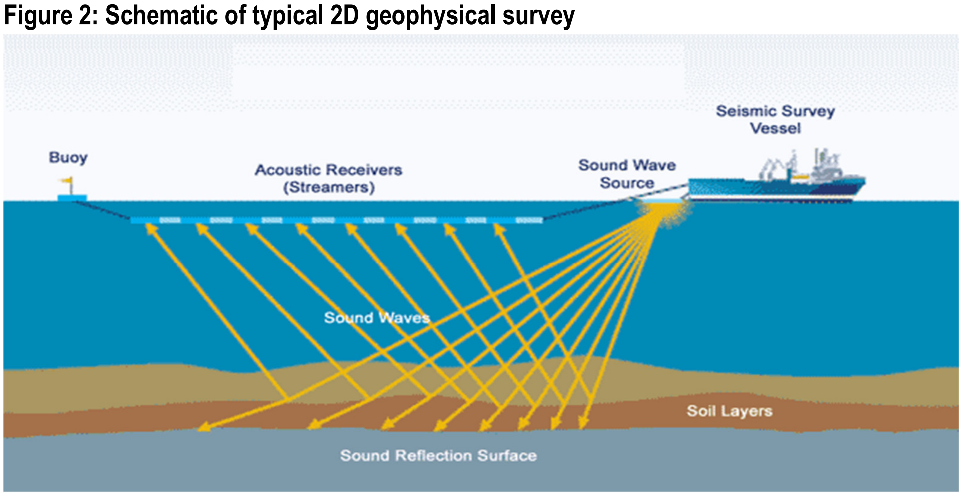
6	140.36	-37.97	34	142.78	-39.30
7	140.31	-38.01	35	142.83	-39.33
8	140.47	-38.11	36	142.75	-39.40
9	140.53	-38.07	37	143.08	-39.63
10	140.72	-38.15	38	143.13	-39.69
11	140.68	-38.18	39	143.16	-40.00
12	141.01	-38.35	40	143.19	-40.07
13	141.14	-38.32	41	143.21	-40.15
14	141.22	-38.36	42	143.23	-40.19
15	141.12	-38.43	43	143.29	-40.32
16	141.31	-38.53	44	143.31	-40.46
17	141.42	-38.47	45	143.36	-40.57
18	141.60	-38.52	46	142.55	-41.23
19	141.45	-38.59	47	137.98	-38.48
20	141.79	-38.80	48	138.08	-38.37
21	141.91	-38.72	49	138.07	-37.57
22	142.02	-38.80	50	138.91	-37.02
23	141.90	-38.89	51	139.74	-37.63
24	142.28	-39.16	52	139.80	-37.58
25	142.58	-38.98			
26	142.68	-38.92			
27	142.83	-38.92			
28	139.80	-37.58			

Figure 2: Schematic of typical 2D geophysical survey



Schlumberger

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Coordinates for the Operational Area are outlined in **Table 1**. In developing the Operational Area, a 15 km buffer has been applied around the proposed survey lines in most cases.

The Operational Area experiences rough metocean conditions, and to ensure safety and efficiency, it is proposed the survey is undertaken during the months of October 2019 to April 2020. The survey is expected to require no more than 100 days of continuous activity, but a maximum activity window of 180 days is proposed to allow flexibility for weather and logistics, and to avoid any potential sensitivities identified during the stakeholder engagement. This maximum activity window will not consist of continuous survey days. The Environment Plan (**EP**) is being prepared for the entire year to fully understand the entire marine environment in this area.

PROPOSED ACTIVITY

Offshore seismic surveying is used to improve the understanding of subsurface geology in marine environments.

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YOUR FEEDBACK

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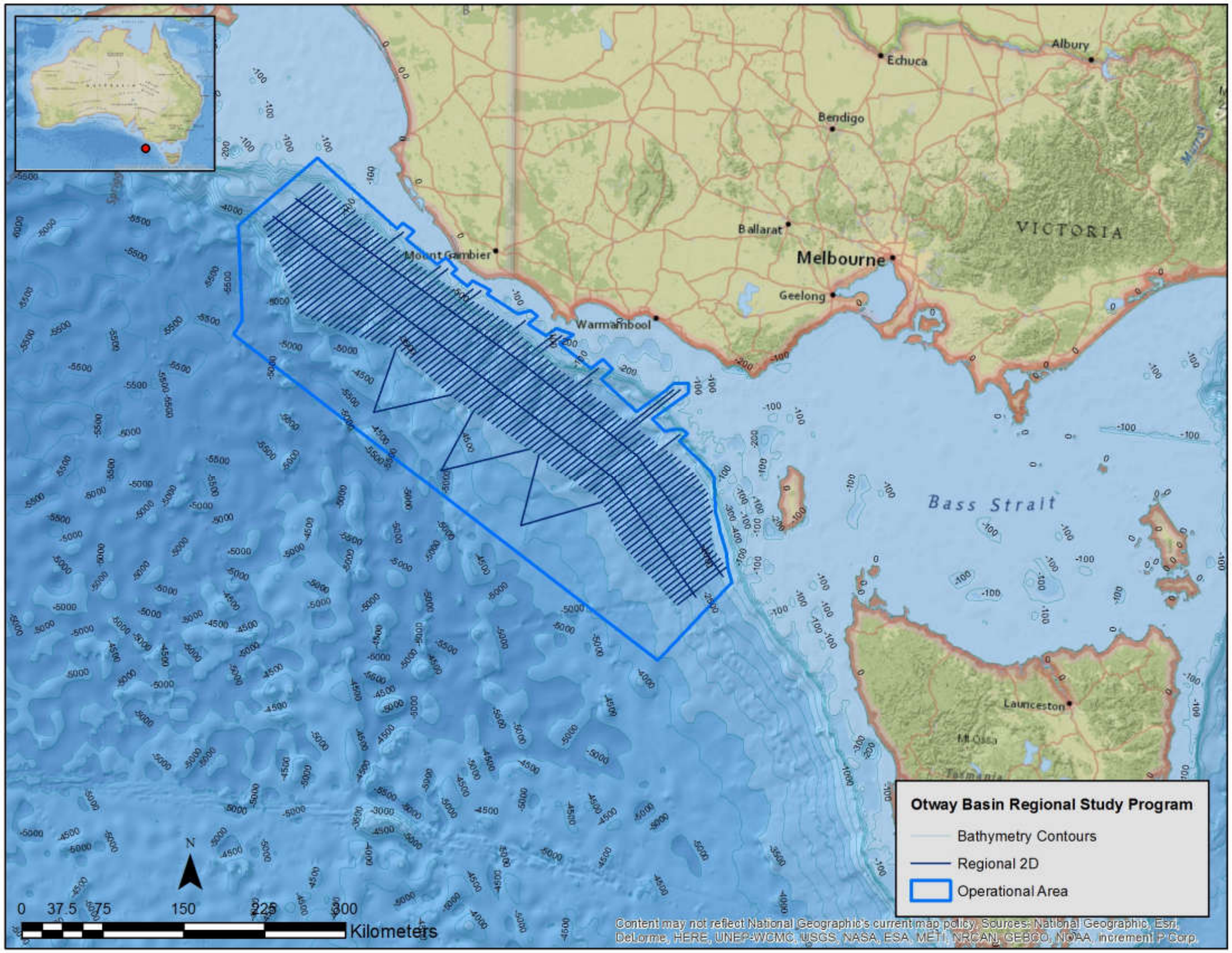

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6	140.36	-37.97	**34**	142.78	-39.30
7	140.31	-38.01	**35**	142.83	-39.33
8	140.47	-38.11	**36**	142.75	-39.40
9	140.53	-38.07	**37**	143.08	-39.63
10	140.72	-38.15	**38**	143.13	-39.69
11	140.68	-38.18	**39**	143.16	-40.00
12	141.01	-38.35	**40**	143.19	-40.07
13	141.14	-38.32	**41**	143.21	-40.15
14	141.22	-38.36	**42**	143.23	-40.19
15	141.12	-38.43	**43**	143.29	-40.32
16	141.31	-38.53	**44**	143.31	-40.46
17	141.42	-38.47	**45**	143.36	-40.57
18	141.60	-38.52	**46**	142.55	-41.23
19	141.45	-38.59	**47**	137.98	-38.48
20	141.79	-38.80	**48**	138.08	-38.37
21	141.91	-38.72	**49**	138.07	-37.57
22	142.02	-38.80	**50**	138.91	-37.02
23	141.90	-38.89	**51**	139.74	-37.63
24	142.28	-39.16	**52**	139.80	-37.58
25	142.58	-38.98			
26	142.68	-38.92			
27	142.83	-38.92			
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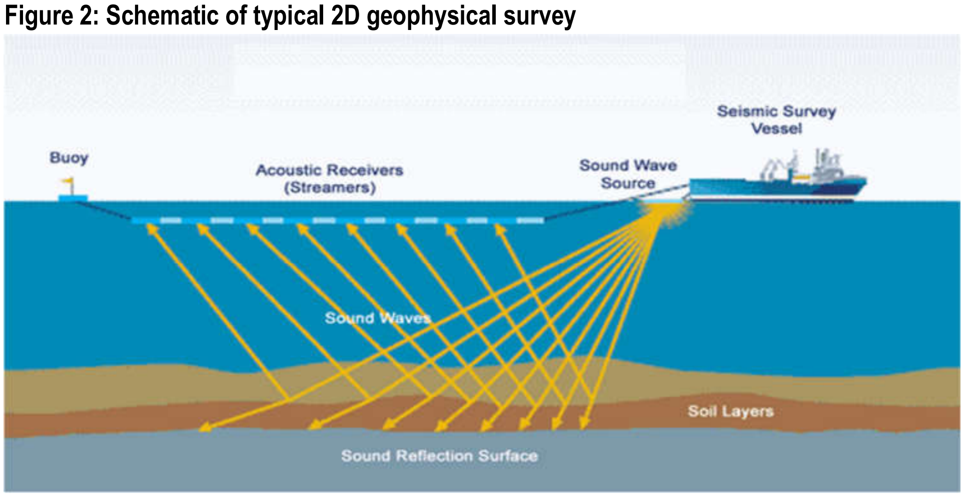
Figure 2: Schematic of typical 2D geophysical survey



APPENDIX F

Summary of all Feedback Received and Responses Provided by SLB

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
Department or Agency of the Commonwealth							
1	Australian Fisheries Management Limited (AFMA)	03-09-18	Email outgoing		Introductory email from SLB with Information Pack Rev 1.	N/A	Information Packs can be viewed in **Appendix E**.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	See above.
2	Australian Fisheries Management Limited (AFMA) – Petroleum Sector	31-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	See above.
		31-10-18	Email incoming	Website link provided for all information with regard to fishing associations and contact details.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		31-10-18	Email outgoing		**Response to AFMA email dated 31-10-18:** Engagement process with fishing industry is already underway, and a fisheries assessment will be provided by SETFIA. SLB will engage SIV for consultation, as well as TSIC although this is not yet confirmed. SLB would appreciate any further information AFMA are willing/able to provide. Enquired on AFMA's ability to provide contact details of licence holders with Commonwealth statutory fishing rights.	N/A	See above.
		07-11-18	Email incoming	**Response to SLB email dated 31-11-18:** Contact AFMA Licensing to receive contact details of licence holders with Commonwealth statutory fishing rights.		No objections or claims – no response/actions required.	See above.
		18-03-19	Email outgoing		Timing update email sent with Information Pack Rev 4.	N/A	Information Packs can be viewed in **Appendix E**.
3	Australian Fisheries Management Limited (AFMA) – Southeast Trawl Sector	24-10-18	Email outgoing		Introductory email with information sheet attached and request for meeting. Information Pack Rev 1.	N/A	See above.
		24-10-18	Email incoming	**Response to SLB email dated 24-10-18:** [redacted] is based in Lakes Entrance. He will be unable to meet on the proposed dates but is happy to catch up on the phone or if SLB are ever in Lakes Entrance.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		25-10-18	Email outgoing		**Response to [redacted] email dated 24-10-18:** [redacted] interested in having a phone call with [redacted] and enquired as to the best time to phone.	N/A	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		31-10-18	Phone Call	[redacted] comfortable to hear that SETFIA were undertaking a fisheries assessment as to the fisheries that may be impacted. While [redacted] did not have many concerns, he stated that SLB need to consider the indirect effects on shallower waters.		Concerns were raised regarding effects on shallow waters. These have been addressed in the EP. No response back was required, and no additional control measures were considered.	Memo from phone call available in **Appendix D**. SETFIA report incorporated throughout fisheries descriptions in **Section 5.5.2.5**. The full SETFIA report is provided in **Appendix G**. Potential impacts from acoustic disturbance on protected areas in coastal/shallow waters are discussed in **Section 7.2.2.4.**
		21-11-18	Email outgoing		Update email sent with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update email sent with Information Pack Rev 4 sent.	N/A	See above.
		18-03-19	Email incoming	Acknowledgement email received		No objections or claims – no response/actions required.	N/A
4	Commonwealth Fisheries Association	07-09-18	Email outgoing		Introductory email with Information Pack Rev 1.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update email sent with Information Pack Rev 4 sent.		
5	Department of Agriculture & Water Resources	04-12-18	Email outgoing		Introductory email with Information Pack Rev 3 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
6	Parks Australia – Director of National Parks	07-12-18	Email outgoing		Introductory email with Information Pack Rev 3 sent.	N/A	Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
		08-05-19	Email incoming	**<u>Response to SLB email dated 18-03-19:</u>** Thanked SLB for the opportunity to comment on the summary provided. Operational Area is located within the Zeehan and Nelson Marine Parks, and in close proximity to Murray and Apollo Marine Parks.		No objections or claims were made; however, guidance on the natural values required to be assessed were noted and have been	Unedited correspondence provided in **Appendix C**. A description of the

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				The South-east Commonwealth Marine Reserves Network Management Plan allows for mining authorisation to be given through a class approval. SLB needs to be aware of their obligations under the class approval. Provided guidance on what is required to be assessed as part of preparing an EP. Need to consider the impacts and risks in the context of the management plan objectives and values and ensure that the impacts and risks on Australian marine parks are ALARP and at an acceptable level. Provided a description of the specific natural values for each of the marine parks within or near the Operational Area. Requested the DNP is notified of an oil/gas pollution incident which may impact on a marine park as soon as possible, including the details required in the notification. DNP also requested notification if the EP is approved by NOPSEMA. In addition, notification at least 10 days prior to all survey activities occurring within a marine park (except transiting) and conclusion of the activity.		discussed within the EP. SLB ensured notifications requested by DNP were included within the EP.	Australian Marine Parks is provided in **Section 5.3.3**, and specifically those within the Operational Area in **Section 5.3.3.2** (including Zeehan and Nelson Marine Parks), and those within the wider environment **Section 5.3.3.3** (including Murray, Apollo, Boags and Franklin Marine Parks). Potential impacts from acoustic disturbance on Australian Marine Parks are discussed in **Section 7.2.2.4.1** which provides various cross referencing to sections throughout **Section 7** which assessed potential impacts on specific natural values. Notifications of a hydrocarbon spill includes DNP within **Table 107** in **Section 10.9.5.3**. Notification of DNP prior to and at the conclusion of activities within a marine park included within **Table 15** in **Section 4.5.10**.
		13-05-19	Email outgoing		**<u>Response to DNP email dated 08-05-19:</u>** Thanked DNP for detailed response and the information provided. Detailed the fact that the South-east Commonwealth Marine Reserves Network Management Plan has been utilised extensively during the preparation of the EP. Provide assurance that the sensitivities within the marine parks, along with other sensitive areas have been considered within the risk assessment process. Extensive control measures will be implemented to reduce potential impacts to marine mammals as one of the key sensitivities within the marine parks. Notification requirements included within the operational procedures and the implementation strategy of the EP. Provided update on lodgement under the latest amendments to the Environment Regulations and offered to provide link to the EP once its available online for public submission.	N/A	
7	Department of Defence	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		31-10-18	Email incoming	Acknowledgement email received		No objections or claims – no response/actions required.	N/A
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
8	GeoScience Australia	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	See above.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
9	Shipping Australia	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with. Information Pack Rev 4 sent.		
Department or Agency of the State							
10	Bass Coast Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	See above.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		21-11-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
11	Borough of Queenscliffe, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	See above.

Stakeholder Engagement Table

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		18-03-19	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
12	Burnie City Council – Tasmania	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
13	CarbonNet – Victoria State Govt, Economic Development, Jobs, Transport, Resources	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
14	Central Coast Council – Tasmania	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
15	Circular Head Council – Tasmania	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
16	City of Port Lincoln	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	See above.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
17	Colac Otway Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	N/A
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	See above.
		18-03-19	Email incoming	Automated reply acknowledging email		No objections or claims – no response/ actions required.	N/A

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
18	Conservation Council SA	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
19	Corangamite Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
20	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Gippsland Basin Activities (DEDJTR)	31-10-18	Email outgoing		Introductory email sent, information sheet not included.	N/A	Unedited correspondence provided in **Appendix C**.
		31-10-18	Email incoming	**<u>Response to SLB email dated 31-10-18:</u>** [redacted] requested clarification on the following: • Confirmation Otway Basin is Victorian Otway Basin; • Onshore or offshore?; • If offshore, is it within 3 NM?; and • Are SLB notifying DEDJTR as a stakeholder or seeking approval?		No objections or claims were made but SLB provided clarification to stakeholder (see below).	See above.
		31-10-18	Email outgoing		**<u>Response to [redacted] email dated 31-10-18:</u>** [redacted] confirmed/answered [redacted] questions.	N/A	See above
		31-10-18	Email incoming	[redacted] will notify regional managed (South-west) and is assuming it is a multiclient survey.		No objections or claims – no response/actions required.	See above.
		31-10-18	Email outgoing		Information Pack Rev 1 sent as it was omitted from earlier email.	N/A	See above.
		01-11-18	Email incoming	**<u>Response to SLB email dated 31-10-18:</u>** [redacted] provided email addresses for stakeholder engagement and for incident reporting within 3 NM.		No objections or claims – no response/actions required.	See above.
		01-11-18	Email outgoing		**<u>Response to [redacted] email dated 01-11-18:</u>** Acknowledged supply of contact details and Information Sheet attached to be passed on to the newly provided email addresses.	N/A	See above.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		22-11-18	Email incoming	[redacted] requested all future communication to include Operational Reports email.		No objections or claims were made but SLB confirmed request (see below).	Unedited correspondence provided in **Appendix C**.
		23-11-18	Email outgoing		**<u>Response to [redacted] email dated 22-11-18:</u>** Confirmation of previous request from [redacted] that Operational Reports email was included in the email.	N/A	See above.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		23-11-18	Email incoming	[redacted] leaving Earth Resources and requested removal from further correspondence.		No objections or claims – no response/actions required.	See above.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
21	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Incident Reporting	21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
22	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Otway Basin Activities	21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
23	Department of Economic Development, Jobs, Transport & Resources (Victoria) – Petroleum	21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
24	Department of Environment, Land, Water and Planning (Victoria) DELWP	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Unedited correspondence provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C.**
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		22-11-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C.**
25	Department of Primary Industry, Parks, Water and Environment (DPIPWE) (Tasmania)	24-08-18	Email outgoing		Following receiving contact details from [redacted], [redacted] sent an introductory email and stated that any feedback is welcome and that SLB are contactable by phone or email with any concerns or queries. [redacted] informed of meetings being arranged with local stakeholders and requested confirmation of availability.	N/A	Unedited correspondence provided in **Appendix C**.
		30-08-18	Email outgoing		Introductory email with Information Pack Rev 1 to [redacted].	N/A	Information Packs can be viewed in **Appendix E**.
		08-10-18	Email outgoing		Introductory email sent. Information Pack Rev 1 to [redacted].	N/A	

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
							Unedited correspondence provided in **Appendix C**.
		23-10-18	Email outgoing		Introductory email sent to [redacted]. Information Pack Rev 1 sent.	N/A	See above.
		23-10-18	Email incoming	[redacted] requested map of survey area that doesn't cover Tasmania.		No objections or claims raised. SLB provided additional information as requested by stakeholder.	Unedited correspondence provided in **Appendix C**.
		24-10-18	Email outgoing		**<u>Response to [redacted] email dated 24-10-18:</u>** [redacted] attached map of proposed survey area showing survey lines and seabed bathymetry. Noted line spacing (5 km) and distance to Tasmania (28 km). Suggested meeting with [redacted]/managers when SLB are in Hobart.	N/A	See above.
		23-10-18	Email incoming	**<u>Response to SLB email dated 23-10-2018</u>** [redacted] forwarded request to [redacted] and [redacted]. If no response is heard back from [redacted] or [redacted] will chase it up.		No objections or claims – no response/actions required.	See above.
		26-10-18	Email outgoing		**<u>Response to [redacted] email dated 26-10-2018:</u>** [redacted] has not heard from [redacted] or [redacted] SLB will be meeting with a number of fishing associations on Monday morning and requested a meeting for the afternoon.	N/A	See above.
		29-10-18	Email incoming	**<u>Response to SLB email dated 26-10-18:</u>** [redacted] to follow up with [redacted] and [redacted]		No objections or claims – no response/actions required.	See above.
		29-10-18	Email outgoing		**<u>Response to [redacted] email dated 29-10-18:</u>** Acknowledged [redacted]	N/A	See above.
		29-10-18	Email incoming	**<u>Response to SLB email dated 29-10-18:</u>** [redacted] confirmed availability of [redacted] to meet with SLB.		No objections or claims – no response/actions required.	See above.
		29-10-18	Meeting	**<u>Meeting attendees:</u>** [redacted] – DPIPWE; [redacted] – DPIPWE; [redacted] (SLB); [redacted] – SLR Consulting **<u>Stakeholder Comments/Concerns:</u>** [redacted] questioned the shape of the Operational Area. [redacted] questioned water depths and where it comes into 50 m. This was clarified that tie lines come into 50 m and that 90% of survey is in water depths >200 m. Water depths off Tasmania coast were discussed.	**<u>SLB Comments:</u>** [redacted] provided an overview of SLB and the proposed survey and [redacted] association with SLB. [redacted] stated that there is some flexibility in the survey plan and that SLB are committed to trying to minimise concerns where possible. [redacted] confirmed that he has had discussions with [redacted] to get rock	Concerns raised related to operational impacts from the presence of the seismic vessel and potential impacts on giant crab. SLB have discussed these effects in the EP and have provided control measures within EP to mitigate against these	Meeting minutes available in **Appendix D**. Impacts from the presence of the seismic vessel and towed equipment on commercial fisheries are discussed in **Section 7.1.3.1**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				[redacted] stated that the two main concerns are the immediate operational impact from the seismic vessel and streamer with gear (i.e. pots), and the potential impact on the giant crab fishery. It was asked if SLB have met with IMAS as they do most of the science work for DPIPWE. [redacted] is the main contact and [redacted] said that generally any request that [redacted] gets will come back to her. [redacted] and [redacted] were appreciative of the visit and offered to meet again for another update.	lobster summary data and stock assessment reports but has been referred to someone else. [redacted] and [redacted] clarified that nothing was required of DPIPWE and that the meeting was introductory in nature and so that DPIPWE know about the survey should concerned fishers/members of the public being in contact.	impacts.	Possible impact from acoustic disturbance on giant crab is discussed in **Sections 7.2.2.1.4** (physiological effects), **7.2.2.2.1** (behavioural effects) and **7.2.3.1** (catch rates – crustaceans)
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		22-11-18	Email incoming	**<u>Response to email dated 21-11-18:</u>** [redacted] has taken over the role of [redacted].		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		23-11-18	Email incoming	**<u>Response to [redacted] email dated 21-11-18:</u>** Attachment was missing, please re-send.		SLB re-sent missing attachments.	Unedited correspondence provided in **Appendix C**.
		23-11-18	Email outgoing		**<u>Response to [redacted] email dated 23-11-18:</u>** [redacted] attached new Information Sheet and summarised changes that had been made.	N/A	Unedited correspondence provided in **Appendix C**. Information Packs provided to stakeholders can be viewed in **Appendix E**.
		23-11-18	Email incoming	**<u>Response to email dated 23-11-18:</u>** Thanks from [redacted] for Information Sheet.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		23-11-18	Email outgoing		**<u>Response to email dated 23-11-18:</u>** [redacted] informed [redacted] that they had met with [redacted] while in Hobart and would email an update to [redacted] and [redacted] thanked [redacted] for passing on emails.	N/A	See above.
		23-11-18	Email incoming	No need to keep [redacted] in the loop anymore.		No objections or claims – no response/actions required.	See above.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.

Stakeholder Engagement Table

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26	Department of State Growth – Tasmania	21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
27	District Council of Lower Eyre Peninsula (DCLEP)	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
		18-03-19	Email incoming	Automated reply acknowledging email.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
28	Flinders Ports – SA	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
29	Glenelg Shire Council, Portland, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
30	Huon Valley Council – Tasmania	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	See above.
		30-10-18	Email incoming	Automated reply acknowledging email.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		21-11-18	Email incoming	Automatic reply stating the email will be forwarded to the relevant department for action.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email incoming	Automatic reply stating the email will be forwarded to the relevant department for action.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
31	Kangaroo Island Council	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		30-10-18	Email incoming	Automated reply acknowledging email.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.

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ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	See above.
32	King Island Council	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
33	Mornington Peninsula Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		30-10-18	Email incoming	Automated reply acknowledging email.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		21-11-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
34	Moyne Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
35	Parks Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
36	Primary Industries and Regions SA (PIRSA) PIRSA/SARDI	27-08-18	Email incoming	[redacted] to [redacted] [redacted] has tried calling [redacted] [redacted] informs that PIRSA will put SLB in touch with commercial and recreational fishing interests when it comes to stakeholder consultation on exploration or surveys. [redacted] will provide any contact details as appropriate.		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		27-08-18	Email outgoing		**Response to PIRSA email dated 27-08-18:** [redacted] apologised for missing [redacted] call.	N/A	See above.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					Attached survey details and stated that SLB consider the proposed activities to be temporary and localised. SLB appreciate stakeholder feedback and will use it to identify and reduce risks. Provided dates for potential meetings to discuss the survey further.		
		30-08-18	Email outgoing		Introductory email with Information Pack Rev 1.	N/A	Information Packs can be viewed in **Appendix E**.
		30-08-18	Email incoming	Out of Office response		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		31-08-18	Email incoming	**Response to SLB email dated 30-08-18:** [redacted] provided a number of key contacts. [redacted] is based in Adelaide and unable to meet in Melbourne on the proposed dates.		No objections or claims – no response/actions required.	See above.
		02-09-18	Email outgoing		**Response to PIRSA email dated 31-08-18:** [redacted] thanked [redacted] for the contact details and will contact [redacted] and [redacted]	N/A	See above.
		04-09-18	Email outgoing		Discussed meeting in Adelaide with SLB and Keith.	N/A	See above.
		24-09-18	Email outgoing		**From [redacted] to [redacted]:** Requested link for rock lobster stock assessments in South Australia. [redacted] to review this data to see whether a data request is required to be submitted. [redacted] requested [redacted] email through data request form.	N/A	See above.
		24-09-18	Email incoming	**Response to SLB email dated 24-19-18:** Data request form received from [redacted]. [redacted] informed that reports have not yet been uploaded.		No objections or claims – no response/actions required.	See above
		24-09-18	Email outgoing		**Response to [redacted] email dated 24-09-18**: [redacted] thanked [redacted] for providing data request form.	N/A	See above.
		24-09-18	Email incoming	**Response to SLB email dated 24-09-18:** [redacted] suggested [redacted] call him if he requires assistance with data request form.		No objections or claims – no response/actions required.	See above.
		24-09-18	Email outgoing		[redacted] highlighted that over 80% of rock lobster catch over the last 12 seasons has come from water depths of less than 60 m, reducing conflict with survey. Questioned if [redacted] knows the maximum water depth that rock lobster fishers fish in.	N/A	See above.
		21-11-18	Email outgoing		Follow up email sent with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
37	Regional Development Australia, Whyalla and Eyre Peninsula (RDAWEP)	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
38	South Gippsland Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Unedited correspondence provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		21-11-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		31-03-19	Email incoming	Request from [redacted] to have a copy of the environmental impact assessment. She is interested in the studies of fish, cetacean and other marine life breeding grounds, breeding and migratory cycles in relation to the timing of the proposed seismic testing.		No objections or claims, but a request for further information which SLB will provide once the full document is complete (see below).	See above.
		24-04-19	Email outgoing		SLB responded to [redacted] to inform her that SLB intends to submit the EP shortly under the new assessment regulations which will included publication of the EP and an opportunity for public comment. The EP includes the details on environmental impact assessment with the proposed seismic programme. SLB informed [redacted] that once the EP is publicly available online that they can provide her with the link to download the document.	N/A	See above.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
39	Surf Coast Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Unedited correspondence provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		22-11-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
40	Tourism Tasmania	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
41	Waratah Wynyard Council – Tasmania	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
42	Warrnambool City Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
43	Wellington Shire Council, Victoria	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Unedited correspondence provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		30-10-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		21-11-18	Email incoming	Automated reply acknowledging email		No objections or claims – no response/actions required.	Unedited correspondence provided in **Appendix C**.
44	West Coast Council – Tasmania	30-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
45	Victorian Fisheries Authority (VFA)	08-10-18	Email outgoing		[redacted] provided an introductory email to [redacted] whose contact details were provided by [redacted] from UTAS, to introduce the proposed Otway Survey. A request was made in regard to finding out the amount of fishing effort for rock lobster and crabs that takes place in Victorian waters. A map was provided of the proposed survey area and was asked if any further information was required.		Unedited correspondence is provided in **Appendix C.**
		23-10-18	Email incoming	Response to SLB email dated 08-10-18: A response to the email to [redacted] was received from [redacted] about the rock lobster and giant crab catch in western Victoria. [redacted] had asked that [redacted] respond to the query. [redacted] stated VFAs policy on its role in assisting companies with catch data for Victorian fishers and provided a link to the document. [redacted] noted that the proposed survey area covers the entire wester zone rock lobster fisher and giant crab fishery. As a result, the catch data for these fisheries is already available on the VFA website and the links to this data was provided. [redacted] also stated that for consultation with the fishers, she recommends contacting SIV to discuss the best approach for consultation. A map was provided with the email showing the grid system for the western zone rock lobster fishery.		SLB have utilised the information provided within the catch assessments within the EP. This has also been incorporated with the SETFIA fisheries assessment.	Unedited correspondence is provided in **Appendix C.** **Section 5.5.2** (Commercial Fisheries), **Section 5.5.2.4.2** (Seafood Industry Victoria), **Section 5.5.2.5.2** (Commonwealth and State Rock Lobster Fisheries), **Section 5.5.2.5.9** (Giant Crab Fishery), **Section 7.2.3** (Known and Potential Impacts on Commercial Fisheries).

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
Relevant Persons							
46	3D Oil	20-09-18	Email outgoing		Introductory Email from SLB. Information Pack Rev 1.	No objections or claims raised but SLB followed up with phone call.	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		24-09-18	Email incoming	**<u>Response to SLB email dated 20-09-18:</u>** 3D Oil are aware of SLB's proposed survey and have concerns. Due to three very large multi-client surveys planned to commence at the same time, 3D Oil are concerned they won't be able to acquire this season. 3D Oil welcomes a phone call at any time to discuss issues.			
		12-11-18	Email outgoing		**<u>Response to 3D Oil email dated 24-09-208:</u>** SLB thanks [redacted] for his time on the phone. An Information Sheet was attached to email and the proposed survey timing and lack of overlap with 3D Oil's permit T/49P was discussed.		
		27-11-18	Email outgoing		Requested feedback/response to SLB's email dated 12-11-18.		
		28-11-18	Email incoming	**<u>Response to SLB email dated 27-11-18</u>**: [redacted] did not have any feedback but appreciated SLB staying out of their permit. Noted that slightly reducing the size of the area was a good move.			
		05-02-19	Email incoming	From [redacted] touching base as he thought the survey should have started by now			
		05-02-19	Email outgoing		From [redacted] requesting a time for phone call		
		20-02-19	Email incoming	From [redacted] advising their S&B has been awarded for their Otway Block. They have until Feb 21 2020 to shoot our 3D in T/49-P.			
		21-02-19	Email outgoing		From [redacted] thanking [redacted] for the update and would like to discuss the opportunity.		
		21-02-19	Email incoming	Agreed to a call anytime			
47	Abalone Council of Australia	21-11-18	Email outgoing		Update email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
48	Alissa Enterprises Pty Ltd (Innes)	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
49	Anz Fishing Company Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
50	Austar Fishing Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
51	Australian Fishing Enterprises Pty. Ltd.	03-09-18	Email outgoing		Introductory email with Information Pack Rev 1.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
52	Australian Southern Bluefin Tuna Industry Association	03-09-18	Email outgoing		Introductory email with Information Pack Rev 1.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		03-09-18	Email incoming	**<u>Response to email dated 03-09-18:</u>** [redacted] stated that she will discuss the survey with members and be in touch with questions or a formal response.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**.
		13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Follow up email sent with Information Pack Rev 2 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
53	Australian Tuna Fisheries Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		15-11-18	Email incoming	**<u>Response to email dated 13-11-18:</u>** [redacted] thanked SLB for the information. Australian Tuna Fisheries Pty Ltd have significant concerns on the impact of seismic in the area through the period of southern bluefin tuna migration and their fishing activities. Advised that the Australian Southern Bluefin Tuna Industry Association will submit a more detailed response.	The email from Australia Tuna Fisheries Pty Ltd stated that the Southern Bluefin Tuna Association would submit a more detailed response on the proposed survey, as this email was very brief. SLB decided to wait for this submission from the industry body and continued to keep all of the tuna fishers informed throughout the engagement process of what was happening as the survey plan and proposed timing was evolving. No further communication or concerns were received.	Response from [redacted] stated there are concerns with seismic and their fishing activities, but this was not backed up with any further information. SLB assessed potential effects on southern bluefin tuna and other fisheries within the relevant sections of the EP.	Unedited correspondence is provided in **Appendix C**. A description of the biology and habitat use of southern bluefin tuna is provided in **Section 5.2.3.1.4.** Potential impacts from acoustic disturbance on fish are discussed in **Section 7.2.2.1.5** (physiological effects) and **7.2.2.2.2** (behavioural effects, including a discussion specific to southern bluefin tuna).

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
							Potential impacts on the southern bluefin tuna fishery are discussed in **Section 7.2.3.6**.
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
54	Australian Wildcatch Fishing	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	N/A	Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.
		15-11-18	Email incoming	**<u>Response to email dated 13-11-18:</u>** Does have concerns on the effects of 2D seismic on fishing operations but suggested SLB engage with SETFIA and [redacted] as the industry organisation and fishing representative.		Response stated there are concerns with seismic, but this was not backed up with any further information. SLB consulted with SETFIA as the fishery representative.	Unedited correspondence is provided in **Appendix C**.
		15-11-18	Email incoming	**<u>Email from</u>** [redacted]**<u>:</u>** Confirming SETFIA has been engaged and that data has been applied for.		No objections or claims – no response/actions required.	See above.
55	B Tunnage Fishing Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
56	Blaslov Fishing Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
57	Claudarah Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
58	Corporate Alliance Enterprises Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
59	C R & A Lavalle Pty Ltd	13-11-18	Email outgoing		Introductory email with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
60	Cull Fisheries Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	N/A	Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.
		22-11-18	Email incoming	**<u>Response from [redacted] to SLB email dated 13-11-18:</u>** Cull Fisheries Pty Ltd and Trinsand Fisheries Pty Ltd are investing [redacted] in the squid fishery to take advantage of a growing export industry. Concerns raised are summarised as follows: • Lack of knowledge on the effect of seismic on squid biomass; • Scientific information suggests squid are affected by seismic but there is a lack of information regarding effects in actual seismic testing; • Concerned of possible squid and squid egg damage; • Squid catch will be affected which will put the financial investment of squid fishers at risk; • Are doubtful of the work of McCauley et al. (2002) on larvae and the applicability/relevance of this work (and other work on species other than squid) to the effects of seismic on squid; • Would prefer that squid mortality is restricted to that for human consumption; • Past treatment of the fishing industry by the oil and gas exploration industry; • Proposed Operational Area covers part of the area fished by squid jig fishers and board trawl fishers as well as squid breeding area; • The expansion of the squid fishery and the SLB survey are in conflict; • Seismic kills scallops and affects southern rock lobster; • Lack of scientific research into the effects of seismic on giant grab and note the decline in the fishery; and • Legislation protects the oil and gas industry at the		Stakeholder raised a number of concerns with regard to the effects of seismic on commercial fisheries, squid and scallops, and suggested reducing survey area or the stakeholder will request the Government implement the Precautionary Principle. SLB have discussed the potential effects on commercial fisheries, scallops and squid throughout the EP based on available scientific literature. SLB responded to stakeholder email addressing points of concern. SLB reviewed the survey area following stakeholder feedback.	Unedited correspondence provided in **Appendix C**. The full STLM Report is provided as **Appendix A**. Full SETFIA report is provided as **Appendix G**. Impacts from the presence of vessels and towed equipment on commercial fisheries are discussed in **Section 7.1.3.1.** Impacts from acoustic disturbance on the receptors raised by Cull Fisheries Pty Ltd are discussed in the following sections: - Squid: **Section 7.2.2.1.6** (physiological effects) and 7.**2.2.2.3** (behavioural effects) - Zooplankton (eggs and larvae): **Section 7.2.2.1.1** (physiological effects) - Scallop larvae: **Section 7.2.2.1.2**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				expense of others Propose the following: • Reduce survey area to ensure there is no impact on squid populations and breeding areas; and • If the above is not acceptable, will ask that the Government implement the Precautionary Principle until science can prove there is no effect on squid.			- Commercial fisheries: **Section 7.2.3.1** (crustaceans), **7.2.3.2** (molluscs), and **7.2.3.5** (southern squid jig fishery). These sections take into consideration the literature referenced in the Cull Fisheries Pty Ltd email dated 22/11/2018.
		27-11-18	Email outgoing		**Response to [redacted] email dated 22-11-18:** [redacted] thanked [redacted] for the detailed response and provision of background information into the company and their investment in the squid jig fishery. [redacted] stated that negative feedback from consultation carried out by other companies has been taken onboard and he hopes that relationships are starting to improve. [redacted] stated that SLB attended the recent regional workshop involving the Seafood and Petroleum Industries and outlined the intention of the workshop - the workshop provided a starting point between the two industries to begin to work together. [redacted] informed that SLB are working with SETFIA, SIV and TSIC, with SETFIA preparing a fisheries assessment. [redacted] reiterated that SLB wish to work together with other industries to minimise conflict and disruption and to understand where the areas of conflict and sensitivity area. [redacted] stated that there is scientific literature on the effects of squid but agreed that more literature would enable further understanding of the effects, particularly on different life stages. [redacted] said that an EP is being developed which includes an extensive literature review on all sensitivities in the marine environment within and surrounding the Operational Area which uses this information to assess potential impacts and implement control measures. [redacted] stated that SLB have not found any literature on the effect of seismic on squid eggs and larvae, but that juvenile squid and larvae are mostly found in shallow coastal waters (statement referenced to AFMA). [redacted] provided a discussion on the biology of squid and the survey design and how these will affect the potential impacts of seismic on squid. A map of the survey area was attached showing the 1,000 m contour line, demonstrating that based on squid spawning down	N/A	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					to depths of 700 m, a large part of the survey area is outside of spawning depths. Based on this, [redacted] stated that reductions to the survey area to avoid spawning depths are not necessary. [redacted] described SLB's understanding of the southern squid jig fishery and acknowledged that effort will also occur outside of the described fishing area. [redacted] asked for further information on where squid fishing occurs but said that this will also be made available through the SETFIA report. SLB are happy to share and discuss this report. A close-up map of the survey area with bathymetry lines (50, 100 and 150 m) was attached to indicate potential overlap with squid fishing grounds. It is hope that conflict would be minimised given the small amount of acquisition within the 150 m depth contour. [redacted] asked if there was anything additional other than a reduction in scale that would reduce concerns and any particular time that the eastern side of the Operational Area should be acquired. [redacted] described the sound propagation in shallow waters and introduced the STLM that SLB are carrying out. [redacted] summarised scientific literature on the effects of seismic on squid, i.e. McCauley *et al*. (2000), Fewtrell and McCauley (2012), Fewtrell (2003), and Mooney *et al* (2016). [redacted] summarised scientific literature on the effects of seismic on rock lobster, where there have been no reports of deaths as a result, although some behavioural effects have been observed. [redacted] also summarised the Day *et al* (2016) study on rock lobster larvae where it was concluded that rock lobster larvae are not negatively affected; [redacted] also notes that other rock lobster life stages were not investigated so all effects cannot be dismissed. [redacted] responded to [redacted] concerns with regard to seismic killing scallops by discussing the findings of Day *et al*. (2016), followed by how the survey design will mitigate against impacts on scallops. [redacted] stated that SLB appreciate the feedback regarding [redacted] ongoing discussions with NOPSEMA but that SLB can only comment on their upcoming activity. [redacted] said that he is happy to meet with [redacted] to further discuss SLB's survey.		
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.	N/A	Information Packs can be viewed in **Appendix E**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		13-12-18	Email incoming	**<u>Response to SLB email dated 27-11-18 and 07-12-18:</u>** [redacted] thanked [redacted] for his reply and clarifies some confusion in interpretation of previous emails. [redacted] maintains the stance that scallop deaths have occurred after seismic surveys and the implementation of the precautionary principle.		Concerns were raised with regard to scallop deaths from seismic. SLB discussed available scientific literature on the effects of scallops in EP.	Unedited correspondence provided in **Appendix C**. Potential effects of acoustic disturbance on scallops have been discussed in the following Sections: - **7.2.2.1.2** (physiological - scallop larvae); - **7.2.2.1.4** (physiological - benthic invertebrates); - **7.2.2.2.1** (behavioural – benthic invertebrates); and - **7.2.3.2** (catch rates – molluscs).
		05-02-19	Email outgoing		**<u>Response to [redacted] email dated 05-02-19:</u>** [redacted] provided some clarification on the claims over the scallop deaths and the linkages [redacted] was drawing to Seismic. [redacted] made [redacted] aware of some recent studies that have been published on the Bass Strait scallop mortalities where there is suggestion that the mortality events may be environmentally related. An overview of the sound transmission loss modelling results was provided, and the zones of impact in relation to scallops based on sound thresholds. The survey design was reiterated in regard to the effects on scallops in particular with the large line spacing, distance offshore and the water depths, where 98% of the survey lines are in waters greater than 200 m and 91% are in waters greater than 1,000 m. [redacted] also provided [redacted] with an update on the survey timing, advising that the survey would not go ahead this coming summer and that it would be later in the year, most likely around October. An invite for further discussions or meeting was extended to discuss the survey further.	N/A	See above.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
61	Dewebb Pty Limited	31-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.		
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
62	Eastern Tuna and Billfish Fishery – Tuna Australia	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	N/A	Unedited correspondence provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		21-11-18	Email outgoing		Follow up email sent with Information Pack Rev 2 sent.	N/A	See above.
		21-11-18	Email incoming	**<u>Response to SLB email dated 21-11-18:</u>** [redacted] stated that he has concerns about seismic and the way consultation works for applications. Interpretations of literature say no effects from seismic, but also that seismic cause adverse effects. [redacted] recommends the following: • Commit to a BACI survey; • If the BACI survey demonstrates effects, then compensation needs to be paid to fishers.		Concerns were raised but further information not provided. SLB considered the use of a BACI survey in the EP and responded to email with further information on southern bluefin tuna studies.	Unedited correspondence provided in **Appendix C**. The use of a BACI study as a control measure has been assessed in **Table 66**.
		27-11-18	Email outgoing		[redacted] **<u>Response to [redacted] email dated 21-11-18:</u>** [redacted] acknowledged that SLB are aware of the sensitivities with the tuna fishery and that a detailed literature review has been undertaken to understand the sensitivities of the area. [redacted] stated that SETFIA are preparing a fishery assessment and have engaged with AFMA and Commonwealth permit holders. SETFIA's preliminary assessment has identified that fishing effort in the Operational Area by the Small Pelagic Fishery, Eastern Tuna and Billfish Fishery, Western Tuna and Billfish Fishery, and Southern Bluefin Tuna Fishery is negligible. [redacted] stressed that published, peer reviewed literature on the potential effects of seismic on difference receptors has been used and that SLB are also conducting STLM to support the assessment. [redacted] stated that following feedback regarding southern bluefin tuna (SBT), SLB have undertaken literature reviews on SBT to understand the fishery. [redacted] summarised the results of Hobday *et al.* (2015) to state that the timing of the survey is not likely to overlap with the passing of adult SBT. [redacted] outlined the issues with implementing a BACI experiment to	N/A	Unedited correspondence with stakeholders provided in **Appendix C**. Full SETFIA report is provided as **Appendix G**. The full STLM report is provided as **Appendix A**. A description of the biology and habitat use of southern bluefin tuna is provided in **Section 5.2.3.1.4.** Potential effects of acoustic disturbances on fish and specifically the southern bluefin

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					determine the effects on seismic and the reasons why SLB do not consider a BACI experiment to be appropriate. [redacted] stressed that SLB are willing to work in with fishers and encourage feedback which can be incorporated into the survey, that SLB operate to the highest level of health, safety, security and environmental policies, and that the EP is prepared in accordance with all current legislation and required approval by NOPSEMA. [redacted] also outlined the provision of 48-hour look-aheads to fishers.		tuna fishery are discussed in **Sections 7.2.2.1.5** (physiological – fish), **7.2.2.2.2** (behavioural – fish), and **7.2.3.6** (catch rates – southern bluefin tuna). The use of a BACI study as a control measure has been assessed in **Table 66**.
		28-11-18	Email incoming	**Response to SLB email dated 27-11-18**: Stated that SLB's response is typical to that of energy exploration companies and that if seismic testing has a measurable impact on the environment/fisheries, there needs to be restitution until the environment and fisheries are restored to full health. This requires a BACI.		Further concerns were raised with regard to the use of a BACI study. SLB assessed the use of BACI studies in the EP.	Unedited correspondence with stakeholders provided in **Appendix C**. The use of a BACI study as a control measure has been assessed in **Table 66**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs can be viewed in **Appendix E**.
63	F & H Trawling Co. Pty. Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
64	Fina K Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
65	Fishan Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	N/A	Unedited correspondence provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		13-11-18	Email incoming	**Response to SLB email dated 13-11-18:** [redacted] fishes a lot of the area and the survey will be disruptive to operations.		Concerns were raised with regard to disruptions to fishing operations, but no further information provided. SLB requested clarification	Unedited correspondence with stakeholders provided in **Appendix C**. Potential effects of displacement from

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
						of fished areas and discussed displacement from fishing grounds and appropriate control measures in EP.	fishing grounds and acoustic effects on fish catch are discussed in **Sections 7.1.3.1** and **7.2.3** respectively.
		13-11-18	Email outgoing		**Response to [redacted] email dated 13-11-18:** [redacted] requested further details on the disruption that will be caused, specifically what part of the Operational Area is fished, depth range fished in, species targeted, fishing method used and seasonality of operations. [redacted] also enquired about any timing that would help minimise disruptions to fishing operations.	N/A	See above.
		13-11-18	Email incoming	**Response to SLB email dated 13-11-18:** [redacted] currently fishes with gillnets for sharks in 10-80 fathoms and hold rock lobster licence and commonwealth squid permit. They are based out of Portland and fish year-round.		No concerns were raised. Stakeholder provided further information on operations. Potential effects on fishing operations are discussed in EP.	See above.
		15-11-18	Email outgoing		**Response to [redacted] email dated 13-11-18:** [redacted] thanked [redacted] for the further information and enquired as to if [redacted] would meet with SLB to further discuss the survey. [redacted] described the proposed timing of the survey and asked [redacted] if he could roughly identify on a map where they fish and what species they target so that conflict can be further understood	N/A	Unedited correspondence with stakeholders provided in **Appendix C**. Potential effects of acoustic disturbances on gummy shark, rock lobster and squid are provided in the following Sections: - Shark: **7.2.2.1.9** (physiological) and **7.2.2.2.7** (behavioural); - Rock lobster: **7.2.2.1.3** (physiological – larvae), **7.2.2.1.4** (physiological – benthic invertebrates), **7.2.2.2.1** (behavioural – benthic invertebrates), and **7.2.3.1** (catch rates – crustaceans); and - Squid: **7.2.2.1.6** (physiological), **7.2.2.2.3**

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
							(behavioural), and **7.2.3.5** (southern squid jig fishery).
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	See above.
		18-03-19	Email incoming	[redacted] responded to [redacted] update email stating that if the survey comes in under 90 fathom it will be a problem for him.		SLB provided maps and further information.	Unedited correspondence with stakeholders provided in **Appendix C**.
		22-03-19	Email outgoing		[redacted] thanked [redacted] for his email and attached maps overlying the bathymetry contours with the survey area and survey lines, focusing around the Portland area. [redacted] provided further discussion around the tie lines shown on the map. [redacted] stated that SLB would like to work with [redacted] to minimise conflict and that he can contact [redacted] with any questions and will be provided with the 48-hour look-aheads if he would like.	N/A	See above.
66	Friend Fishing Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
67	Gabo Bay Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
68	Gail Jeanette Pty Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
69	Galaxy Fishing Co. Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
70	Gazak Holdings Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.
		14-11-18	Email incoming	From [redacted] suggesting [redacted] contact [redacted] at SETFIA		No objections or claims – no response/actions required. [redacted] confirmed SETFIA are involved (see below)	Unedited correspondence with stakeholders provided in **Appendix C**.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		14-11-18	Email incoming	From [redacted] to [redacted] and [redacted] confirming that SETFIA are involved.		N/A	See above.
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
71	George Town Seafoods Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
72	Guillot Enterprises (L.E.) Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
73	Hagfish Australia Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
74	Hefem Trawl Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
75	Hursey & Sons Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Update email with Information Pack Rev 4 sent.		
76	Ironnet Pty. Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
77	J & N Jarvis Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
78	Ka Olver Pty Ltd	14-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
79	Lyenna Proprietary Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
80	Mahina Bay Fishing Co Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
81	Marellen Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
82	Marnikol Fisheries Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
83	Muollo Fishing Pty Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
84	Mures Fishing Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
85	Nautical Fishing (Nsw) Pty Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
86	Nautilus Fishing Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
87	Nina Fishing Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
88	Pescatore Di Mare Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
89	Raptis Fishing Licences Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
90	Rhylan Fishing Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
91	Richey Fishing Co Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	N/A	Information Packs can be viewed in **Appendix E**. Unedited correspondence with stakeholders provided in **Appendix C**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		19-11-19	Email outgoing	**Response to SLB email dated 13-11-18:** [redacted] replied with an outline of their concerns, stating that the survey will have a significant impact on their fishing activities and that he would like to be involved in any proposed industry consultations and receive all publicly available information. **A summary of [redacted] response is as follows**: Key concerns and relevance to typical operations: Highly relevant. Squid come to the Bonney Upwelling and disruption may impact on migratory patterns. Dependent on other fishing operations (i.e. squid) if not engaged in charter operations in January – June. Suggestions to minimise concerns: Don't do the survey or give fishers and alternative source of income for this season and the following 4-5 seasons. Summarised the findings of both McCauley and Andre on squid. Notification periods (i.e. how long do you need pre-survey): Does not care – facts are clear that seismic impacts squid, as it has done with scallops. [redacted] summarised that the survey should be dropped, or fishers compensated.		Stakeholder raised a number of concerns with regard to the effects of seismic on commercial fisheries, particularly squid. Stakeholder provided interpretation of some scientific literature on squid (i.e. the McCaluey and Andre papers). SLB provided a response to stakeholder with discussions on available scientific literature. SLB discussed potential effects on commercial fisheries and squid in the relevant EP sections. SLB discussed compensation to commercial fishers as a control measure within the EP.	Unedited correspondence with stakeholders provided in **Appendix C**. Potential effects of displacement of commercial fisheries from fishing grounds are discussed in **Section 7.1.3.1.** Potential effects of acoustic disturbances on squid are provided in **Sections 7.2.2.1.6** (physiological effects), **7.2.2.2.3** (behavioural effects) and **7.2.3.5** (southern squid jig fishery), with consideration given to the McCauley and Andre references. Potential effects of acoustic disturbances on catch rates of other fisheries are discussed throughout **Section 7.2.3.** Compensation to affected fishers has been assessed in **Table 66**.
		27-11-18	Email outgoing		**<u>Response to [redacted] email dated 19-11-18:</u>** [redacted] thanked [redacted] for his response and stated that [redacted] has all current information, with an EP currently being prepared. [redacted] gave an overview of reductions to the Operational Area, with a retraction from the coast, and away from the Bonney Upwelling (with the exclusion of the tie lines). [redacted] provided a closer map of the survey with bathymetry (50, 100 and 150 m) contours showing where the tie lines go within these shallower depths and stated that a very small amount of acquisition (0.5%) will occur inside the 150 m depth contour	N/A	Unedited correspondence with stakeholders provided in **Appendix C**. Potential effects of displacement of commercial fisheries from fishing grounds are discussed in **Section 7.1.3.1.** Potential effects of acoustic disturbances

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					[redacted] provided an indication of the best time to conduct the tie lines (i.e. March) based on an extensive literature search into the presence of blue whale and the Bonney Upwelling. [redacted] noted [redacted] suggestion of not doing the survey and outlined the objectives of the survey and why it is required. [redacted] stated that 90% of survey lines are in waters deeper than 1,000 m, deeper than the depth of spawning for squid (i.e. 700 m). [redacted] summarised the findings of literature searches on the effects of seismic on squid, stating that the findings do not support that the survey will have the impact on spawning and recruitment failure for years to come like [redacted] described. Squid literature presented by [redacted] include: McCauley *et al.* (2000), Fewtrell & McCauley (2012), Mooney *et al.* (2016), Fewtrell (2003), Andre *et al.* (2011). [redacted] summarised literature on the effects of seismic on scallops (i.e. Day *et al.*, 2016) and how the survey is likely to affect scallops (i.e. based on line spacing and water depths, survey is considered to be very unlikely to have an effect on scallop populations). [redacted] provided details on notification that SLB are able to provide (i.e. 48-hour look-aheads). [redacted] finished by summarising the predicted effects of the survey, how SLB will minimise any potential effects, and that SLB do not agree with [redacted] statement that there will be significant loss to the fishery and justified why there would not be any compensation of loss of catch to fishers.		on squid are provided in **Sections 7.2.2.1.6** (physiological effects), **7.2.2.2.3** (behavioural effects) and **7.2.3.5** (southern squid jig fishery), with consideration given to the McCauley and Andre references. Potential effects of acoustic disturbances on catch rates of other fisheries are discussed throughout **Section 7.2.3.** Compensation to affected fishers has been assessed in **Table 66**.
		04-12-18	Email incoming	**<u>Response to SLB email dated 27-11-18:</u>** [redacted] stated that the email response dated 27-11-18 did not ally his fears but alarmed him more at the prospect of the damage and loss of income. Of particular concern was the use of percentages of area to discount the impact on squid and that the overlap with the western Victorian squid fishery is overlooked. [redacted] stated that short-term (i.e. seasonal decline in catches) and impacts on larvae and squid eggs have not been addressed. [redacted] states that impaired hearing is death to an animal that relies on all of its sensors to escape predators in response to [redacted] summary of Fewtrell and McCauley (2012). [redacted] was also critical of the use of soft-starts as squid moving		SLB responded to stakeholder email with further clarification/interpretation of scientific literature. SLB discussed potential effects on commercial fisheries and squid in the relevant EP sections.	Unedited correspondence with stakeholders provided in **Appendix C**. Information Packs are provided in **Appendix E**. The full STLM report is provided as **Appendix A.** Potential effects of acoustic disturbances on squid are provided in **Sections 7.2.2.1.6**

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				away from the ramping up source is a sign of discomfort and is concerned squid will more to different areas (i.e. higher in water column or different fishing area). [redacted] disagreed with [redacted] interpretation of Day *et al.* (2016) and suggests that based on the authors' findings, a mass mortality occurred. [redacted] reiterates that SLB have no addressed the impact on larvae or eggs, therefore a catastrophic impact is still a possible scenario. [redacted] is concerned that SLB have not addressed how far squid will move away and states that some Norwegian literature suggests a response from finfish at greater than 12 NM and up to 20 NM from the survey vessel. [redacted] concluded that it is his livelihood on the line so is much more concerned than SLB and that the fishing industry in SE Australia has been severely impacted by past seismic. He believes that any seismic company that believes they have no impact should be prepared to put up a $50m bond.			(physiological effects), **7.2.2.2.3** (behavioural effects) and **7.2.3.5** (catch rates – southern squid jig fishery). Squid noise exposure thresholds are outlined in **Table 60**. Effects of acoustic disturbance on fish eggs and larvae are discussed in **Section 7.2.2.1.1** (physiological effects). Potential effects of acoustic disturbances to the southern squid jig fishery are discussed in **Section 7.1.3.1.** An assessment Day *et al.* (2016) has been provided in **Section 7.2.2.1.4**. Compensation to affected fishers has been assessed in **Table 66**.
		06-12-18	Email outgoing		<u>**Response to [redacted] email dated 04-12-18:**</u> [redacted] thanked [redacted] for his detailed response and provided responses to [redacted] concerns and further updates on the survey that have occurred since their last correspondence. [redacted] believes that there has been some misunderstanding with [redacted] interpretation of his last email and wanted to alleviate [redacted] concerns with additional information and clarification. [redacted] provided further updates to further reductions that have be made in the extent of the Operational Area. An updated Information Pack Rev 3was attached. A map of the survey area was also attached showing survey lines in relation to the 1,000 m bathymetry contour.	N/A	Unedited correspondence with stakeholders provided in **Appendix C**. Information Packs are provided in **Appendix E**. The full STLM report is provided as **Appendix A.** Potential effects of acoustic disturbances

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					[redacted] stated that STLM has been conducted for the survey and provided an introduction to this modelling and noise propagation and stated that sound should not force squid to the surface as [redacted] suggested. [redacted] also provided a discussion on noise exposure thresholds/indicative noise levels at which there is the potential for certain effects to occur (based on current relevant scientific literature and accepted industry and international standards). [redacted] provided a discussion on why the effects of seismic on cephalopod larvae and eggs have not been specifically assessed and a brief discussion on squid spawning. Due to the lack of data on cephalopod eggs and larvae, [redacted] provided a discussion on the potential effects on fish eggs and larvae but stressed that although there are differences, this is the best available information due to the lack of squid-specific studies. [redacted] also emphasised that thresholds, zones of influence, modelling inputs and modelling outputs are all highly conservative and are assumed as worst case; therefore, they likely over-predict real world sound exposure levels. [redacted] provided the Peak Sound Pressure Level threshold for mortality and potential mortal injury to fish eggs and larvae and the maximum horizontal distance within which these thresholds would be met based on modelling results. [redacted] then described how the survey design will mitigate against any potential effects based on these distances. Behavioural responses in squid based on thresholds and modelling results were then discussed. [redacted] stated that habituation has been observed in squid, therefore catch rates should not be influenced due to behavioural disturbance. Based on [redacted] concerns, [redacted] re-assessed Day *et al.* (2016), with this reinforcing SLB's position on their original comments, and what SLB intend to include within the EP submission to NOPSEMA. It is SLB's belief that [redacted] has incorrectly interpreted the Day *et al.* (2016) paper. [redacted] puts forward his argument as to why it is believed that [redacted] interpretation is incorrect. [redacted] agreed with [redacted] that there may be some disruption to fishers due to the physical presence of the seismic vessel and equipment while the tie lines are acquired. [redacted] reiterates SLB's willingness to engage on potential for activities to coincide and to do all they can to minimise conflict and disruption such as acquiring over certain periods. [redacted] states that there have been no studies to back-up [redacted] claim that squid move away from a sound source and that comparisons between squid and finfish are not realistic. [redacted] presents an argument as to why squid will not swim a long distance from the		on squid are provided in **Sections 7.2.2.1.6** (physiological effects), **7.2.2.2.3** (behavioural effects) and **7.2.3.5** (catch rates – southern squid jig fishery). Squid noise exposure thresholds are outlined in **Table 60**. Effects of acoustic disturbance on fish eggs and larvae are discussed in **Section 7.2.2.1.1** (physiological effects). Potential effects of acoustic disturbances to the southern squid jig fishery are discussed in **Section 7.1.3.1.** An assessment of Day *et al.* (2016) has been provided in **Section 7.2.2.1.4**. Compensation to affected fishers has been assessed in **Table 66**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					acoustic source. [redacted] provides a brief discussion around the use of modelling to predict sound levels in shallower (i.e. fished) water depths. In response to negative interactions in the past, [redacted] hopes that this engagement will be more positive and that SLB's mitigations will avoid the impacts that were perceived from previous encounters. [redacted] states that determining and defining the effects from sound when combined with environmental and socio-economic variables would be very difficult and the costs would be grossly disproportionate to the environmental benefit gained. The use of a bond is outside [redacted] expertise but would have the same difficulties due to being unable to determine a single activity causing the impact.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.	N/A	Information Packs are provided in **Appendix E**.
92	Rockfish 1 Pty Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
93	Sanpool Fisheries Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
94	Sarin Marine Farm Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2 sent.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
95	Scallop Fishermen's Association of Tasmania	23-10-18	Email outgoing		Introductory email with Information Pack Rev 1 sent.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs are provided in **Appendix E**.
		24-10-18	Email incoming	**Response to SLB email dated 23-10-18:** [redacted] was concerned that SLB had left consultation so late and said that SLB have an obligation to others before they commit to such an invasive activity that potentially threatens the immediate and long-term livelihood of many fishers and businesses.		Stakeholder concerns are not addressed in EP; however, SLB continued engagement.	Unedited correspondence is provided in **Appendix C**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				[redacted] is prepared to meet with SLB in Hobart and said that SLB will need to speak to other Tasmanian fishery representatives. [redacted] provided [redacted] (TSIC) contacts.			
		24-10-18	Email outgoing		**Response to [redacted] email dated 24-10-18:** [redacted] thanked [redacted] for his email and said that SLB would like to meet with him to discuss concerns and potential controls to minimise concerns and displacement. [redacted] explained that the survey still has to gain regulatory approval before commencing and that engagement will continue after submission to NOPSEMA. [redacted] discussed a potential meeting. A revised map showing the survey area in relation to Tasmania was attached.	N/A	Unedited correspondence is provided in **Appendix C**.
		24-10-18	Email incoming	**Response to SLB email dated 24-10-18:** [redacted] raised concerns on the impact on the Bass Strait scallop fishery despite the Operational Area not being immediately above known scallop grounds. [redacted] confirmed meeting with SLB.		Stakeholder raised concerns over the effect of seismic over scallop grounds but did not provide any scientific evidence. SLB addresses stakeholder concerns on scallops within the relevant sections of the EP.	Unedited correspondence is provided in **Appendix C**. Effects on scallops are discussed in **Sections 7.2.2.1.2** (physiological effects on scallop larvae), **7.2.2.1.4** (physiological effects on benthic invertebrates), **7.2.2.2.1** (behavioural effects on benthic invertebrates), and **7.2.3.2** (catch rates – molluscs).
		24-10-18	Email outgoing		**Response to [redacted] email dated 24-10-18:** [redacted] confirmed meeting.	N/A	Unedited correspondence is provided in **Appendix C**.
		29-10-18	Meeting	**Meeting attendees:** [redacted] – TSIC; [redacted] – Tasmanian Scallops and Bass Strait Scallops; [redacted] – Tasmanian Rock Lobster Fisherman's Association Ltd (TRLFA); [redacted] – SLB; [redacted] – SLR Consulting. **Stakeholder Comments/Concerns:** [redacted] questioned how the survey can happen in the proposed timeframe given the lateness of commencement of engagement. The late engagement process was raised multiple times, and it was stated that due to this, SLB needs to improve their engagement	**SLB Comments:** [redacted] explained why the engagement process has occurred late; i.e. SLB do not undertake engagement until there is certainty that the survey will take place as they do not want to place additional stress on stakeholders and create additional work or worry over a survey that may not go ahead. This means that when	Stakeholder raised concerns on the potential impacts of seismic on scallops and rock lobster, particularly larval settlement, as well as cumulative effects from multiple surveys being acquired	Meeting minutes available in **Appendix D**. Engagement with shark and giant crab fisheries is summarised in **Appendix F**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				approach. The engagement policy that TSIC and SIV have developed was discussed and how that might work going forward. [redacted] requested a terms of policy is put forward requesting exactly what is wanted out of the engagement process. [redacted] will then provide a price and timeframe to do so. [redacted] can meet with licence holders to introduce the SLB survey, make introductions, and seek a collated set of feedback from licence holders, but will not do so without a contract. [redacted] stated that TSIC members have requested legal action is taken against all seismic companies to prevent further surveys but that he is hold off undertaking further action until after the round table with APPEA in November. [redacted] stated that the main concern is over recruitment of scallops and lobsters. [redacted] gave an overview on rock lobster and stated that the map of the survey area worries him in relation to killing rock lobster larvae. It was stated that most scallops are in water depths less than 80 m and that a number of scallop fishers are correlating poor scallop recruitment with seismic. [redacted] provided an overview of the 2010 Bass Strait 3D seismic survey by Geoscience Victoria. Following the survey, all scallops had died, however, when questioned further the follow up survey was not documented, nor was Geoscience Victoria questioned about it. [redacted] stated that EPs do not reference recent scallop literature which shows there to be effects. Studies showing low scale effects are referenced but not the recent IMAS study. [redacted] wanted to see more recent studies referenced by SLB. [redacted] stressed the importance of the IMAS study and said that seismic is one of many stressors in the marine environment. [redacted] said that scallop fishers would prefer the survey occurred over winter, outside of scallop spawning. [redacted] said that SLB needs to have mitigation measures to fix what effects the survey has on the marine environment or pay compensation to fishers such as what Origin paid. [redacted] enquired what happens with another survey and the cumulative effects on the fishery and larvae, including	engagement does go ahead, SLB are committed to the process and can have meaningful discussions. [redacted] questioned [redacted] over swim bladders in sharks. [redacted] would not elaborate too much but [redacted] confirmed following the meeting that sharks do not have swim bladders. [redacted] gave an overview of seismic in NZ where there have not been any negative interactions with fisheries (e.g. mid-water mackerel fishery), with trawlers working around the seismic vessel. The game fishing season in north Taranaki following SLB's 3D survey was the best season for 7 years. This was not appreciated by [redacted] who quoted extensive literature about seismic where effects have been observed on fisheries and plankton. __SLB Actions__: [redacted] and [redacted] will pull together a request for [redacted] for the engagement with licence holders so that he can provide a cost estimate.	simultaneously. SLB addressed these concerns by discussing available literature within the relevant sections of the EP. Control measures to minimise disturbance to commercial fisheries and mitigate against potential effects on rock lobster and scallops are described in the EP.	TSIC/SIV Consultation Policy is discussed in **Section 5.5.2.4.3.** The full TSIC Industry Communication and Engagement Report is provided in **Appendix J,** with SLB's full response provided in **Appendix K.** The commercial rock lobster fishery is described in **Section 5.5.2.5.1.** Acoustic disturbance on scallop and rock lobster juveniles is discussed in **Sections 7.2.2.1.2** and **7.2.2.1.3** respectively. Acoustic disturbance impacts on catch rates of commercial fisheries are discussed throughout **Section 7.2.3.** Cumulative effects are described in **Section 9,** with control measures relating to simultaneous surveys assessed in **Table 44/Table66** and finalised in **Table 45/Table67.** The use of control measures such as compensation to fishers, BACI surveys, removal of fishing equipment and plankton tows are assessed in **Table 66.**

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				multi-year cumulative effects. [redacted] queried if shark fishers have been engaged with as he believes the survey will have effects on sharks, particularly their swim bladders. [redacted] quoted a survey near Tasmania where sharks were impacted. [redacted] also stated that squid fishers will be affected. Key questions/statements around seismic are: • Avoid key times of the year during recruitment; • Need to have knowledge where scallop and rock lobster recruitment is coming from and where resettlement is occurring; and • How does mitigation of the late stage resettlement phase take place? [redacted] stated that they would be happy for the survey to commence if a larval tow for scallops and rock lobster took place, with the survey halted if larvae are present in the water column. There was a discussion among them all about the meeting with APPEA about the surveys, and a lot of discussion around the approach Spectrum took with engagement and the very rushed approach. It was discussed that [redacted] will also be in attendance at the meeting as the representative for scallops and rock lobster. [redacted] stated that SLB (and the industry in general) need to acknowledge they are having a far greater impact on fish stocks, i.e. giant crab, and would like to see an acknowledgement in the EP that seismic impacts larvae in the water column. [redacted] wants funds available for rehabilitation of fish stocks/environmental issues and gave examples. [redacted] suggested a BACI survey on fisheries but acknowledged that opinions between oil and gas companies' science and fishing industries' science will always differ. [redacted] commented that rock lobster fishers are required to get EPBC Act approval to export fish to prove that their operations are ecologically sustainable. This is a big operation for licence holders. [redacted] suggested seismic activity should be looked at as a risk in influencing recruitment levels of rock lobster based on the IMAS report.			

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				All attendees made it clear they wanted to be engaged with again very soon, they did not want this meeting to be a box ticking exercise and that the engagement should not take place like what has been done during the Spectrum engagement process.			
96	Seafood Industry Australia	04-09-18	Email outgoing		Introductory email sent to info email address requesting an email address and suggesting arranging a meeting.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		04-09-18	Email incoming	Email stating best email addresses to use for the [redacted]		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**.
		04-09-18	Email outgoing		**<u>Response to email dated 04-09-18:</u>** [redacted] re-sent background information and Information Pack Rev 1 and suggested a meeting in Melbourne to discuss survey details.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		06-09-18	Email incoming	**<u>Response to SLB email dated 04-09-18:</u>** SIA do not consult in seismic issues and cannot be seen as speaking for members on such issues. SIA are working with APPEA to try to improve the process of consultation and would welcome SLB's collaboration to develop a more appropriate mechanism for seeking input from the seafood industry. [redacted] stated that the lead time is far too short.		Stakeholder concerns were not addressed further.	Unedited correspondence is provided in **Appendix C**.
97	Seafood Industry Victoria (SIV)	24-08-18	Email outgoing		SLB provided details of the proposed survey and advised that environmental approval is being sought for the activity within the period November 2018 – May 2019. SLB stated that potential environmental impacts and risks are considered to be temporary and localised and that SLB are committed to working with all interested parties to reduce risks to as low as reasonably practicable. SLB welcome feedback concerning potential or perceived impacts and any further queries or concerns can be relayed to SLB via email or phone call.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		24-08-18	Email outgoing		Follow up email to SIV to arrange meeting.	N/A	Unedited correspondence is provided in **Appendix C**.
		27-08-18	Email incoming	[redacted] sent SIV/TSIC's Consultation Policy for the Oil, Gas, Mining and Petroleum sectors and stated that communication and consultation needs to be informed by the development of a consultation plan. [redacted] welcomes the opportunity to meet with SLB in early September.		SLB used the SIV/TSIC Consultation Policy to inform stakeholder consultation. No further response/actions are required.	Unedited correspondence is provided in **Appendix C**. SIV's consultation policy is outlined in **Section 5.5.2.4.3**.
		30-08-18	Email outgoing		[redacted] emailed [redacted] to arrange Melbourne meeting in September.	N/A	Unedited correspondence is provided in **Appendix C**.
		05-09-18	Email incoming	Confirmation of meeting.		No objections or claims – no response/actions required.	See above.
		11-09-18	Meeting	<u>**Meeting attendees:**</u> [redacted] – SIV; [redacted] – SLB; [redacted] - SLR <u>**Stakeholder comments/concerns:**</u> [redacted] stated that he has been approached by multiple companies proposing seismic in the region but that he is very heartened by the fact that SLB are the only APPEA members amongst these companies. [redacted] was queried why the survey is 2D, not 3D. [redacted] stated that summer (from November onwards) is not a good time to do a survey in the region and that the rock lobster and abalone fishery is closed from September to November for spawning. [redacted] raised that the Bonney Upwelling is extremely important to the area, is crucial for the fishery, and is a no-go zone for seismic. [redacted] summarised his involvement with Origin Energy for their Crowes Foot and Enterprise-2 surveys and stated that Origin put a large compensation in place with the fishing industry through a detailed and robust engagement process. Compensation was paid to those fishers that were genuinely affected by the survey through exclusion and not being able to access their fishery. [redacted] queried what monitoring SLB would to show they are	<u>**SLB comments:**</u> [redacted] gave an introduction to SLB and an overview of the survey. He stressed that this is an initial introductory meeting to introduce the survey, listen to SIV's concerns and find out more on the SIV engagement policy. [redacted] discussed that monitoring programmes are something that should be done on an industry-wide approach and stated that APPEA are looking at further research into the effects of seismic. [redacted] showed [redacted] a map of the proposed survey lines, which made [redacted] nervous due to the closeness of the lines to shore. [redacted] raised that a number of associations are offering to undertake engagement and sought clarification from [redacted] on what he offers (i.e. SIV look after State Fisheries while SETFIA look after Commonwealth fisheries). [redacted] questioned what depth the rock lobster and crab fishers work in. [redacted] asked for further information on how SIV would engage with fishers. [redacted] provided an overview of SLB's dealings with commercial and	Stakeholder raised concerns with regard to acquisition within the Bonney Upwelling and cumulative impacts from simultaneous surveys. SLB has discussed potential effects from the survey within the relevant sections of the EP and have taken into consideration impacts on the Bonney Upwelling. Additional control measures for operating within the Bonney Upwelling have been provided in the EP, as well as control measures to mitigate against impacts on commercial fisheries. SLB have assessed the use of BACI surveys/monitoring	Meeting minutes are available in **Appendix D**. The effects of displacement on commercial fisheries are discussed in **Section 7.1.3.1.** The effects of acoustic disturbances on marine sensitivities are discussed throughout **Section 7.2.** Cumulative impacts from multiple surveys are discussed in **Section 9**. The implementation of a BACI monitoring programme is assessed in **Table 66.**

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				not causing effects on the environment or adding some value back to the fishery or supporting the gathering of further information to help understand the effects of seismic. [redacted] summarised CarbonNet's monitoring programme, the results of which have not yet been published. [redacted] said that if SLB progress with the survey, as part of the engagement meetings it would be good to determine whether a potential monitoring programme is possible as this shows that SLB are keen on developing a working relationship with the fishing industry [redacted] requested more information to show his members that seismic does not have an effect – he made it clear that many SIV members speak badly of the seismic industry but have no factual information. [redacted] considers the SIV engagement policy to be 'best practice'. NOPSEMA have reviewed the policy and overall agree with the principals and policy. It will be finalised with NOPSEMA shortly. [redacted] specifically mentioned the rock lobster, giant crab and squid fisheries and stated that the most important part of engagement is going to be identifying what licence holders are affected and to what extent. [redacted] can provide this service. [redacted] indicated timing to implement the engagement policy; the scoping/planning stages could comment in the next week or two, with engagement in early October. [redacted] indicated is it likely to take five days of engagement to cover affected fishers. [redacted] raised the importance of King Island for rock lobster. [redacted] stated that the middle long survey line is probably the separation line between Victorian and Tasmanian crab fishery; there is only one active operator in this fishery. [redacted] is seeking to review a copy of the EP before submission. [redacted] clarified what parts [redacted] is interested in. [redacted] raised that APPEA are wanting to bring all operators proposing seismic in the Victorian region together to pool resources and look at one large state-wide assessment. Once prepared, the information would be available to all operators. This is unlikely to happen prior to SLB submitting.	recreational fishing grounds in New Zealand, including 24-hour look-aheads. **SLB actions:** [redacted] to discuss internally whether a draft of the EP will be released. [redacted] to determine water depth of inshore survey lines. [redacted] and [redacted] to investigate and discuss what can be proposed to minimise conflict with fishers. [redacted] to discuss with management as to what the way forward for engagement will be.	programmes within the EP.	

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				[redacted] stated there is serious concern that two seismic vessels will be working simultaneously and requested SLB provide details about why SLB are proposing a 2D survey. [redacted] asked about sound modelling for the survey and asked if SLB can provide a map with survey lines and the sound modelling results overlaid, with an exposure line around the survey area. [redacted] confirmed that he is asking for a determined Sound Exposure level to be indicated as a contour around the survey area.			
		23-10-18	Email incoming	**Email response to [redacted] voicemail message:** [redacted] questioned if SLB have any specific questions? He is taking leave and is struggling to complete all the information SLB require. Information will hopefully be completed tonight.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**.
		24-10-18	Email outgoing		[redacted] emailed [redacted] to arrange meeting in Melbourne.	N/A	See above.
		30-10-18	Meeting	**Meeting attendees:** [redacted] – SIV; [redacted] – SLB; [redacted] - SLR **Stakeholder comments/concerns:** [redacted] wants the Victorian fishing grids overlaid with the survey map to provide to licence holders, so they can identify areas of concern with regard to where they fish. [redacted] commented that the map in the Information Sheet is too busy and requested a clean version for distribution. [redacted] queried what the seismic acquisition plan would be. [redacted] discussed the regional workshop with NOPSEMA. He questioned [redacted] how long the survey had been planned for before he was advised and noted that three other companies have been in contact looking at the same area. What [redacted] would like to see happen as an outcome of the meeting is that instead of SIV being engaged individually by the companies, there would be one map developed for all of Victoria fisheries across all regions and all seasons. Which is then made publicly available when requested as it will be a fishing industry resource. However, the question will be who will resource the development of such information. [redacted] questioned what the acoustic source details are and stated that licence holders will want to see the STLM results. [redacted] stated that as part of the engagement SIV will contact Victorian fishers and Commonwealth fishers that land	**SLB comments:** [redacted] provided an update on the survey and made it clear that SLB are flexible on timing of when lines are acquired. [redacted] and [redacted] explained the tie lines and why they go into shallower waters. [redacted] advised that SLB have pulled back some of the lines in shallower waters based on feedback from the first round of meetings. **SLB actions:** [redacted] to develop a sound modelling package that can be distributed out to fishers once the STLM is complete.	No objections or claims were raised; however, SLB provided stakeholder with the requested information.	Meeting minutes provided in **Appendix D**. Responses received to SIV-lead engagement are summarised in **Table 32**, with the full Consultation Feedback Report provided in **Appendix H**. SLB's response to the SIV report is provided in **Appendix I**. The full STLM report is provided as **Appendix A**. Information Packs provided to stakeholders can be viewed in **Appendix E**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				their fish into Victoria, as well as squid fishers. [redacted] requested a word version of the Information Sheet to allow him to edit it into 'industry speak'. [redacted] explained that the information sheet will be sent to approximately 300 licence holders and he would like to see what response he receives before any meetings. He hopes to have meetings with licence holders in the next four weeks. [redacted] requested the fishery assessment section of the EP, so he could review the section. The key take home message from [redacted] was that the information that is distributed to the licence holders as to provide as much detail on the survey as possible within 3-4 pages and in a format so that industry can understand it. The provision of the look ahead documents were discussed but [redacted] said that can be provided in further discussions if people say they are fishing in particular areas, it can be a way of mitigating effects by enabling the fishers to know exactly where the survey vessel will be.			
		01-11-18	Email outgoing		[redacted] emailed to thank [redacted] for his time (meeting dated 30-10-18). A word version of the Information Sheet was provided to [redacted] for him to review and mark-up for SLB to finalise prior to distribution to licence holders. A revised version of the survey map was also provided. [redacted] requested the shapefiles for fishing grids for Victoria are sent through, so they can be overlaid to allow licence holders to show where they fish.	N/A	Unedited correspondence is provided in **Appendix C**.
		20-11-18	Email outgoing		Attached Information Pack Rev 2 and map of Operational Area with Victorian reporting grid lines overlaid. [redacted] asked [redacted] to distribute this information to members that he thinks are likely to be influenced by the proposed survey and seek any feedback, questions, or concerns they may have. [redacted] was asked who he distributes this information to in terms of the number of licence holders in the different fisheries etc.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		20-12-18	Email incoming	Email from [redacted] attaching the first draft consultation report.		The consultation report was reviewed by SLB and a response to the questions and comments was provided (**Appendix I**).	Unedited correspondence is provided in **Appendix C**. Full SIV report is provided as **Appendix H**.
		20-12-18	Email outgoing		From [redacted] to [redacted] with thanks for the feedback and distribution of information.	N/A	Unedited correspondence is

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		31-01-19	Email outgoing		From [redacted] to [redacted] to request a phone call to discuss meetings with members who have expressed concerns	N/A	provided in **Appendix** C.
		31-01-19	Email incoming	From [redacted] to [redacted] suggesting tomorrow might be possible for a call		No objections or claims – no response/actions required.	
		06-02-19	Email outgoing		From [redacted] to [redacted] with Information Pack Rev 4 and advising of amended survey timeframe	N/A	
		20-02-19	Email outgoing		From [redacted] to [redacted] with response from SLB to SIV in regard to the questions and comments that were raised in the SIV Consultation Report to distribute to members.	N/A	Unedited correspondence is provided in **Appendix** C. Full SLB response to the SIV Consultation Report is provided in **Appendix I**.
		28-03-19	Email outgoing		[redacted] asked if [redacted] had any further response/comments back from members with regard to the new timing of the survey and if industry wanted to meet or not.	N/A	Unedited correspondence is provided in **Appendix** C.
98	Shark Gillnet and Shark Hook Sector – Sustainable Shark Fishing Inc.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
99	Silver Phoenix Holdings Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
100	Skipjack Tuna Fisheries	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
101	Slidell Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 sent.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4 sent.		
102	Small Pelagic Fishery – Small Pelagic Fishery Industry Association	03-09-18	Email outgoing		Introductory email and Information Sheet Rev 1 sent after phone call.	N/A	Unedited correspondence is provided in **Appendix** C. Information Packs can be viewed in **Appendix** E.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
103	South Australian Rock Lobster Fishery (SARLF)	03-09-18	Email outgoing		**Email to [redacted]:** [redacted] attached an Information Pack Rev 1. [redacted] requested [redacted] distribute this to members that would be best placed to receive the information. [redacted] requested any information with regard to concerns over area, timing, particular sensitivities etc. SLB may be in Adelaide next week so [redacted] suggested a meeting to further discuss the survey.	N/A	Unedited correspondence is provided in **Appendix C**.
		04-09-18	Email outgoing		**Follow up email to [redacted]** Email arranging meeting with [redacted] in Adelaide.	N/A	See above.
		04-09-18	Email incoming	**Response to email dated 04-09-18:** Email arranging meeting in Adelaide.		No objections or claims – meeting organised.	See above.
		11-09-18	Email outgoing		**Response to email dated 04-09-18:** Email arranging meeting in Adelaide.	See above.	See above.
		11-09-18	Email incoming	Confirmation of upcoming meeting.		N/A	See above.
		13-09-18	Meeting	**Meeting attendees**: [redacted] – SARL), [redacted] – SLB), [redacted] – SLR) **Stakeholder comments/concerns:** Questioned why SLB are proposing a 2D survey as opposed to 3D. The research on rock lobster by UTAS and the identification of sub-lethal effects (i.e. self-righting and tail flapping) has caused some concern among the rock lobster fishers. Said that the industries need to work together, as they are also an extractor of a resource from the sea, so there needs to be some give and take by everyone. Representative's opinion was that the 3D surveys have more of an effect on the fishery, so he was a little less concerned that SLB are proposing 2D. As it takes a lot of time for the industry to deal with all of the O&G proponents, they would like a more streamlined approach to the process. Recommended that SLB should submit a data request to SARDI to find out exactly where all the rock lobster fishing effort takes place. Said that PGS have gone through this process with SARDI recently as part of their EP preparation.	**SLB comments:** Explained reasoning and that early exploration phase is best done with a 2D survey. SARLF have had discussions with NOPSEMA about the advice they can provide and the research with the aim to make the consultation process more streamlined. SLB also commented that SLB have had discussions with NOPSEMA and the working group of the Reference Case and are following the Reference Case process. **SLB Actions:** [redacted] is going to get in touch with SARDI to see what is involved in getting a data extract of rock lobster effort, in terms of timeframe for a delivery and whether any cost is associated with the request. [redacted] from SARDI provided [redacted] with the rock lobster stock assessments for South Australia.	Stakeholder raised concerns with regard to effects of seismic on rock lobster. SLB have addressed these concerns within the relevant sections of the EP.	Meeting minutes provided in **Appendix D**. Consideration to the UTAS study has been provided in **Section 7.2.2.1.3** (Rock Lobster Larvae – Potential Physiological Impacts), **Section 7.2.2.1.4** (Benthic Invertebrates - Potential Physiological Impacts), **Section 7.2.2.2.1** (Benthic Invertebrates - Potential Behavioural Impacts), **Section 7.2.3.2** (Catch Rates – Molluscs), **Section 9.3** (Multiple Exposures – Infilling). **Section 7.1.3.1** (Potential Impacts to Commercial Fishing Operations).

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		23-10-18	Email outgoing		Follow up with [redacted] regarding meeting in SA to discuss the refinements to the survey and any feedback from members on the survey.	N/A	Unedited correspondence is provided in **Appendix C**.
		01-11-18	Meeting	**Meeting attendees:** [redacted] – Southern Rock Lobster Ltd (SRL); [redacted] – South Australian Rock Lobster Fishery & South Eastern Professional Fisherman's Association (SARLF); [redacted] – SLB; [redacted] -SLR **Stakeholder comments/concerns:** [redacted] gave an introduction to SRL and stated that the biggest concern to the rock lobster industry is the death of larval stages (i.e. puerulus) of rock lobster, and the cumulative effects over a year or multiple years with multiple/repeated surveys. Genetic studies suggest most rock lobster juveniles come from South Australia and drift in a western direction, therefore larvae may be exposed multiple times as they drift. The effects of seismic on adult rock lobster were discussed. [redacted] asked whether the data is being gathered for clients and if other data has already been gathered. [redacted] said that he has spoken to a number of licence holders and they are happy that a large part of the survey has been moved further offshore but are concerned with the 10% in water depths less than 200 m. [redacted] claimed that rock lobster in the GAB moved behind Kangaroo Island following seismic and drilling but that this is anecdotal. There is also anecdotal evidence that lobsters were affected in a 2011/12 survey – this was discussed. [redacted] explained the depths rock lobster are targeted in and the reasons for this. Due to this, [redacted] said that they would like SLB to exclude South Australia and remove more lines from close to shore. [redacted] discussed concerns around proposed timing due to the presence of larval stages. [redacted] suggested SLB talk to [redacted] at SARDI about the best timing, and [redacted] and [redacted] from University of Tasmania about rock lobster moulting/sensitive stages.	**SLB comments:** [redacted] gave an introduction to SLB and the differences between 2D and 3D seismic. [redacted] advised that previous survey areas have been avoided so there have been no previous surveys where SLB is proposing. [redacted] offered timing mitigations but said that excluding a large area around South Australia would be difficult. [redacted] queried if [redacted] and [redacted] had spoken to the western rock lobster fishers about seismic as catch rates in this fishery are extremely high and they have probably experienced the most seismic along the western coast. [redacted] replied that it is a different species of rock lobster, but [redacted] said this would not affect how larval stages are affected. **SLB actions:** [redacted] to do investigations around western rock lobster and the influence of seismic. [redacted] to provide map showing the current survey map and initial survey map. [redacted] and [redacted] to prepare document of what has changed as a result of stakeholder engagement and who has been engaged with.	Stakeholder raised concerns with regard to effects of seismic on rock lobster larvae. SLB have addressed these concerns within the relevant sections of the EP.	Meeting minutes provided in **Appendix D**. Displacement from fishing grounds is discussed in **Section 7.1.3.1**, with the alterations made to the Operational Area mapped in **Figure 56** and **57**. Rock lobster fisheries are described in **Section 5.5.2.5.1**. Potential impacts of acoustic disturbance on rock lobster are assessed in **Sections 7.2.2.1.3** (physiological effects on rock lobster larvae), **7.2.2.1.4** (physiological effects on benthic invertebrates), **7.2.2.2.1** (behavioural effects on benthic invertebrates), and **7.2.3.1** (impacts on catch-rates – crustaceans). The use of a BACI study as a control measure has been assessed in **Table 66**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				[redacted] queried the use of BACI surveys but admitted this would be difficult to do. [redacted] requested a map of the survey area before and after amendments to show licence holders how SLB are taking their concerns onboard. [redacted] also requested a document to be distributed to licence holders stating what has changed based on consultation to date and who has been engaged with. [redacted] and [redacted] discussed arranging a meeting with select licence holders			
		17-11-18	Email outgoing		**Follow up email to meeting dated 17-11-18:** [redacted] followed up from last meeting with further updates and summaries for [redacted] to share with members. The latest Information Pack Rev 2was attached providing the latest details and survey map incorporating changes to the survey that resulted from discussions with SARLF. [redacted] provided a map showing the initial Operational Area and the revised current Operational Area, which has moved further offshore into deeper waters following discussions with SARLF. [redacted] asked for further information on timing to minimise disturbance as much as possible through temporal management of the survey. [redacted] summarised some key point relating to water depths within the Operational Area and introduced the tie lines that will be acquired. [redacted] suggested another meeting when SLB are next in South Australia, during which they will run through the STLM results. The meeting invitation was extended to any member that were willing to meet and who were available at the time.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**. The full STLM report is provided as **Appendix A.**
		10-12-18	Email incoming	[redacted] requested [redacted] provide an update on the latest regarding the propose survey. [redacted] stated that significant concern remains from the industry even with the changes to the Operational Area. [redacted] is interested to know where the formal EP is at for the activity and when SLB were intending to consult with SARLF fishermen on the EP.		No new objections or claims raised that had not already been addressed.	Unedited correspondence is provided in **Appendix C**.
		10-12-18	Email outgoing		**Response to [redacted] email dated 10-12-18:** [redacted] advised that SLB are still preparing the EP and although it has not yet been lodged, it will be lodged shortly.	N/A	Unedited correspondence is provided in **Appendix C**. The full STLM report is

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					[redacted] also advised that the survey area was further reduced to enable survey objectives to be achieved within a reduced timeframe, and that delays now mean that the earliest the survey could commence is late January, pending regulatory approval. [redacted] also stated that the survey design is still to be confirmed but proposed design will allow most of the rock lobster fishing in SA to be completed, based on SLB's understanding of the rock lobster fishery. [redacted] asked [redacted] to confirm timing with regard to fishing activity. [redacted] mentioned again coming to South Australia to meet with [redacted] and members. [redacted] stated that the STLM was completed and described the thresholds and zones of potential impact used for rock lobster. [redacted] presented the proposed timing of the tie lines based on the presence of fishing and large cetaceans in the area. [redacted] suggested discussing proposed control measures with [redacted] including the use of a 'Fisheries Support Vessel'. [redacted] further described this vessel, as well as potential compensation in the event that lobster pots are lost due to the survey vessel. [redacted] will call [redacted] to further discuss the survey and control measures and to arrange a time to meet with members. [redacted] requested any further details on the main concerns from members so that further changes can be considered. [redacted] stated that it was hoped that moving the survey further offshore beyond the 200 m line would reduce potential for concurrent activities. [redacted] also stated that STLM shows how sound will behave during the survey.		provided in **Appendix A** Alterations to the Operational Area throughout the development of the EP are depicted in **Figures 56** and **57** and discussed in **Section 7.1.3.1**. A discussion on the effects of acoustic disturbance on rock lobster has been provided in **Sections 7.2.2.1.3** (physiological effects on rock lobster larvae), **7.2.2.1.4** (physiological effects on benthic invertebrates), and **7.2.2.2.1** (behavioural effects on benthic invertebrates). Rock lobster acoustic thresholds are provided in **Table 52**. A discussion on the effects on commercial rock lobster fisheries is provided in **Sections 7.1.3.1** (displacement of commercial fisheries) and **7.2.3.1** (impacts on rock lobster fisheries from acoustic disturbances). Control measures specific to minimising the effects of the physical presence of the survey vessel and acoustic disturbance are assessed in **Tables 44** and **66**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		12-12-18	Email incoming	**Response to [redacted] email dated 10-12-18:** [redacted] thanked [redacted] for the update and advised that he had forwarded the provided information to members and is trying to arrange a meeting between SLB and fishermen in January.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**.
		13-12-18	Email outgoing		**Response to [redacted] email dated 12-12-18:** [redacted] thanked [redacted] for distributing information to members and updated [redacted] on additional developments to the project (i.e. new timing) and lodging of EP.	N/A	See above.
		13-03-19	Email outgoing		**Update email from [redacted] to [redacted]** [redacted] provided further updates following update email dated 12-12-18 with regard to proposed October timing of survey. [redacted] attached the latest Information Pack Rev 4 with this updated timing and asked [redacted] to provide any feedback from members with regard to this new timing. [redacted] queried if [redacted] had had any responses from members with regard to possible dates for a meeting with SLB.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		14-03-19	Email incoming	**Response to email dated 13-03-19**: [redacted] thanked [redacted] for the updated information and asked if it would be possible for SLB to attend a South Eastern Professional Fishermen's Association (SEPFA) meeting scheduled for May 2019.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**.
		15-03-19	Email outgoing		**Response to [redacted] email dated 14-03-19:** [redacted] thanked [redacted] for the SEPFA meeting invitation. SLB will check their schedule as to whether they can attend and will get back to [redacted] with regard to attendance. [redacted] advised that SLB will need to submit the EP to NOPSEMA before the end of March 2019 but that SLB are still committed to working with SARLF members leading up to and during the survey (should it gain approval).	N/A	See above.
		31-03-19	Email incoming	[redacted] informed [redacted] that the SEPFA meeting has been postponed and will be in touch once new date is confirmed.		No objections or claims – no response/actions required.	See above.
		17-04-19	Email outgoing		[redacted] provided [redacted] an update on SLB's plans to lodge the application towards the end of the month due to the upcoming amendments to the Environment Regulations. [redacted] stressed that submission of the EP does not mean a halt to discussions with SARLF (and others) and that SLB are still committed to meeting and working with members to minimise conflict.	N/A	Unedited correspondence is provided in **Appendix C**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					[redacted] enquired when [redacted] would be available to meet and if [redacted] has received any further feedback or has any further questions. [redacted] offered to call [redacted] to discuss the survey and regulatory process.		
104	South East Trawl Fishing Association (SETFIA)	03-09-18	Email incoming	[redacted] emailed [redacted] (SLB) introducing himself and requesting SLB make contact. [redacted] would like to talk about understanding the fishing effort in the polygon SLB are considering.		N/A	Unedited correspondence is provided in **Appendix C**.
		04-09-18	Email outgoing		**Response to [redacted] email dated 03-09-18:** [redacted] suggested a meeting with [redacted] when [redacted] is travelling to Victoria to discuss an operational outline and get feedback from SETFIA. [redacted] stated that SLB has flexibility in their plan and feedback will be incorporated to minimise potential disturbance. [redacted] will get information required for the meeting ahead passed on to SB.	N/A	See above.
		04-09-18	Email outgoing		Introductory email from [redacted] to [redacted] suggesting a date to meet.	N/A	See above.
		04-09-18	Email incoming	**Response to [redacted] email dated 04-09-18:** Reply to arrange meeting with SLB.		No objections or claims – no response/actions required.	See above.
		05-09-18	Email incoming	[redacted] advised [redacted] that SLB are likely to be covering three states and the Commonwealth fisheries which could be 20-30 different sub-fisheries.		No objections or claims – no response/actions required.	See above.
		05-09-18	Email outgoing		Reply from [redacted] saying he will speak with Schlumberger about the services offered.	N/A	See above.
		05-09-18	Email incoming	[redacted] can provide: catches by species, value, seasonality (where available), effort, fishery, points of individual and association contact, descriptions of methods, and % of fishery potentially impacted.		No objections or claims – no response/actions required.	See above.
		07-09-18	Email outgoing		[redacted] asked [redacted] if he represents the Scallop Fisherman Association Inc.	N/A	See above.
		07-09-18	Email incoming	Reply from [redacted] advising SETFIA represents the following but not Scallop Fisherman Association Inc: Shark Trawl Small pelagic Eastern rock lobster		No objections or claims – no response/actions required.	See above.
		23-10-18	Email incoming	From [redacted] containing contact details for industry associations to arrange meetings with.		No objections or claims – no response/actions required.	See above.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		25-10-18	Email outgoing		From [redacted] advising timelines and whether information gathered in a certain timeframe would reflect the period when the actual seismic activities will take place	N/A	See above.
		29-10-18	Email incoming	[redacted] attaches Milestone 1 Document		Includes contacts for high level consultation contacts with fishing industry.	See above. These groups were included as part of the stakeholder engagement programme (**Appendix B**).
		31-10-18	Meeting	Meeting with [redacted]	Initial introductory meeting at Melbourne airport to finally meet face to face. Went through survey design and process for going forward with the fisheries assessment and ongoing engagement once the survey was underway should the EP be approved.	No objections or claims. SETFIA are willing to work with SLB and the fishers in the area to minimise conflict so everyone can utilise the area and resources.	Meeting minutes provided in **Appendix D**.
		31-10-18	Email outgoing		**Follow up email to [redacted]** Follow up after meeting to inform [redacted] that SLB were unable to get through everything during meeting. [redacted] advised that there are some last-minute changes that have only just been confirmed so there will be more survey lines into the deeper water, resulting in an extension to the Operational Area/polygon. [redacted] attached a new map showing these changes and asked if it would affect anything in [redacted] assessment based on water depths of 500 m.	N/A	Unedited correspondence is provided in **Appendix C**. Alterations to the Operational Area throughout the development of the EP are depicted in **Figures 56** and **57** and discussed in **Section 7.1.3.1**.
		01-11-18	Email incoming	**Response to [redacted] email dated 31-10-18:** [redacted] stated there is no fishing past 1,000m area deeper than 4,000 has no impact.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**.
		01-11-18	Email outgoing		**Response to [redacted] email dated 01-11-18:** [redacted] stated that the 1,000 m bathymetry contour has been overlaid on the survey area with survey lines to give [redacted] an idea of the actual survey lines inshore of the 1,000 m contour. From [redacted] stating that we have just overlaid the 1,000 m bathy contour on the survey area with the survey lines just to give him an idea of the actual survey lines inshore of the 1,000 m contour.	N/A	See above.
		01-11-18	Email incoming	**Response to [redacted] email dated 01-11-18:** [redacted] re-stated that if that is the 1000m contour you are in good shape.		No objections or claims – no response/actions required.	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		01-11-18	Email outgoing		**Email to [redacted]:** The polygon has extended a little into deeper water. In the introduction of the report please can you explain that SLB have extended their polygon a little into deeper water and that this will not mean that additional catch will be impacted. We might need to include both polygons as images.	N/A	See above.
		12-12-18	Email incoming	From [redacted] attaching their draft report		N/A	See above.
		19-12-18	Email incoming	From [redacted] attaching their final report		N/A	See above.
		16-04-19	Email outgoing		**Email to [redacted]** [redacted] updated [redacted] on the new proposed timing and queried if [redacted] had received his recent emails as no response was received. [redacted] informed [redacted] that the EP will be submitted under the new regulations so the EP and SETFIA report will be in the public domain. [redacted] questioned if [redacted] had any concerns over the outcome of the report and if he had heard anything back from the fishers he represents.	N/A	See above.
105	South Eastern Professional Fishermans Association (SEPFA)	03-09-18	Email outgoing		Introductory email with Information Pack Rev 1 attached.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		17-11-18	Email outgoing		Update email with Information Pack Rev 2 attached.		
106	Southern Bluefin Tuna Fishery	21-11-18	Email outgoing		Update email with Information Pack Rev 2 attached.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3 attached.		
107	Southern Rock Lobster Limited (SRL)	03-09-18	Email outgoing		Introductory email to [redacted] with Information Pack Rev 1 attached.	N/A	Unedited correspondence is provided in **Appendix C**. Information Packs can be viewed in **Appendix E**.
		04-09-18	Email outgoing		Follow up email from [redacted] advising that SLB will be in Adelaide and enquiring as to if SRL will be available for a meeting.	N/A	Unedited correspondence is provided in **Appendix C**.
		09-09-18	Email incoming	**Response to [redacted] email dated 04-09-18:** [redacted] replied thanking [redacted] for his email and introduced SRL. [redacted] apologised for the delayed reply – SRL are inundated with consultation requests. [redacted] is unable to meet but is happy to take a phone call instead if that suits SLB. [redacted] had the following queries: 1. What is SLB's policy in relation to "no fishing from		SLB provided a response to stakeholder's questions. Available scientific literature was used throughout the EP to determine the potential effects on	Unedited correspondence is provided in **Appendix C**. Displacement of fishers from fishing grounds is discussed in **Section 7.1.3.1**. Control measures to

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				support/commercial vessels"?; 2. What process does the proponent have in place to quantitatively assess any damage to fish stocks, fish spawn, the food chain such as plankton etc. due to seismic survey activity?; 3. What processes are in place to quantitatively assess any damage to fish stocks in the event of a spill (with reference to assessments during the construction phase and later the operational phase of a project)?; 4. Is the proponent's staff, and contractors and sub-contractor all aware of the difference between exclusion zones and cautionary zones?; 5. What is the proponents communication policy with all staff and vessel crew, contractors and sub-contractors regarding interacting and protecting the rights of active commercial fishers on the water?; and 6. What recognised scientific evidence is there to suggest that "any key potential environmental impacts and risks associated with the proposed survey activities will be temporary and localised, including ... disturbance to ... fishing activities."?. [redacted] also stated that SRL can offer a fee-for-service consultation on a case-by-case basis to assist SLB's consultation with individual stakeholders.		marine receptors.	mitigate against displacement, including communication with commercial fishers have been assessed in **Table 44**, with final measures provided in **Table 45**. Potential effects on fish stocks/catch rates from acoustic disturbance are described in **Section 7.2.3.** Scientific literature on the effects of acoustic disturbance on marine life and commercial catch rates has been utilised throughout **Section 7.2**. The use of a BACI study as a control measure has been assessed in **Table 66**. Potential effects from a hydrocarbon spill are addressed throughout **Section 8.4**.
		27-09-18	Email outgoing		<u>**Email response to [redacted] email dated 09-09-18:**</u> [redacted] advised that there have been revisions to the survey and Operational Area and that a revised information sheet will be provided. It is hoped that the revised area may settle concerns had by the fishing industry in regard to displacement. [redacted] provided the following responses to [redacted] questions: 1. [redacted] requested further clarification but stated that SLB are not looking to stop fishing activities from occurring and want to work with fishers to minimise conflict; 2. No physical survey will take place during the survey but AIMS and CSIRO are undertaking further research; 3. All refuelling will be undertaken in port so the only potential for a spill event would be from a significant vessel collision and rupturing of the vessel hull/tanks. [redacted] discussed the	N/A	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					control measures in place to avoid a collision; 4. [redacted] requested further explanation to what context [redacted] is referring to for exclusion zones and cautionary zones; 5. Master is in charge of vessel and responsible for implementing all the measures put in place to minimise conflict. Engagement will assist in understanding how fishers may be affected, and feedback will be incorporated into the EP. A communication plan will be put in place for the duration of the survey, including 48-hour look-aheads; and 6. The EP summarises all of the literature that is currently available. [redacted] discussed some issues with claims made in the literature that require further investigation. [redacted] stated that there is flexibility in the survey design with regard to minimising displacement of fishers. [redacted] stated that he had viewed the latest southern zone rock lobster fishery stock assessment and notes that over 80% of catch has come from water depths >60 m. [redacted] requested further breakdown of costing and services that SRL can provide and what groups would be covered as part of the consultation service. [redacted] advised that SLB will be back in South Australia and Victoria soon, and he will be in touch with regard to arranging a meeting but is also happy to discuss questions or provide clarification over the phone.		
		02-10-18	Email incoming	**Response to [redacted] email dated 27-09-18:** [redacted] acknowledging receipt of [redacted] queries and will formulate a reply ASAP.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**
		10-10-18	Email outgoing		[redacted] followed up with [redacted] to see if he had had a chance to pull together information on costings for engagement with members and advised that a revised Information Pack Rev 1with a revised Operational Area will be provided shortly.	N/A	See above.
		23-10-18	Email incoming	[redacted] emailed saying that SRL have provided consultation services to other companies including in relation to drilling in the GAB. This has taken up a considerable amount of [redacted] time. Meetings suit [redacted]		No objections or claims – no response/actions required.	See above.
		23-10-18	Email outgoing		[redacted] touched based to arrange a meeting with [redacted] and also followed up on [redacted] offer to assist with consultation with members and queried if [redacted] has any further information on this or if any members would be available to meet with SLB when they are in Victoria and South Australia.	N/A	See above.
		23-10-18	Phone Call	[redacted] explained that as they have been dealing with lots of oil and gas companies, the requests were too much and following a meeting with the commonwealth, SRL engaged an ex oil and gas employee in Perth to help out with consultation and provide some expert advice to SRL.		No objections or claims – no response/actions required	Memo available in **Appendix D**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				[redacted] said that if we require responses to any questions we have from their licence holders, or about the fishery or wish to organise meetings, he can speed this process up by hiring in a consultant to assist them with this process that they use. Currently, when [redacted] gets a request for information or advising of a survey, he has to discuss with the directors on the board. There are currently five professional fishers on the board, who only come back to shore every two weeks, so he cannot provide a response without their feedback. However, he said a consultant would help speed this response up. And a consultant they use could also go out to the fishers at Port Lincoln and other ports and discuss the survey with fishers and listen to their concerns. [redacted] asked if [redacted] is able to give some indication of costs for what it would take for their consultant to organise the meetings and that we would want to be in attendance as well if possible.			
		25-10-18	Email outgoing		[redacted] confirmed meeting.	N/A	Unedited correspondence is provided in **Appendix C**
		25-10-18	Email incoming	[redacted] confirmed meeting location.		No objections or claims – no response/actions required.	See above.
		01-11-18	Meeting	See summary of meeting dated 01-11-18 attended by [redacted] and [redacted] under **Stakeholder ID# 103**			
		17-11-18	Email outgoing		**<u>Follow-up email to [redacted] after meeting dated 01-11-18:</u>** [redacted] provided [redacted] with further updated and summarises to be provided to licence holders, including the latest Information Pack Rev 2. [redacted] attached a map showing the initial Operational Area and the revised current Operational Area, with discussions resulting in a reduction of 25,000 km^2. [redacted] stated that SLB wish to understand how the survey can be best timed to minimise disturbance as much as possible and summarised a number of key points about the proposed survey and survey plan. [redacted] finished by saying that SLB will be back in South Australia and able to meet with [redacted] again to go through STLM results.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs provided to stakeholders can be viewed in **Appendix E**. Alterations to the Operational Area throughout the development of the EP are depicted in **Figures 56** and **57** and discussed in **Section 7.1.3.1**. The full STLM report is provided as **Appendix A.**
		13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Information Packs provided to stakeholders can be viewed in **Appendix E**.
		10-12-18	Email outgoing	See [redacted] response (dated 10/12/18) to [redacted] of SARLF under **Stakeholder ID#103.**			

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		13-03-19	Email outgoing		Timing update with Information Pack Rev 4.	N/A	Information Packs can be viewed in **Appendix E.**
108	Southern Sea Eagles Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
109	Southern Shark Industry Alliance Inc.	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**
		21-11-18	Email incoming	Email Delivery Failure		N/A	Unedited correspondence is provided in **Appendix C.**
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	N/A	Information Packs can be viewed in **Appendix E**
110	Southern Squid Jig - Commonwealth Fisheries Association	07-09-18	Email outgoing		Introductory email with Information Pack Rev 1.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
111	Southern Zone Abalone Fishery	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
112	Southlander Fisheries Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
113	St Antonios Nominees Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
114	Sustainable Shark Fishing Association	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
115	T & Dp Guarnaccia Pty Ltd & Hunt Morrey Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
116	Tasmanian Rock Lobster Fisherman's Association (TRLFA)	07-09-18	Email outgoing		Introductory email with Information Pack Rev 1.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**
		11-09-18	Email incoming	**<u>Response to SLB email dated 07-09-18:</u>** [redacted] thanked SLB for their correspondence and stated that TRLFA have concerns with seismic surveys and their effects on lobsters and other marine species. [redacted] highlighted the TSIC/SIV Consultation Policy and suggested a meeting with TRLFA, TSIC, and SIV to discuss industry concerns.		Concerns with regard to effects on rock lobster and other marine species were raised but no scientific literature was used to support claims. SLB addresses potential effects using available literature throughout EP.	Unedited correspondence is provided in **Appendix C.** TSIC/SIV Consultation Policy is discussed in **Section 5.5.2.4.3.**
		25-10-18	Email outgoing		[redacted] provided an updated Information Pack Rev 1 showing changes to survey area and an attached map showing the proposed survey in relation to Tasmanian waters. [redacted] followed up a voicemail left on [redacted] phone requesting a meeting.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**
		26-10-18	Email incoming	Confirmation of upcoming meeting.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.**
		26-10-18	Email incoming	[redacted] confirmed he will be attending the meeting and advised of an email change.		No objections or claims – no response/actions required.	See above.
		29-10-18	Meeting	See summary of meeting dated 29-10-18 attended by [redacted] (TSIC), [redacted] (Tasmanian Scallops and Bass Strait Scallops), [redacted] (Tasmanian Rock Lobster Fisherman's Association Ltd (TRLFA), [redacted] (SLB), and [redacted] (SLR) under **Stakeholder ID#95**.			
117	Tasmanian Seafood Industry Council (TSIC)	24-08-18	Email outgoing		SLB provided [redacted] with an Information Pack Rev 1 for the proposed survey and stated that SLB believe the impacts and risk to be temporary and localised. SLB welcomed any queries or concerns by phone or email and advised that they will be arranging meetings with stakeholders so would appreciate confirmation of availability.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		14-09-18	Email outgoing		Introductory email with Information Pack Rev 1.	N/A	See above.
		14-09-18	Email incoming	[redacted] advised he will be returning from overseas and will be contactable then.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.**
		25-09-18	Email incoming	[redacted] advised he will be travelling inter and intra state but will be checking emails periodically.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.**
		02-10-18	Email incoming	**Response to email dated 24-08-18:** [redacted] stated that as the map provided covers a large area of water off Tasmania, Victoria and South Australia, it is hard to comprehend what the survey plans would be. He can, however, determine that there is significant overlap with other seismic proposals and raises the issue of cumulative impacts. [redacted] stated that SIV do not have the contact details of Tasmanian operators.		Stakeholder raised concerns over cumulative impacts but did not provide further information. Cumulative SLB addresses cumulative impacts within EP.	Unedited correspondence is provided in **Appendix C.**
		11-10-18	Email outgoing		**Response to [redacted] email dated 02-10-18:** [redacted] advised [redacted] that the Operational Area has been revised and is more focused around where the actual survey is proposed. A revised Information Pack Rev 1and survey map was attached. [redacted] requested [redacted] thoughts on the revised area in terms of influence on Tasmanian waters/fishers. [redacted] confirmed that cumulative effects are being considered within the EP. [redacted] asked for clarification on the best way to engage with Tasmanian fishers.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E** Cumulative effects are discussed in **Section 9**.
		23-10-18	Email outgoing		**Follow up email to [redacted] email dated 11-10-18:** [redacted] followed up from previous email to say that SLB will be in Victoria and South Australia and queried if [redacted] and other appropriate groups/representatives would be available for a meeting.	N/A	Unedited correspondence is provided in **Appendix C.**
		23-10-18	Email incoming	**Response to [redacted] email dated 23-10-18:** [redacted] is overburdened with oil and gas proposals as well as other Tasmanian seafood priorities. [redacted] stated that TSIC do not have the resources to accommodate current demand. [redacted] is happy to meet SLB to discuss the proposed survey and advised [redacted] to propose preferred dates.		No objections or claims. SLB arranged meeting.	See above.
		23-10-18	Emails incoming and outgoing	Emails between SLB and [redacted] to arrange time for meeting.		No objections or claims. SLB arranged meeting.	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		29-10-18	Meeting	See summary of meeting dated 29-10-18 attended by [redacted] (TSIC), [redacted] (Tasmanian Scallops and Bass Strait Scallops), [redacted] (Tasmanian Rock Lobster Fisherman's Association Ltd (TRLFA), [redacted] (SLB), and [redacted] (SLR) under **Stakeholder ID#95**.			
		13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Information Packs can be viewed in **Appendix E**.
		20-11-18	Email outgoing		[redacted] provided [redacted] with the latest Information Pack Rev 2 to be distributed to members. [redacted] was informed by Schlumberger that they are currently organising a meeting time with NOPSEMA for the afternoon of the 29th in Perth. Also asked how he distributes the fact sheet in terms of the different licence holders and quota holders in the different fisheries.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		04-12-18	Emails incoming and outgoing	Emails between [redacted] and [redacted] to arrange time for meeting.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.**
		05-12-18	Email incoming	Provided conference call details for meeting.		No objections or claims – no response/actions required.	See above.
		10-12-18	Email outgoing		From [redacted] to [redacted] and [redacted] with brief outline of planned discussion points for meeting.	N/A	Unedited correspondence is provided in **Appendix C.**
		10-12-18	Phone conference	Conference call was held between SLB, SIV, TSIC and SLR. Attendees: [redacted] (SLB), [redacted] (SLB), [redacted] (SIV), [redacted] (TSIC), [redacted] (SLR) Purpose was to discuss the proposed Otway survey. [redacted] ran through a presentation set of slides that was shared prior to the meeting with attendees. It provided an overview of the survey reductions since discussions first began. Discussed potential risks to the proposed survey timing. An overview of SIV in relation to the proposed survey area and the feedback to date from licence holders in the area. An overview of TSIC in relation to the survey area and some questions asked of TSIC in regard to who has the information sheet being shared with so far, how many responses have been received so far, and what has been the general feedback or concerns from license/quota holders. Discussions were held around the EP submission, what were the timelines for the SIV and TSIC feedback and consultation reports. An update was provided on the survey vessel and project timing based on EP submission dates. Commitment was made that further and ongoing engagement with TSIC and SIV would continue following the submission of the EP. Details around the distribution of the 48-hour look-aheads were discussed and how to best distribute that information. And the fisheries assessment report that SETFIA were preparing at the time was discussed.		No objections or claims – no response/actions required.	Meeting minutes and presentation slides are provided in **Appendix D**.

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		11-12-18	Email incoming	[redacted] found meeting useful but was cut off shortly before the end.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C**.
		11-12-18	Email outgoing		From [redacted] to meeting attendees advising he will distribute meeting minutes in due course.	N/A	See above.
		31-01-19	Email outgoing		From [redacted] to [redacted] touching base and requesting a phone call	N/A	See above.
		19-02-19	Email incoming	From [redacted] with apologies for the delay in response. Requesting timeframe for consultation requirements.		No objections or claims – no response/actions required.	See above.
		20-02-19	Email outgoing		From [redacted] to [redacted] attaching Information Pack Rev 4 and advising of the amended survey timeframe.	N/A	See above.
		29-03-19	Email incoming	[redacted] provided SLB with a draft final of their Industry Communication and Engagement Report. [redacted] advised that this will be updated within the following week or so with any further comments that come through and a final will be provided within the next few weeks.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.** The full TSIC Industry Communication and Engagement Report is provided in **Appendix J.**
		23-04-19	Email outgoing		**<u>Response to [redacted] email dated 29-03-19:</u>** [redacted] provided SLB's response to the TSIC Industry Communication and Engagement report and suggested a conference call to go through any questions/further clarifications. [redacted] provided an update on the submission of the EP to NOPSEMA under the new Environment Regulations and emphasised that engagement with TSIC will continue following submission.		Unedited correspondence is provided in **Appendix C.** SLB's response to the TSIC report is provided in **Appendix K**.
118	Three Friends Fishing Company Pty Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing.		Timing update email sent with Information Pack Rev 4.		
119	Toberfish Pty. Ltd.	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		14-11-18	Email incoming	**<u>Response to SLB email dated 13-11-18:</u>** [redacted] thanked SLB for the information and advised that he and his wife are a 4th generation fishing		No objections or claims – no response/actions	Unedited correspondence is provided in

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				family that operates out of Portland. His main area of operation overlaps directly with the Operational Area. [redacted] stated that he has done a lot of research into seismic surveys and that he does not have a problem with them and does not believe that they fatally impact on fish. [redacted] stated that he believes the greatest problem is the interaction with trawl vessels and the seismic vessel. [redacted] offered the use of his fishing vessel as a support vessel.		required. Stakeholder is not against seismic.	**Appendix C.**
		15-11-18	Email outgoing		**Response to [redacted] email dated 14-11-18:** [redacted] has passed [redacted] information on to SLB but also said that he would like to talk to [redacted] further about his proposal and requested [redacted] phone number.	N/A	See above.
		16-11-18	Email incoming	**Response to [redacted] email dated 15-11-18:** [redacted] provided further contact details.		No objections or claims – no response/actions required. Stakeholder is not against seismic.	See above.
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	N/A	See above.
120	Tony's Tuna International Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		14-11-18	Email incoming	**Response to email dated 13-11-18**: [redacted] replied stating that they have significant concerns above the impact of seismic through the period of SBT migration and their fishing activities to secure stocks for ranching, including the period from mid-October to April. [redacted] advised that the Australian Southern Bluefin Tuna Industry Association would be submitting a detailed response.		Stakeholder has concerns with regard to southern bluefin tuna but does not provide literature to support claims. SLB discussed potential impacts on southern bluefin tuna using available scientific literature throughout the EP.	Unedited correspondence is provided in **Appendix C**.
		27-11-18	Email outgoing		**Response to [redacted] email dated 14-11-18:** [redacted] advised that SLB have been in contact with the Australian Southern Bluefin Tuna Industry Association throughout the duration of the stakeholder process to keep them up-to-date with	N/A	Unedited correspondence is provided in **Appendix C**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					the project's progression. [redacted] stated that SLB are preparing an EP that involves an extensive literature search into SBT and that the EP considers a number of control measures to reduce potential impacts to as low as reasonably practicable.		Engagement with other stakeholders is summarised in **Appendix F**. SBT are described within **Sections 5.2.3.1.4** (biology) and **5.5.2.5.7** (fishery). Potential impacts to the SBT fishery are discussed in **Section 7.2.3.6.**
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.	N/A	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	N/A	See above.
121	Trinsand Fisheries Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		22-11-18	Email incoming	Refer to email response dated 22-11-18 from **Stakeholder ID #60**. [redacted] responded on behalf of Cull Fisheries Pty Ltd and Trinsand Fisheries Pty Ltd.		Refer to email response dated 22-11-18 from **Stakeholder ID #60**.	Unedited correspondence is provided in **Appendix C.**
		27-11-18	Email outgoing		Refer to [redacted] email response to [redacted] **(Stakeholder ID #60)** dated 27-11-18. [redacted] responded on behalf of Cull Fisheries Pty Ltd and Trinsand Fisheries Pty Ltd.	N/A	See above.
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
122	Tullaberga Fishing Pty Limited	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
123	Tweed Bait Pty. Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
124	Uptop Fisheries Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
125	Victorian Giant Crab Fishery	25-10-18	Phone Call	[redacted] advised that they are not interested in meeting with SLB and that they have an engagement policy in place for engagement with the oil and gas industry that SLB need to be familiar with and that SLB should be talking to [redacted] from SIV. [redacted] said to keep [redacted] fully informed and then [redacted] will sit down with [redacted] for a briefing when the time is right, and all the available information is available. [redacted] was happy to hear that SLB will be meeting with [redacted] from Southern Rock Lobster Ltd. [redacted] confirmed that [redacted] has been engaged for his services and that SLB are aware of the consultation policies. [redacted] and said that his call to [redacted] was to extend an invite to meet when SLB were in the region.		No objections or claims – no response/actions required. SLB to consult with [redacted] and [redacted].	Unedited correspondence in **Appendix C**
126	Victorian Rock Lobster Fishery	25-10-18	Phone Call	See above.	See above.	See above.	See above.
		21-11-18	Email outgoing		Update sent with Information Pack Rev 2.	N/A	Information Packs can be viewed in **Appendix E**.
127	Victorian Rock Lobster Fishery – Eastern Zone	07-09-18	Email outgoing		Introductory email with Information Sheet Rev 1 attached	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
128	Victorian Scallop Fisherman's Association	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
129	Wellington Cape Pty Ltd	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
130	Wildcatch Fisheries SA Inc. (WFSA)	03-09-18	Phone Call	Phone conversation to discuss meeting times.		N/A	N/A
		04-09-18	Email outgoing		<u>**Email dated 03-09-18:**</u> [redacted] emailed [redacted] to arrange a meeting.	N/A	Unedited correspondence is provided in **Appendix C.**
		11-09-18	Emails incoming and outgoing	A meeting was scheduled for the 12th September at 9am at [redacted] office. [redacted] had to cancel that meeting and rescheduled for 1pm. [redacted] then had to cancel the meeting at 11:30am and could not reschedule. Several emails back and forth between [redacted] and [redacted] trying to arrange a meeting. Attempts to arrange a meeting for the week beginning 10 September 2018 were not successful. A Memorandum was prepared which summarises the phone call between [redacted] and [redacted]		N/A	Memorandum is provided in **Appendix D**.
		17-09-18	Email incoming	[redacted] emailed [redacted] to apologise for not being able to meet. [redacted] sent though the following emails for SLB to answer: 1. What processes does Schlumberger have in place to quantitatively assess any damage to fish stocks, fish		SLB provided a response to stakeholder's questions and addressed the use of BACI	Unedited correspondence is provided in **Appendix C.**

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				spawn, the food chain such as plankton etc. due to the impact of seismic survey activity?; 2. Does Schlumberger plan to do any bespoke pre-survey (commercial fishing key indicator species, stock assessments, the food chain etc.) and environment assessments?; 3. If Schlumberger is not planning on doing any bespoke pre-survey stock etc. assessments, what science is Schlumberger using to have a complete understanding of the marine environment prior to the commencement of a seismic survey?; 4. What science is Schlumberger using to demonstrate they have full understanding of fish spawning practices in the region of the proposed seismic survey and how does Schlumberger plan to avoid any survey dates which may potentially impact fish / crustacean etc. spawning periods of commercial fishing key indicator species?; 5. What science is Schlumberger using to demonstrate that they have a full understanding of fish behavioural activities and will completely avoid all seismic activities during key fish schooling, migrating patterns etc.?; and 6. If Schlumberger is not planning on doing any bespoke pre seismic survey fish stock etc. surveys, should there be any negative impacts on commercial fishing activity etc. necessitating assessment and potential financial compensation what science is Schlumberger relying on to understand the pre and post seismic survey environment?		surveys/monitoring programmes in the EP.	Scientific literature has been taken into consideration throughout **Sections 5** (existing environment), **7** (impacts from planned activities), **8** (impacts from unplanned activities), and **9** (cumulative effects). Control measures to avoid displacement of commercial fishers have been assessed in **Table 44**, with adopted control measures provided in **Table 45**. Potential impacts of acoustic disturbance on larval stages are discussed in **Sections 7.2.2.1.1** to **7.2.2.1.3** (physiological effects). Potential impacts of acoustic disturbances on fish behaviour are discussed in **Section 7.2.2.2.2**.
		15-10-18	Email outgoing		**<u>Response to [redacted] email dated 17-09-18:</u>** [redacted] attached a revised Information Sheet to be distributed amongst members and provided the following responses to [redacted] questions: 1. CSIRO and AIMS are undertaking further research with the study designed to ensure optimal data collection. SLB have no processes/plans to replicate this study but will take the findings of the study into consideration; 2. SLB are preparing an EP that requires approval by NOPSEMA and are engaging with all key commercial interests but will not undertake any stock assessments on fisheries; 3. SLB will utilise all available and current literature which is considered as the best available information at the time. This will combine with modelling data, feedback from stakeholders and observations from previous seismic surveys; 4. The EP assesses fishing activities and biological behaviour of	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**. Engagement with other stakeholders is summarised in **Appendix F.** Alterations to the Operational Area throughout the

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					fish in the area and engagement with fishers and industry representatives help identify key areas/times of the year that may have sensitive life stages or behaviours taking place. SLB have some flexibility and endeavour to minimise conflict and displacement. 48-hour look-aheads will be provided; 5. Best available literature, reports, guidance documents, briefs and key sensitivities following engagement will be incorporated into the EP which will then be incorporated into the risk assessment where mitigation measures will be adopted as required; and 6. No pre- or post-surveys on fish stocks are planned but the EP considers all currently available literature. Given the high levels of natural variation, it would be difficult to determine whether a single survey was attributable to negative effects. STLM will be undertaken and used to determine the likely impact. SLB believe the AIMS and CSIRO research will provide the necessary data to quantify any potential impacts. [redacted] stated that SLB are aiming to be in Adelaide towards the end of the month and that it would be good to meet with some of the industry representatives as well as [redacted] at a time that is convenient. [redacted] requested [redacted] provide an indicative timeframe of when representatives/[redacted] would be available. [redacted] advised that [redacted] can contact him with any questions.		development of the EP are depicted in **Figures 56** and **57** and discussed in **Section 7.1.3.1**. Scientific literature has been taken into consideration throughout **Sections 5** (existing environment), **7** (impacts from planned activities), **8** (impacts from unplanned activities), and **9** (cumulative effects). Control measures to avoid displacement of commercial fishers have been assessed in **Table 44**, with adopted control measures provided in **Table 45**. Potential impacts of acoustic disturbance on larval stages are discussed in **Sections 7.2.2.1.1** to **7.2.2.1.3** (physiological effects). Potential impacts of acoustic disturbances on fish behaviour are discussed in **Section 7.2.2.2.2**. The full STLM report is provided as **Appendix A**.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		12-09-18	Phone call	[redacted] asked how SLB have tailored their consultation process to the seafood industry as the Information Sheet does not address what processes are in place to assess damage to fish spawn, food sources for fish stocks etc. from seismic operations and does not address the main concerns of the industry. [redacted] stated that the engagement which has been undertaken with the seismic industry to date has felt like a waste of time as fisheries comments are not taken seriously and the survey commences no matter what is said during engagement.		SLB have engaged SIV, SETFIA and TSIC to assist with the fisheries engagement (**Section 4**). SLB are committed to ongoing engagement with all stakeholders and have developed an ongoing stakeholder engagement plan (**Section 4.5.8**).	Memo available in **Appendix D**.
		23-10-18	Email outgoing		[redacted] followed up regarding meeting in Adelaide Thursday 1st November.	N/A	Unedited correspondence is provided in **Appendix C.**
		30-10-18	Phone Call		[redacted] phoned [redacted] to check availability for a meeting following numerous calls and emails. [redacted] stated that she is not trying to ignore [redacted] but is waiting to hear back from a number of people with regard to their availability. [redacted] requested [redacted] call her on Wednesday to check her availability.	N/A	Memo available in **Appendix D**.
		31-10-18	Email outgoing		[redacted] phone [redacted] to follow up as to her availability.	N/A	Unedited correspondence is provided in **Appendix C.**
		31-10-18	Email incoming	**<u>Response to [redacted] email dated 31-10-18:</u>** [redacted] unable to meet as cannot reschedule her meeting.		No objections or claims – no response/actions required.	See above.
		31-10-18	Email outgoing		**<u>Response to [redacted] email dated 31-10-18:</u>** [redacted] thanked [redacted] for trying to make the meeting work. [redacted] asked [redacted] if she had any questions/concerns raised from members about the survey or if she had any further questions. [redacted] stated that it would be good to discuss with [redacted] about meeting licence holders/members to allow them to ask questions or allow SLB to further understand their concerns and South Australia's major sensitivities. [redacted] emphasised that SLB are willing to minimise conflict and disturbance as much as possible, so it would be good to have some open discussions. [redacted] requested scheduling a call for next week at a time convenient to [redacted] so they can discuss a plan going forward that would work best for everyone.	N/A	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
Any other Persons considered relevant							
131	Aegir Divers	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
132	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
133	Allways Dive Expeditions	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
134	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
135	Apollo Bay Fishing & Adventure Tours	08-11-18	Email outgoing		Introductory email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
136	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
137	Aquability	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
138	[redacted]	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
139	Australian Marine Conservation Society (AMCS)	30-10-18	Email outgoing		Introductory email with Information Pack 1.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
140	Australian Diving Instruction	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
141	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
142	Bagout Fishing Charters - Portland	08-11-18	Online submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
143	Bass Strait Aquatic Club	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
144	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
145	Blue Whale Study	30-10-18	Email outgoing		Introductory email with Information 1.	N/A	Unedited correspondence is provided in **Appendix C.** See below for reference in EP to where concerns are addressed, based on [redacted] response.
		01-11-18	Letter	<u>**Response to email dated 30-10-18:**</u> [redacted] stated that the survey location shown in the map places SLB's operation spatially and temporally in a globally significant pygmy blue whale feeding area throughout the duration of the feeding season (typically November – April/May). [redacted] highlighted the presence of the Bonney Upwelling and its importance to krill and blue whales. [redacted] stated that the hearing range of blue (and other large) whales overlaps with the frequency range of airgun shots and that there is wide-spread and well-documented concern among the global marine mammal research community about potential disturbance to foraging whales and their prey. [redacted] also states that it is well known that the area affected by propagation of airgun noise can be huge, particularly in a large survey like SLB's. [redacted] is most concerned about the displacement of blue whales (by underwater noise and vessel movement) from preferred feeding habitat and states that the industry view that the ocean is large, and whales can move ignores		Stakeholder raised concerns with regard to the Bonney Upwelling, blue whales, and zooplankton/krill. Stakeholder backed claims up using scientific literature. SLB responded to stakeholders concerns and addressed concerns throughout the relevant sections of the EP using available scientific literature.	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**. The full STLM Report is provided in **Appendix A**. PAM specifications are provided as **Appendix N**. The Bonney Upwelling is described in **Section 5.3.8.1**, with potential acoustic impacts discussed in **Section 7.2.2.4.6.**

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
				the special requirements of feeding blue whales. [redacted] commented on the patchy distribution of krill and describes their largely unpredictable distribution as a puzzle faced by blue whales. [redacted] emphasised that when blue whales find their prey, they are usually reluctant to be parted from it and if parted from prey, their condition may deteriorate. Observations of whales in poor health have been made, with changes possibly attributed to inadequate food resources. [redacted] commented on issues with the use of MFOs and PAM. [redacted] described a recent publication showing significant krill mortality from seismic which may impact blue whales. He does not believe any prior survey has properly taken effects on planktonic prey into account. [redacted] raises SLB's reputation for holding to the highest standards of environmental protection in environmentally sensitive areas and questions how SLB's proposed mitigation measures will ensure that the survey will have little or no detrimental effect on pygmy blue whales or their prey. [redacted] asked what mitigation measures (apart from MFOs and PAM) SLB will employ and how they will minimise potential disturbance.			Descriptions on the presence of cetaceans in the Operational Area are based on scientific literature and provided throughout **Section 5.2.6**. Potential impacts are discussed in **Sections 7.1.2.2** (physical presence of the survey vessel), **7.2.2.1.8** (physiological effects from acoustic disturbance), **7.2.2.2.5** (behavioural effects from acoustic disturbance), and **7.2.2.3.2** (perceptual effects). Cetacean thresholds are listed in **Table 57** (PTS and TTS) and **62** (behavioural). Control measures considered to mitigate against the effects of the physical presence of the survey vessel and acoustic disturbance on cetaceans are assessed in **Table 44** and **66**, with adopted control measures provided in **Table 45** and **67**. Cetacean specific control measures are also thoroughly described in **Section 3.4.7**. Potential effects of acoustic disturbance on zooplankton/krill are discussed in **Section 7.2.2.1.1.**

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		18-11-18	Email outgoing		**Response to [redacted] email dated 01-11-18:** [redacted] attached the latest Information Sheet for [redacted] consideration. [redacted] confirmed that [redacted] letter had been passed on and considered within the planning and development stages of the survey. [redacted] highlighted that the Operational Area has been reduced and retracted away from shallower areas, including the Bonney Upwelling, and provided a discussion around the water depths now found within the Operational Area. [redacted] informed [redacted] that the timing of the survey has since also changed and it is only the tie lines that now go near the identified Bonney Upwelling. [redacted] stated that these tie lines will be acquired at the end of the survey, when the chance of interacting with blue whales is lower. [redacted] stated that the mitigation measures are still being worked on but stressed that the Bonney Upwelling and objectives of the Blue whale Conservation Management Plan are being considered. [redacted] discussed the STLM that SLB are conducting and how the results of the modelling are used to determine the Precautionary Zones monitored by MMOs. [redacted] confirmed that PAM will be used as a control measure as well as the system's capabilities/frequency detection range. [redacted] discussed the issue of vessel noise masking cetacean vocalisations and limiting the performance of PAM, and how this will be avoided. [redacted] stated that SLB will source a PAM system that is suitable to detect vocalisations of all the species likely to be in the Operational Area and MMO sightings will be correlated with the PAM system to ensure the reliability of PAM. [redacted] provided a discussion on SLB's seismic surveys in New Zealand and the Taranaki region's importance as a blue whale feeding ground. [redacted] discussed how this area confirms [redacted] statement that the presence of blue whales at feeding grounds is variable. [redacted] stated that is it due to PAM/MFOs that the use of Taranaki by blue whales is known, and that MFOs were able to observe blue whales to the extent of their visual field, therefore [redacted] disagrees that these measures have no value. [redacted] also suggests that [redacted] comment of whales turning away from a vessel at 17 km is evidence that soft-starts work. [redacted] discussed the findings of McCauley *et al* (2017), and how SLB's survey design will act to minimise impacts on krill/plankton. [redacted] confirmed that SLB operate to a high environmental standard and that mitigation measures will be considered within the EP. [redacted] provided an example of a control measure being considered with regard to the Bonney Upwelling.	N/A	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		21-11-18	Email incoming	**<u>Response to [redacted] email dated 18-11-18:</u>** [redacted] will reply once he has considered it properly.		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.**
		21-11-18	Email outgoing		**<u>Response to [redacted] email dated 21-11-18:</u>** [redacted] assured that SLB are giving full consideration to blue whales, the Bonney Upwelling and the BIA as part of the operational planning and development of control measures. [redacted] stated that SLB are looking at the best timing for operating in the inshore parts of the Operational Area near South Australia to have the lowest encounter rates with blue whales but acknowledged that blue whales travel to where food is so SLB will implement other control measures. [redacted] stated that most of the survey the vessel will be over the shelf edge in deep water but there is a small percentage where the measures discussed will be implemented.	N/A	See above.
		21-11-18	Email incoming	**<u>Response to [redacted] email dated 21-11-18:</u>** [redacted] acknowledged that most of the survey lines are in deep water and said that this is a good mitigation measure for most blue whales but noted that blue whales will also be in deep water off the shelf. [redacted] asked that SLB keep Blue Whale Study in mind for any pre-survey aerial surveys.		No objections or claims – no response/actions required.	See above
		21-11-18	Email outgoing		**<u>Response to [redacted] email dated 21-11-18:</u>** [redacted] clarified that SLB are still expecting to see blue whales in deep water but that the frequency is expected to decrease. [redacted] stated that control measures will still be in place to detect their presence. [redacted] thanks [redacted] for the offer of aerial surveys and is interested in discussing aerial surveys with [redacted].	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E.**
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.	N/A	See above.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	N/A	See above.
		29-03-19	Email outgoing		[redacted] asked [redacted] if he received the updated Information Sheet that was sent to the generic Blue Whale Study email address and advised that the timing of the survey has changed. The Information Sheet was attached again. [redacted] asked if he could speak with [redacted] about the presence of blue whales in and around the Bonney Upwelling, particularly timing. [redacted] referred to literature by [redacted] with regard to timing and location of whales.	N/A	

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		29-03-19	Email incoming	Incoming and outgoing emails discussing appropriate time to call.		N/A	Unedited correspondence is provided in **Appendix C.** Memorandum of phone call in **Appendix D.**
		03-04-19	Email outgoing				
		03-04-19	Phone call	Phone call between [redacted] and [redacted]			
146	Boating Industry Association (BIA)	30-10-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
147	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
148	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
149	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
150	[redacted]	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
151	Cetacean Biological Sciences – Flinders University	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No objections or claims – no response/actions required	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E.**
		21-11-18	Email incoming	Out of Office Automatic reply.			
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
152	Charter Boat Fishery – SA	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
153	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
154	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
155	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
156	Dive Adventures	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Email sent with Information Pack Rev 4.		
157	Daktari Sports	08-11-18	Online Submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
158	Dive and Dive	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-10	Email outgoing		Timing update with Information Pack Rev 4.		
159	Dive Victoria	14-11-18	Online Submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
160	Dive Works Subea Solutions	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
161	Diveline Aus	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
162	Diving and Marine Services	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
163	Elstone Diving Services	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
164	Extreme Watersport	14-11-18	Online Submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
165	Geelong Dive Centre (Divein2Scuba)	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
166	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
167	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
168	Go Dive Launceston	14-11-18	Online Submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
169	Gone Fishing Charters	08-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
170	Industrial Divers	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
171	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
172	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
173	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
174	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
175	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
176	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
177	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
178	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
179	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Information Packs can be viewed in **Appendix E** Unedited correspondence in **Appendix C**.
		24-11-18	Email incoming	**Response to SLB email dated 13-11-18:** [redacted] stated he is a cray fisherman and can supply two fishing vessels if needed for the survey.		No objections or claims – no response/actions required.	
		26-11-18	Email outgoing		**Response to [redacted] email dated 24-11-18:** [redacted] replied that he has passed [redacted] details on to SLB and asked if [redacted] will have finished catching his quota by January. [redacted] requested [redacted] contact phone number to pass on and from what port [redacted] is based in.	N/A	
		26-11-18	Email incoming	**Response to [redacted] email dated 26-11-18:** [redacted] provided phone number and advised that his home port is Southend and that he has a smaller vessel to finish quota if needed.		No objections or claims – no response/actions required.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
180	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
181	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
182	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
183	Macs Diving Services Pty Ltd	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
184	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
185	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
186	Matthew Hunt Fishing Charters	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
187	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
188	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
189	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
190	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
191	Neptune Diving Services Melbourne	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		14-11-18	Email incoming	From [redacted]: Email has been forwarded to the relevant managers, including base managers in Melbourne. They don't believe they have any current operations in this region.		No objections or claims – no response/actions required.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	N/A	
192	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack 4 attached.		
193	Ocean Divers	14-11-18	Email outgoing		Email sent with Information Sheet.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
194	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
195	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
196	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
197	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
198	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
199	Peninsula Dive School	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
200	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
201	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
202	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
203	Petuna Sealord Deepwater Fishing Pty Limited (PSDF)	13-11-18	Email outgoing		Update email with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.**
		16-11-18	Email incoming	<u>**Response to email dated 13-11-18:**</u> [redacted] would like to send coordinates through to the vessel skipper. [redacted] is a deepwater longlining operator in commonwealth waters. [redacted] requested any information on the effects of seismic on finfish such as blue eye, pink ling and ribald.		No objections or claims; however, SLB provided requested information.	Unedited correspondence is provided in **Appendix C.** Impacts to finfish from acoustic disturbance have been discussed in **Section 7.2.2.1.5** (physiological), **7.2.2.2.2** (behavioural), **7.2.2.3.1** (perceptual), and **7.2.3.3** (catch rates). Impacts to commercial fisheries from displacement are discussed in **Section**

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
							7.1.3.1. Potential control measures for minimising displacement of commercial fishers are assessed in **Table 44**, with adopted control measures provided in **Table 45.**
		26-11-18	Email outgoing		**<u>Response to [redacted] email dated 16-11-18:</u>** [redacted] confirmed email from [redacted]. [redacted] asked [redacted] to send through the coordinates from the Information Sheet to the skipper to see if he has any questions/concerns after plotting coordinates up. [redacted] stated that there are no specific studies on the effects of seismic on blue eye, pink ling and ribald and that studying the effects on deep sea fish is difficult. [redacted] stated that results from shallower water fish species are used as a reference for deeper water species. [redacted] provided a summary of SLB's knowledge on the effects of seismic on fish including movement away from the acoustic source, no documented cases of fish kills. [redacted] provided a summary of the 2007 Woodside Energy investigation, including a link to the study and a summary of the Carroll *et al.* (2017) review paper (showing some inner-ear damage, TTS and stress indicators with recovery occurring within 24 hours).. [redacted] provided an overview of how the survey design will act to mitigate against effects on fish and emphasised that SLB are wanting to work with fishers to minimise conflict. [redacted] asked [redacted] if there are any periods in where fishing efforts are concentrated in particular areas so SLB can incorporate this into the survey design. [redacted] described the 48-hour look-aheads that will be provided to fishers. [redacted] asked [redacted] what water depths their fishing activities primarily occur in. [redacted] stated that due to survey design, any effects on fish are likely to be displacement as opposed to physiological effects. [redacted] then explained that pelagic trawlers in New Zealand target jack	N/A	Unedited correspondence is provided in **Appendix C.**

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
					mackerel directly behind active seismic surveys. [redacted] stressed that [redacted] is welcome to contact him with any questions.		
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
204	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
205	Professional Diving Services	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
206	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
207	Proline Charters - Sorrento	08-11-18	Online submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	N/A	Unedited correspondence is provided in **Appendix C.**
208	RecFish - SA	03-09-18	Email outgoing		Introductory email.	N/A	Unedited correspondence is provided in **Appendix C.**
		04-09-18	Email incoming	**<u>Response to [redacted] email dated 03-09-18:</u>** [redacted] replied that he will distribute the information.		No objections or claims – no response/actions required.	See above.
		04-09-18	Email outgoing		**<u>Response to [redacted] email dated 04-09-18:</u>** [redacted] followed up on previous email requesting a meeting with [redacted] when SLB are in Adelaide.	N/A	See above.
		07-09-18	Email outgoing		Follow up email about a meeting in Adelaide.	N/A	Unedited correspondence is provided in **Appendix C.**
		25-10-18	Email outgoing		Follow up email with updated Information Pack Rev 1attached and request for meeting in Adelaide.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E.**

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
209	Red Hot Fishing Charters	08-11-18	Online submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	N/A	N/A
210	Reel Time Fishing Charters	08-11-18	Online Submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	N/A No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		08-11-18	Email incoming	**Response to Online Submission dated 08-11-18:** Details received for correspondence as requested from [redacted].			
		08-11-18	Email outgoing		Information Pack Rev 2attached and summary of Operational Area given.		
211	Rip Charters	08-11-18	Online Submission		[redacted] submitted an online form requesting contact details to be able to send an Information Pack to.	N/A	Unedited correspondence is provided in **Appendix C.**
		08-11-18	Email incoming	**Response to Online Submission dated 08-11-18:** From [redacted] to advise all correspondence to be emailed to [redacted]		No objections or claims – no response/actions required.	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		08-11-18	Email outgoing		[redacted] attached Information Pack Rev 2 and provided an introduction to the proposed survey.	N/A	
212	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
213	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
214	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
215	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
216	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
217	Salty Dog Charters	08-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
218	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
219	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
220	Scuba Culture	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
221	Scuba Life	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
222	Seals by Sea Tours (Cape Bridge)	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
223	Sharkmen Charters	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
224	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
225	Snorkel & Dive Safari	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
226	Southern Coast Charters	08-11-18	Email outgoing		Introductory email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		21-11-18	Email incoming	Delivery failure.			
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
227	Southern Divers	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

Stakeholder Engagement Table

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
228	Southwest charters - Portland	21-11-18	Email outgoing		Update email with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
		21-11-18	Email incoming	Delivery failure.			
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
		18-03-19	Email incoming	Delivery failure.			
229	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
230	Surf-n-Fish	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
231	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
232	TasFish	03-09-18	Email outgoing		Introductory email with Information Pack Rev 1.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
233	The SCUBA Doctor	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
234	The Wilderness Society	30-10-18	Email outgoing		Introductory Email sent with Information Pack Rev 1.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		30-10-18	Email incoming	Automated reply acknowledging email.			
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
235	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C.**	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
236	University of Tasmania	24-09-18	Email outgoing		Introductory email to [redacted]	N/A	Unedited correspondence is provided in **Appendix C.**
		25-09-18	Email incoming	Email from [redacted] cc'ing [redacted] and [redacted] for Tasmania and Victoria listing the information required in order to request exact data from state fisheries		No objections or claims – no response/actions required	See above.

ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		27-09-18	Email outgoing		Response to [redacted] listing required information	N/A	Unedited correspondence is provided in **Appendix C.** Potential effects on catch rate of crustacean fisheries are discussed in **Section 7.2.3.1.**
		05-10-18	Email incoming	[redacted] replied with contact details for Tasmanian and Victorian data requests. [redacted] outlined some specifics with regard to the data request concerning depth resolution, spatial scale of data, and time frame. [redacted] stated that of concern are giant crabs, both commercially fished stocks and small crabs in deeper waters.		Stakeholder raised concerns with regard to giant crab. SLB have addressed these concerns using available scientific literature within the relevant EP sections.	Unedited correspondence is provided in **Appendix C**.
		05-10-18	Email outgoing		[redacted] thanked [redacted] for the further information and stated that a request would be submitted to [redacted] and [redacted]	N/A	Unedited correspondence is provided in **Appendix C**.
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.	N/A	N/A
		21-11-18	Email incoming	Automated out of office reply.		No objections or claims – no response/actions required	Information Packs can be viewed in **Appendix E**.
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.	N/A	Unedited correspondence is provided in **Appendix C.** Information Packs can be viewed in **Appendix E**.
237	VRFish – Victorian Recreational Fishers	03-09-18	Email outgoing		Introductory email sent with Information Pack Rev 1.	N/A	Unedited correspondence is provided in **Appendix C.**
		31-10-18	Email outgoing		[redacted] provided an updated Information Sheet with the refined survey area. [redacted] queried if the charter boats in the Victorian region are members of VR Fish.	N/A	See above

Stakeholder Engagement Table

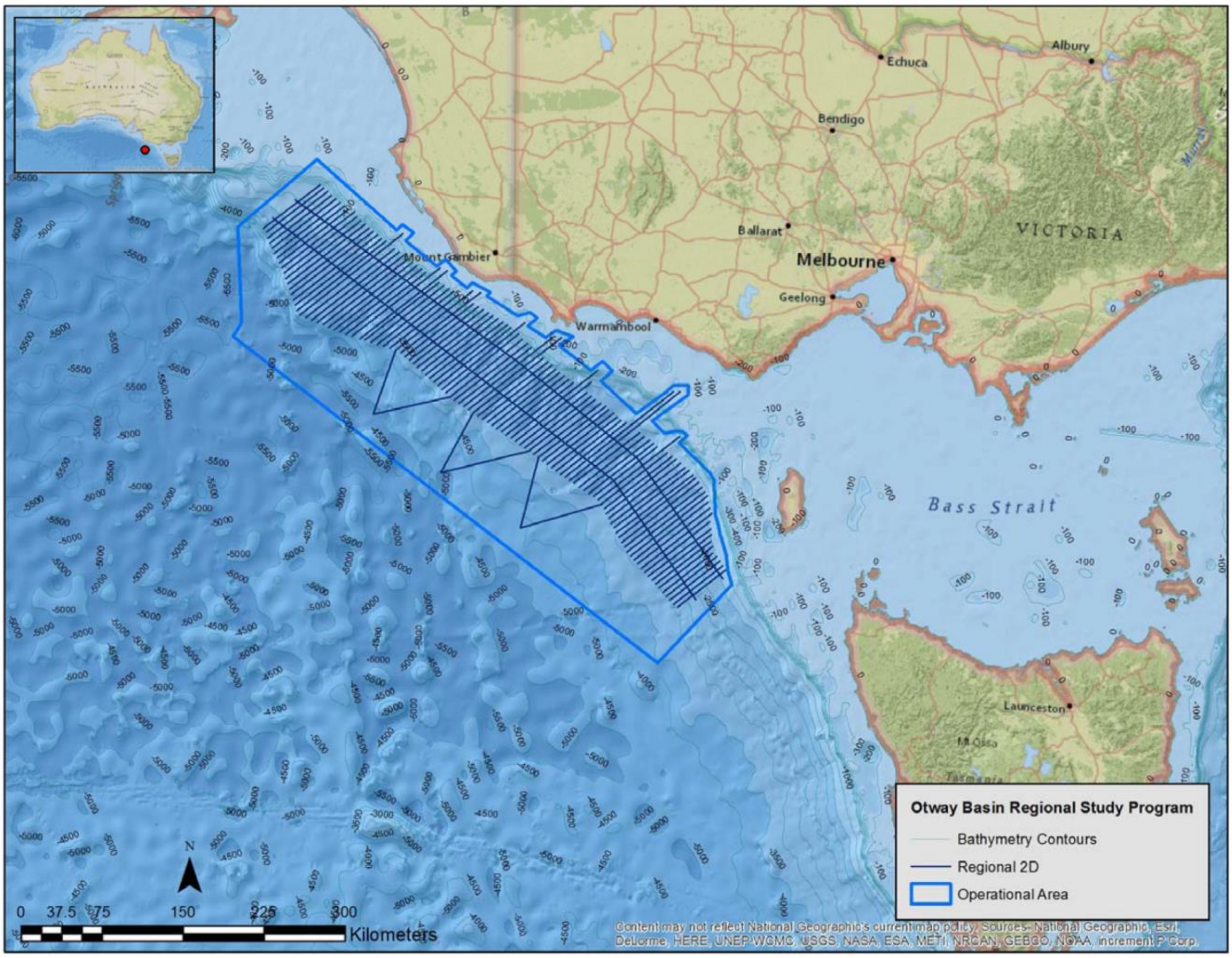
ID	Stakeholder	Date	Communication/ Engagement Type	Summary of Stakeholder Communication / Feedback / Concerns	Summary of SLB Communication / Response	Assessment of merit of stakeholder concern	Reference to Location within EP
		21-11-18	Email outgoing		Update email with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
238	Warrnambool Diving & Firearms	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.**
		15-11-18	Email incoming	**Response to SLB email dated 14-11-18:** Email stating that they have no diving operations in that area.		No objections or claims – no response/actions required.	See above.
		26-11-18	Email outgoing		**Response to email dated 15-11-18:** [redacted] thanked for email and invite.	N/A	See above.
239	WaterMaarQ	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
240	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	N/A	Unedited correspondence is provided in **Appendix C.**
		13-11-18	Email incoming	**Response to SLB email dated 13-11-18:** Reply asking for all correspondence to go through SETFIA.		No objections or claims – no response/actions required.	See above.
		13-11-18	Email outgoing		**Response to email dated 13-11-18:** [redacted] confirmed correspondence will go through SETFIA and that SLB have been in contact with [redacted].	N/A	See above
241	Academy of Scuba	14-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
242	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
243	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		
244	[redacted]	13-11-18	Email outgoing		Email sent with Information Pack Rev 2.	No response to SLB Information Packs was received from stakeholder. Information Packs can be viewed in **Appendix E** and unedited correspondence in **Appendix C**.	
		07-12-18	Email outgoing		Update email with Information Pack Rev 3.		
		18-03-19	Email outgoing		Timing update with Information Pack Rev 4.		

APPENDIX G

SETFIA Fisheries Report

Final Report to Schlumberger
on
Otway Regional 2D Survey Area

Prepared by the
South East Trawl Fishing Industry Association
19 December 2018 updated 16 March 2019 and 17 May 2019



SETFIA
SOUTH EAST TRAWL FISHING INDUSTRY ASSOCIATION
sustainable fishing practices protect our future

fishwell
CONSULTING

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1. EXECUTIVE SUMMARY

With relation to the marine seismic survey (MSS) proposed by Schlumberger, the South East Trawl Fishing Industry Association (SETFIA) was contracted to:

a) identify fisheries impacted;
b) quantify the extent of impact;
c) provide high level contacts for Associations; and,
d) provide contacts for actual fishers in these fisheries.[1]

SETFIA was also engaged to operate an SMS alert system to warn fishers that may be impacted by seismic activity so they are aware of the MSS timing (if approved) and can plan to be elsewhere. This will limit impacts on the fishing industry to some extent. This process will begin if the MSS is approved.

A list of Associations representing potentially affected fisheries (Table 20) was provided to the Client at the beginning of the project, potentially allowing them to begin high-level consultation.

For the purposes of this report, the potential "impact" of the MSS is simply calculated as the overlap of the MSS area of operation with the landed commercial catch (and revenue) taken within that same area. We do not consider the potential impact of seismic ensonification beyond the area of operation or on other life history stages of commercially fished species.

The original area of the proposed Schlumberger MSS (the blue-shaded area in Figure 1) is relatively large and overlaps fisheries across four management jurisdictions (Commonwealth, Victoria, South Australia and Tasmania). This is referred to as the "original MSS area" throughout the document There is perhaps no other place in Australia where a polygon of this size could be placed and cover four fishery jurisdictions. It covers some of the Nelson and Zeehan Commonwealth marine parks and overlaps the Franklin Commonwealth marine park to a very low extent. These parks were established more than 10 years ago and their zoning is complicated but excludes most commercial fishing. As a result, there is now little commercial catch within them, which lessens the impact of the MSS on the fishing industry. Additionally, a very large (Commonwealth) "deepwater" fishing closure (marked with a red perimeter in Figure 1) limits the impact on Commonwealth fisheries as does the fact that half of the proposed survey occurs in depths too deep for fishing.

To estimate the potential MSS impact on fishing, data requests were submitted to the four relevant fishery management agencies: the Australian Fisheries Management Authority (AFMA), the Victorian Fisheries Authority (VFA), Tasmania's Department of Primary Industries, Parks, Water and Environment (DPIPWE) and the South Australian Research and Development Institute (SARDI). All data requests were initially based on the original MSS area.

Towards the end of this project the Client significantly modified the polygon, reducing its range towards the south east end. This modification is shown in Figure 1 and Figure 4 and is termed the "revised MSS area" throughout the document. The revised MSS area reduced the overlay (and catches) taken by Commonwealth and Tasmanian fisheries. We were able to modify the extraction and analysis of Commonwealth data (provided by location) so that it was from within the revised polygon, but it was not possible to amend the analysis of the Tasmanian data (provided by grid) because detailed locations of each fishing operation were not provided. To address this, SETFIA was requested to submit a new data request to DPIPWE based on the revised MSS, and to report on those data. They results are presented in this report.

In Commonwealth fisheries each fishing operation is reported by position meaning that only fishing operations within the revised MSS are included in the report. State fishery catch and effort records

[1] These contact lists for fishers are extensive but will not be complete

are made using areas, grids or zones (called “reporting areas” from this point on). The method of calculating impact on state fisheries is to include all catch from any reporting grid that overlapped the polygon, because we have no way of ascribing catch to a particular position within a reporting area. For example, in Figure 5, catch from all of Victorian reporting grid “E1” is included even though only a tiny fraction of this reporting grid is within the polygon area. Thus, the nature of the way catch is reported in state-managed fisheries and analysed in this report potentially over-estimates the impact of the MSS on state fisheries. A specific exception to this procedure was undertaken to determine the impact of the MSS on the South Australian rock lobster and abalone fisheries, where information on the relative catch by depth allowed us to apportion impact to only the percentage of the reporting area that was in the same depth as the original MSS area.

There are sixteen fisheries that are to some extent affected by the proposed survey. This report determines the impact by the percent of revenue and catch taken by each fishery within the proposed and revised MSS. (Table 1). The most impacted fisheries in order of impact are:

1. Rock Lobster (southern zone) — South Australia $8.2m (6.8% taken from reporting grids and depths that overlap with the original MSS area)
2. Rock Lobster (western zone) — Victoria $5.3m (41% taken from the original MSS area)
3. CTS Otterboard Trawl — Commonwealth $4.5m (15% for this fishery + GHaT Scalefish Hook)
4. Giant Crab — Victoria $230k (100%)
5. Marine Scalefish Fishery — South Australia $167k (1.5%)
6. Rock Lobster — Tasmania $169k (0.3%: over-estimated as explained on the page previous)
7. GHaT Scalefish Hook — Commonwealth $130k (see 3 above)
8. GHat Shark Hook and Shark Gillnet — $130K (0.8%)

Combined, 8.4% of the catch from these fisheries occurs within the revised MSS.

A list of commercial fishers from these fisheries who might be affected are contained in Table 21.

This report contends that the 8.4% of recent catch impacted is the key metric that needs to be considered when trying to minimise the potential impacts of the MSS on the commercial fishing industry. This metric (column D, Table 1) is an inverse indicator of a fishery’s ability to move elsewhere. If the percentage is low, a fishery is generally more able to move elsewhere, and vice-versa. For this reason, the relatively small Victorian Giant Crab will require special consideration because all of their annual catch is taken from the area proposed to survey. The South Australian Southern Zone Rock Lobster, Victorian Western Zone Rock Lobster and CTS Otterboard Trawl fisheries are also noteworthy.

This report notes that the original MSS is 2D rather than 3D and is forecast to only take three months. The fishing industry is generally less concerned about 2D surveys given the larger line spacing, reduced intensity and decreased duration of survey.

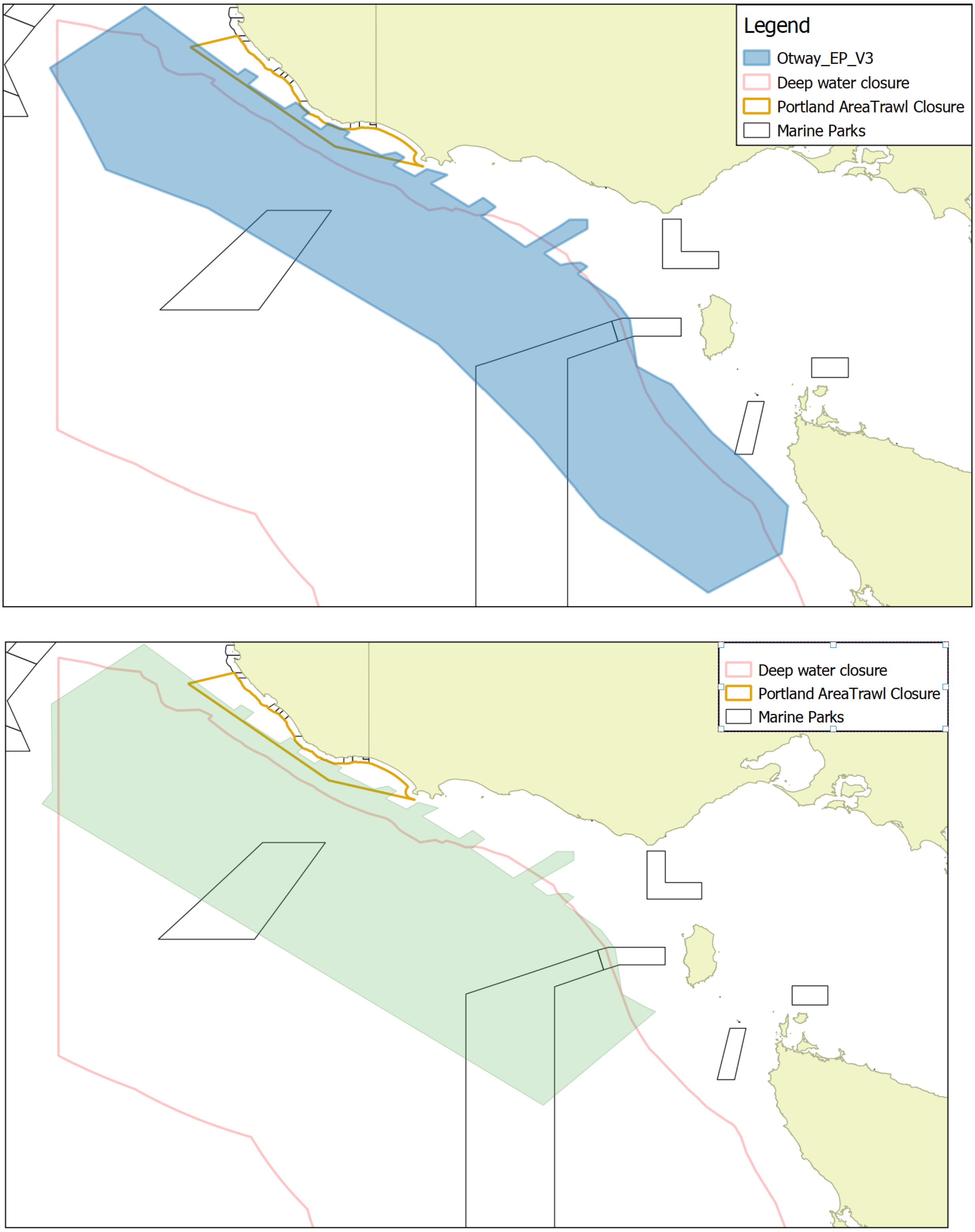
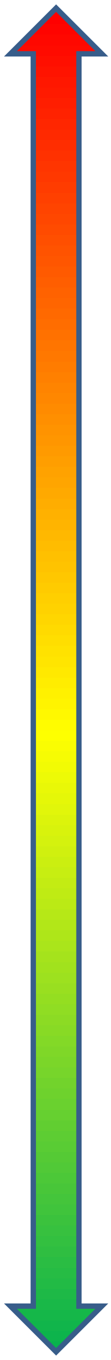


Figure 1. Top panel: area of the original marine seismic survey showing marine parks and fishery closures, and lower panel: area of the revised marine seismic survey showing marine parks and fishery closures.

Table 1. Summary of potentially impacted and unaffected fisheries (figures rounded). Potential relative imp is indicated by the "traffic light" arrow on the right hand side of the table.

Fishery (by impact)	Data	Juris-diction	10 yr av. catch in area	Fishery TAC 2016/17	Fishery catch most recent year	% of catch potentially impacted	Annual average catch value potentially impacted
			A	B	C	D=A/C	E=A*price
			tonnes	tonnes	tonnes	%	tonnes
Rock Lobster (S)	Table 17	SA	90.1	1,245.7	1,237.7	7.2%[i]	$8,171,000[ii] (based on depth analysis)
Rock lobster (W)	Table 8	Vic	85.3	230[iii]	209[iii]	41%	$5,328,000
CTS otterboard trawl	Table 4	Cth	1241	≈21,077[iv]	8413[v]	15%	$4,455,000
GHaT scalefish hook	Table 6	Cth	24.6	410[vi]			$132,000
Giant crab	Table 9	Vic	11.7	10.5[vii]	9[vii]	100%	$223,000
MSF Fishery	Table 18	SA	30	Not applicable	~2000	1.5%	$167,000
Rock lobster	Table 12	Tas	3.2[viii]	1050.7[ix]	1026.7[ix]	0.3%	$169,000
GHaT shark hook	Table 5	Cth	20.8	2,522[x]	2,734[xi]	0.8%	$132,000
GHaT shark gillnet							
Southern squid jig	Table 7	Cth	73	See note [xii]	213 [xiii]	3.4%	$14,000 Variable
Giant Crab (S)	Confidential	SA	Confidential	22.1	16.8	Confidential	Confidential
Charterboat	Confidential	SA	At least 599 fish	Not applicable	94,891 fish[xiv]	0.6%	Confidential
Ocean general	Table 10	Vic	4.1[xv]	Not applicable	2,775[xv]	Not applicable	Confidential
WTBF		Cth	Negligible	10,125[xvi]	322[xvi]	Negligible	Negligible
SZ Abalone	Table 19	SA	Negligible	129.6[xvii]	124	0%	Negligible (based on depth analysis)
Ocean wrasse	Confidential	Vic	Confidential	Not applicable	19[xv]	Confidential	Confidential
Scalefish	Table 13	Tas	0.4	Not applicable	313[xviii]	Confidential	$2,572
Small pelagic		Cth	Negligible	48,900	5,713[xix]	Negligible	Negligible
ETBF		Cth	Negligible	7,592[xx]	4,615[xx]	Negligible	Negligible
SBTF	Confidential	Cth	Negligible	5,697[xiii]	5,334[xiii]	Negligible	Negligible
TOTALS			**1,584**		**18,947**	**8.4%**	**$18,793,572**



[i] Based on directly affected catch.

[ii] Based on directly affected catch, and value for entire reporting grids is in parenthesis.
[iii] 2016/17 (Victorian Fisheries Authority, 2018)
[iv] Combined total for 27 SESSF fish stocks mostly caught by the CTS and SHS for 2018/17 (Table 3)
[v] For CTS and SHS combined (Patterson *et al*, 2018)
[vi] Blue-eye Trevalla TAC stated 2016/17 - the main target species
[vii] 2015/16 (Victorian Fisheries Authority, 2018). Note the average catch of Giant Crab exceeds the current TAC.
[viii] For the 9 fishing seasons 2008/09 to 2016/17
[ix] https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/rock-lobster-fishery/rock-lobster-catch
[x] School Shark, Gummy Shark, Elephantfish and Sawshark quota for 2017/18
[xi] For SGSHS combined (Patterson *et al*, 2018)
[xii] Given the short lifespan of squid the fishery is managed by effort controls not a TAC
[xiii] For 2016–2017 (Patterson *et al*, 2018)
[xiv] In 2014/15. From Steer and Tsolos (2016).
[xv] Total catch includes all offshore fisheries, the vast majority of which is most likely not from this fishery, but cannot be separated out 2016/17 (Victorian Fisheries Authority, 2018). Catch in area of operation does not include catch from 2016, which was omitted due to confidentiality. Ocean Wrasse catch is the 2016–2017 catch of Bluethroat Wrasse and Purple Wrasse by all of Victoria's ocean fisheries.
[xvi] For 2017 (Patterson *et al*, 2018)
[xvii] Combined Blacklip and Greenlip abalone TACC for 2017/18
http://www.pir.sa.gov.au/__data/assets/pdf_file/0011/312968/Notice_to_Fishers_signed.pdf
[xviii] https://secure.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf
[xix] For 2017–2018 Patterson *et al*, 2018
[xx] For 2017 (Patterson *et al*, 2018)

2. INTRODUCTION

The Otway Basin covers an area of about 150,000 km^2 in south-east Australia (Earth Resources, 2018), extending about 500 km in length from Cape Jaffa (South Australia) to the Mornington Peninsula (Victoria) (Mehin and Kamel, 2002). About 80% of the basin is offshore, extending out from shore to an arbitrary depth of 4,500 m (Earth Resources, 2018). The area has revealed a number of important gas discoveries, and wells have been drilled in the Otway Basin since the 1920s (Earth Resources, 2018).

The ocean waters of the Otway Basin have had a rich history of shipping, whaling and fishing since European settlement. These waters now support a range of State and Commonwealth commercial fisheries that target more than 15 commercial species using a variety of different fishing gears (Figure 2) including otter-board trawl, demersal gill nets, demersal longlines, pelagic longline, squid jigging, droplines and baited traps. This commercial fishing provides “fish” (including Scalefish, sharks, crustaceans and molluscs) to local and export markets , and are an important source of employment in Victoria, South Australia and Tasmania (Figure 2).

The proposed Schlumberger MSS area is within the Spencer Gulf Shelf, West Tasmania Transition, Western Bass Strait Shelf Transition, Tasmania and Tasmanian Shelf provincial bioregions within the South East Marine Region (Commonwealth of Australia, 2015). The nearest key ecological features are: the West Tasmania Canyons which are located on the edge of the continental shelf from Western Victoria south to Macquarie Harbour; and the Bonney Coast Upwelling off western Victoria and eastern South Australia (see Figure 9 in Commonwealth of Australia, 2015). The area of operation overlaps with the Zeehan Commonwealth Marine Reserve, the Nelson Commonwealth Marine Reserve and the south-west corner of the Franklin Commonwealth Marine Reserve.

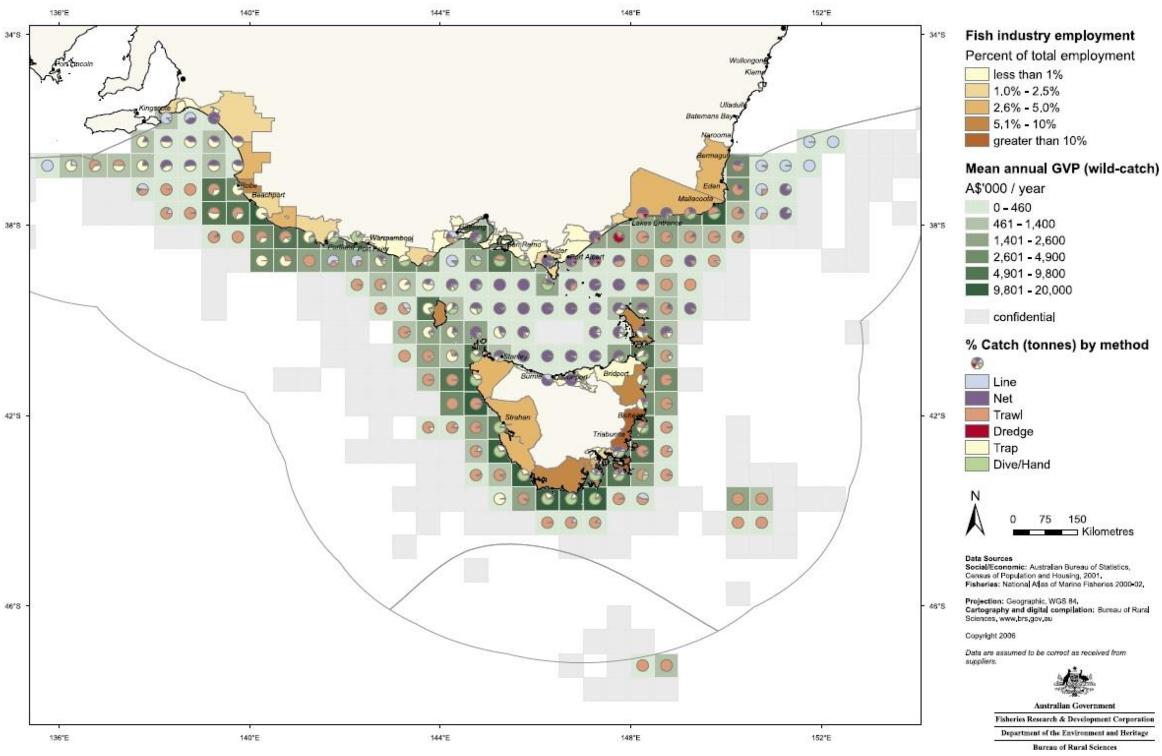


Figure 2. Fishing industry employment, mean annual gross value production from fishing and percent catch by method for south east Australia from 2000–02. From Larcombe *et al.* (2002).

2.1. Client Brief

Schlumberger engaged the South East Trawl Fishing Industry Association (SETFIA) to prepare a report on the original MSS and its potential impact on commercial fishing in the area. Specifically, SETFIA were engaged to provide the following:

1. A description of fisheries who might operate in the proposed area association contacts and any other relevant contacts;
2. A report summarising data requested from jurisdictions splitting (1) to 'affected' and 'unaffected' fisheries. Ranking affected fisheries by revenue impact. Describing fisheries methods and gear used. Containing a large but not total list of industry contacts. Notes where possible on seasonality covering Victorian, Tasmanian, South Australian and Commonwealth fisheries
3. Provide contacts for as many individual fishers as possible from the 'affected' list;
4. Provide assistance and advice in organising a consultation road trip(s);
5. Provide SMS messages to the relevant western fleet at engagement and then at regular and shortening intervals so operators can plan to be elsewhere (doing so minimises your potential effect), SMS messages as required as the survey progresses and then at conclusion.

SETFIA was not engaged to undertake consultation and has not done so.

3. METHODS

3.1. MSS area

The original area of operation provided by Schlumberger is shown as the blue-shaded polygon in Figure 1, referred to as the “original MSS area” throughout the document. Towards the end of the project the Client significantly modified the polygon, reducing its range towards the south east end. This modification is shown in Figure 4 and is termed the “revised MSS area” throughout the document. The revised MSS area reduced the overlay (and catches) taken by Commonwealth and Tasmanian fisheries. We were able to modify the extraction and analysis of Commonwealth data (provided by location) so that it was from within the new polygon, but it was not possible to amend the analysis of the Tasmania data (provided by grid) for the draft report, because detailed locations of each fishing operation was not provided. Subsequently, the client requested that we submit a new data request to DPIPWE with revised reporting grids, and report on those data. The updated data is presented in this report,

3.2. Fisheries data

Fisheries catch and effort figures and information on catch value from published reports were used when available. Data requests were sent to the Australian Fisheries Management Authority (AFMA) for Commonwealth fisheries, the Victorian Fisheries Authority (VFA), Tasmania’s Department of Primary Industries, Parks, Water and Environment (DPIPWE) and the South Australian Research and Development Institute (SARDI).

Commonwealth fisheries data

The format of the data and spatial resolution of effort reporting differs between jurisdictions. Commonwealth-managed fisheries report position by latitude and longitude, usually for each fishing operation (e.g. trawl fishing), or each day / location fished (e.g. scallop fishery) and AFMA provides “raw” data that is required to be aggregated in accordance with the “5-boat rule”[2] for publication and then deleted. Thus, the data request to AFMA was for any catch and effort reported from within a larger polygon that encompassed the operational area bound by the latitudes and longitudes shown in Table 2 and Figure 3. This data was then filtered to select records that overlapped with the

[2] Fisheries agencies have confidentiality policies that restrict making public data comprising of less than 5 vessels.

Schlumberger operational area and then aggregated to as fine a level as possible so as not to break the 5-boat rule, but still be able to address the scope of the work. Raw catch and effort data were requested from ten Commonwealth managed fisheries or fishery sectors are permitted to operate in that area (Figure 107 and Figure 108). Data fields requested included trip, shot and catch data from 2008–2017.

Table 2. Coordinates used for the AFMA data request.

Extent	Latitude / longitude
Northern most latitude	-37.0 S
Southern most latitude	-42.3 S
Western most longitude	138 E
Eastern most longitude	143.686091 E

State fisheries data

The following aggregations were requested from each of the State agencies for the original MSS area:

- Total annual catch by fishery and species (or summed across the 10 years if needed);
- Average annual effort by fishery (or summed across the 10 years if needed);
- Average monthly catch by fishery and species (averaged across the 10 years);
- Average monthly effort by fishery (averaged across the 10 years); and,
- All fisheries that operated in these areas over 2008–2017.

In contrast to AFMA, State fisheries usually report position by reporting grid, with the size of the reporting grids differing between States. The States usually aggregate and filter data in accordance with the "5-boat rule" before distributing it. Thus, data requests to the States were for catch and effort from any reporting grids that overlap with the MSS.

A range of Victorian fisheries are permitted to operate in the MSS area (section 4.3) but may not necessarily actually fish in the area. Most Victorian fisheries report catch and effort by 10 x 10 minutes grid areas (Figure 5). Because of the 5-boat rule, data requests submitted at too small a temporal or spatial scale risk being filtered to such course level of detail that it is not useful for informing a project such as this. We requested data in such a way so that as much of the data can be included, but it is aggregated in a way that can be used to address the information requirements.

Catch and effort reporting of Tasmanian fisheries is undertaken by DPIPWE and the Institute for Marine and Antarctic Studies (IMAS). A range of Tasmanian fisheries are permitted to fish in the MSS area (section 4.3) but may not necessarily do so. Like the VFA, DPIPWE and IMAS are reluctance to distribute raw data, and have a confidentiality policy that includes a 6-boat rule. Tasmanian fishers report catch and effort by 7.5 minute x 7.5 minute grids for Rock Lobster and Giant Crab (Figure 7) and 0.5 x 0.5 (or smaller) degree grids or smaller for other fisheries (Figure 6). We requested data aggregated as for the VFA data request (section 3.2), but for the relevant Tasmanian reporting grid areas.

Catch and effort reporting of South Australian Fisheries is undertaken by SARDI. South Australian fisheries permitted to fish in the original MSS area are listed in section 4.4, however because they are permitted to fish in that area does not necessarily mean they do. Like the VFA, DPIPWE and IMAS, they are reluctant to disburse raw data, and have a confidentiality policy that includes a 5-boat rule. Some South Australian fishers report catch and effort by 1 degree grids (Figure 8), and abalone divers report by reef code (Figure 9). We have requested aggregated data for South Australian fishers.

After the data requests had been submitted and the data provided and analysed, we were provided with a revised area of operation that was significantly different to the original (Figure 4). While this revised area was used to filter data provided by AFMA, data provided by State jurisdictions was already aggregated across reporting grids, and this could not be disaggregated to conform to the revised area.

While our data summaries for State fisheries include all fisheries reporting grids that to any extent overlap with the area of interest, it was not possible to know whether the catch reported in that grid was taken from within the portion of the grid that overlaps with the MSS area. In the case of South Australia's Southern Zone Rock Lobster Fishery, the MSS overlapped with the three reporting grids from which nearly all of the catch of this $100 million per year fishery was reported, and most of the area of those reporting grids that overlapped the MSS was in water deeper than the fishery operates. For this fishery we estimated the proportion of each grid that were in depths of 30 m – 60 m, 60 m – 90 m and 90 m – 100 m. Then combined with the percent catch from each reporting grid by depth reported by Linnane et al. (2017) and the 2015 total catches by reporting grid, we estimated the catch that would be directly impacted by the MSS.

Likewise, the MSS area overlapped a number of abalone reef codes, which extend up to 12 km offshore in places, and depths of 80 m. Blacklip abalone are considered to inhabit waters to 30 m depth (Stobart et al., 2015), while Greenlip Abalone inhabit waters to 50 m depth (Stobart and Mayfield, 2016). Further, the nature of diving restricts the depth at which divers can operate, and the length of time they can operate at depth — the deep you dive, the less time you can safely spend diving. As such, abalone diving is generally restricted to depths of 30 m. Give this, it is very unlikely that any of the Southern Zone Abalone Fishery catch is taken from grounds overlapping the MSS area, and we have classified the catch as negligible.

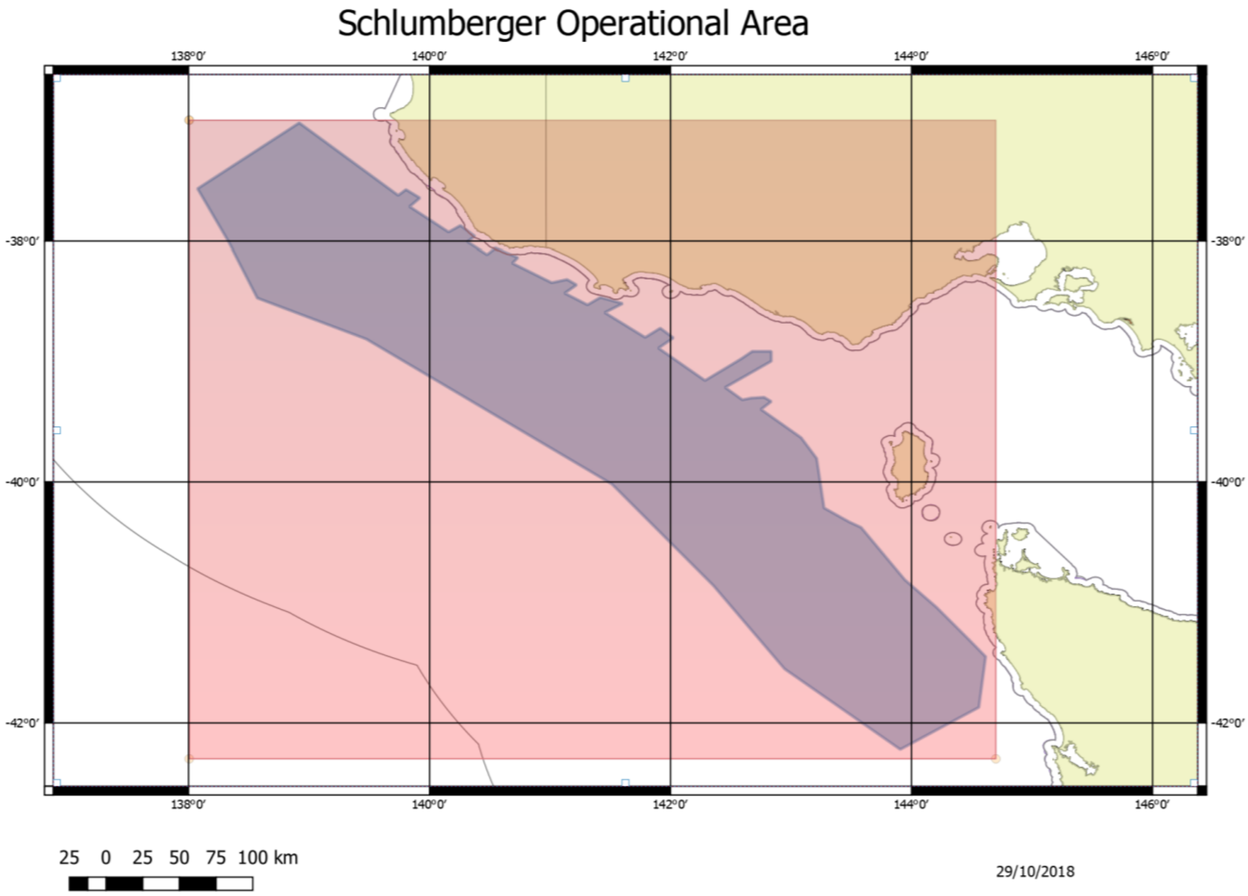


Figure 3. Data requested from AFMA included records from within the red polygon which covered the extent of the original MSS area of operation.

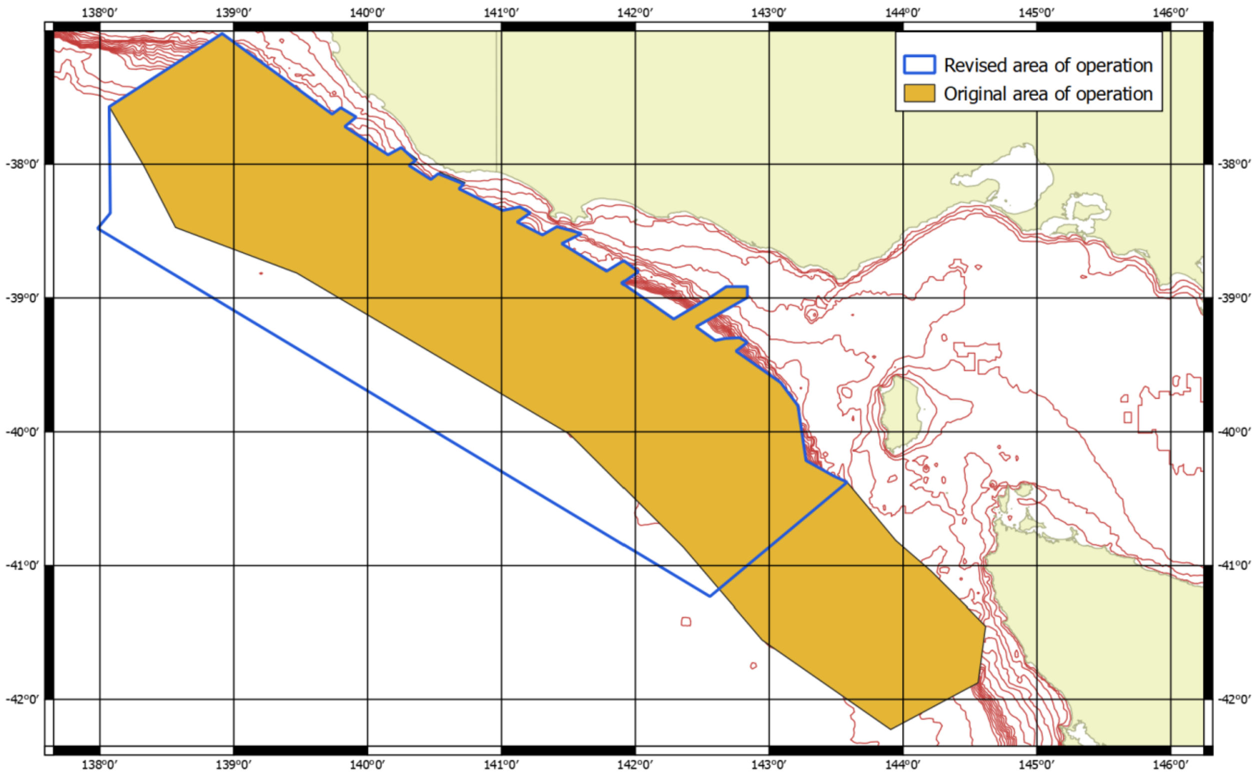


Figure 4. The original area of operation used in data requests (gold area) and the revised area that was used to filter data provided by AFMA.

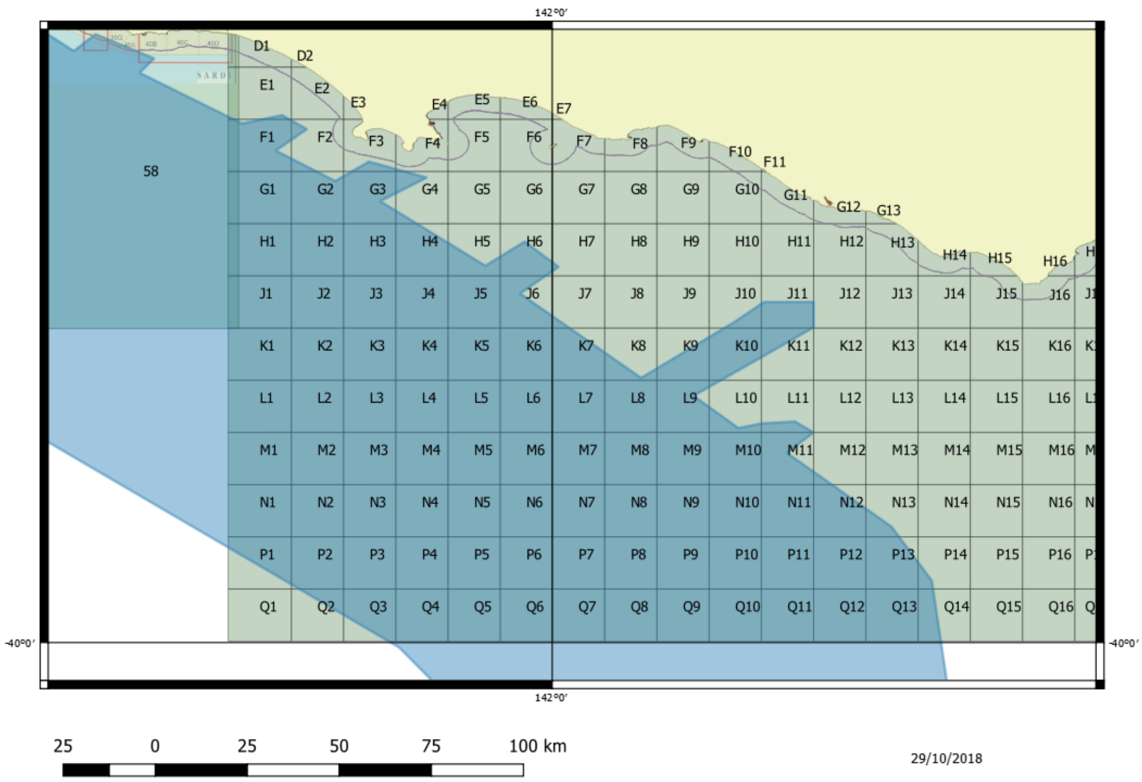


Figure 5. Data requested from VFA included records from within grid areas that overlapped with the original MSS area since 1 January 2008.

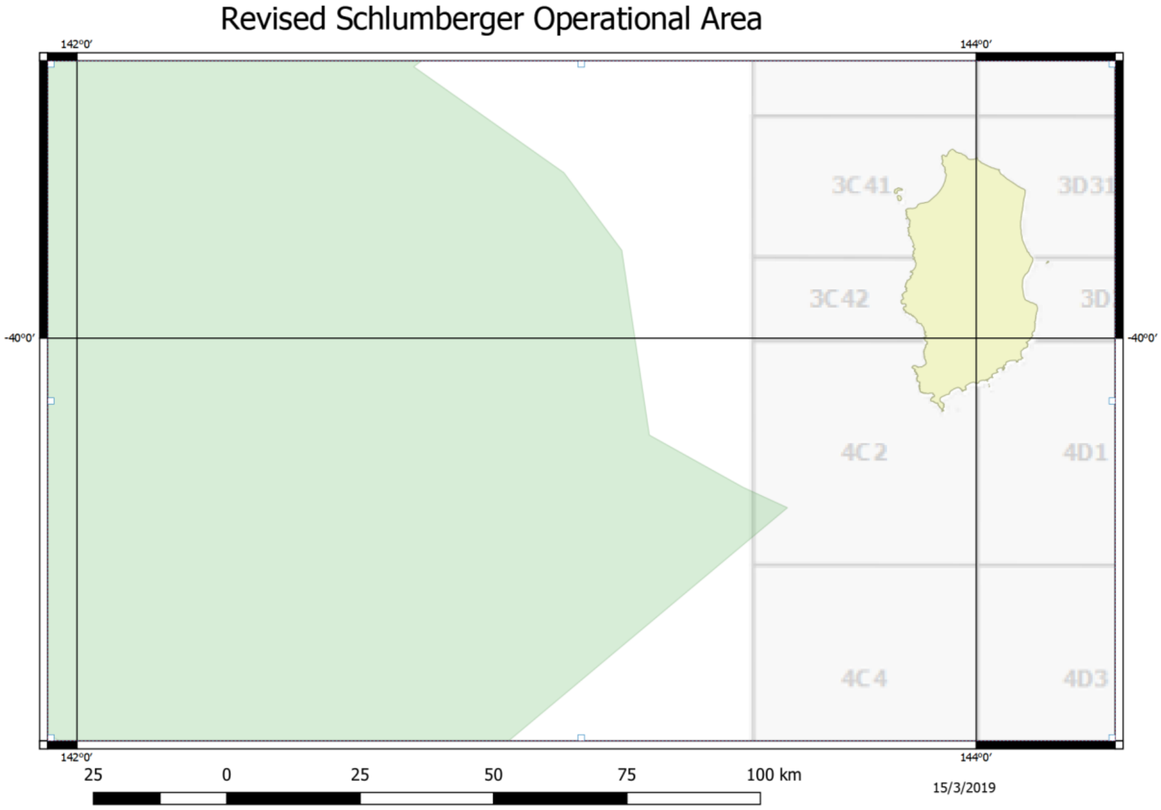


Figure 6. Data requested from IMAS included records from within grid areas and the area of the Tasmanian fisheries that overlapped with the original MSS area since 1 January 2008.

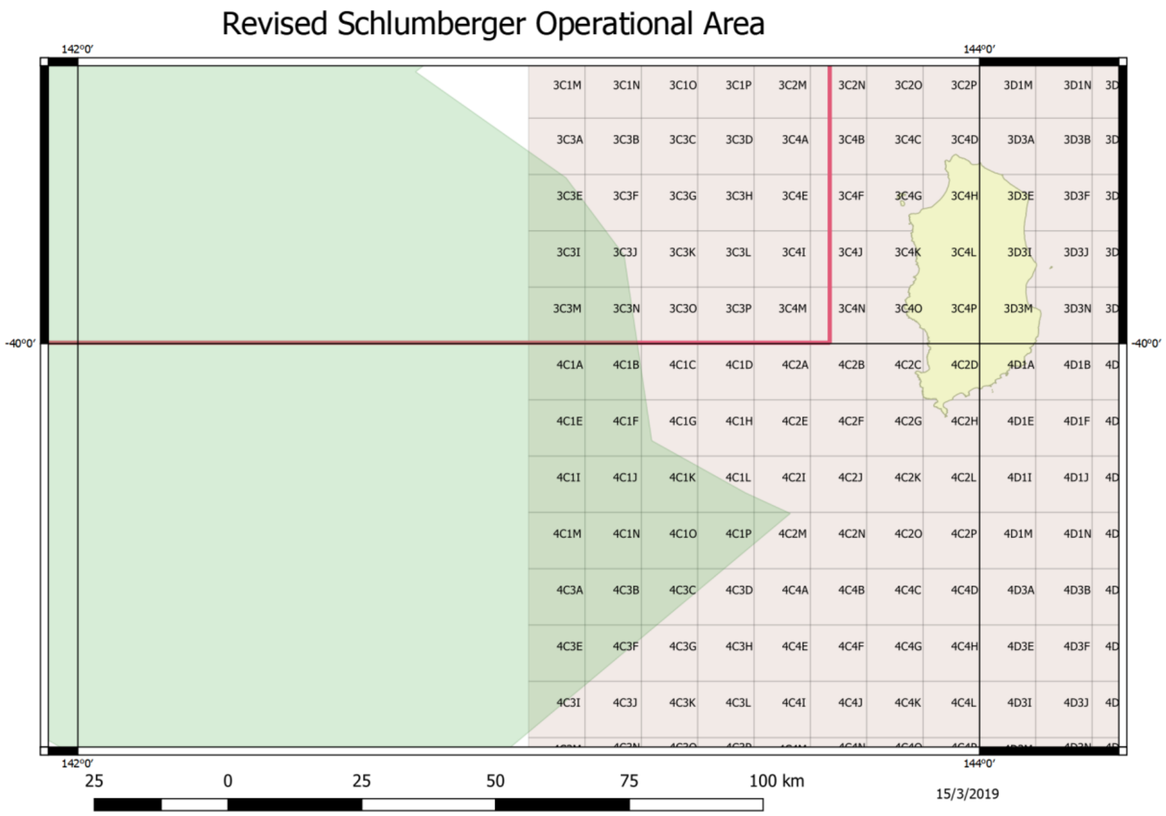


Figure 7. Data requested from IMAS included records from within grid areas and the area of the Tasmanian Rock Lobster and Giant Crab fisheries that overlapped with the original MSS area since 1 January 2008. The extent of the Tasmanian fisheries is shown as a thick red line.

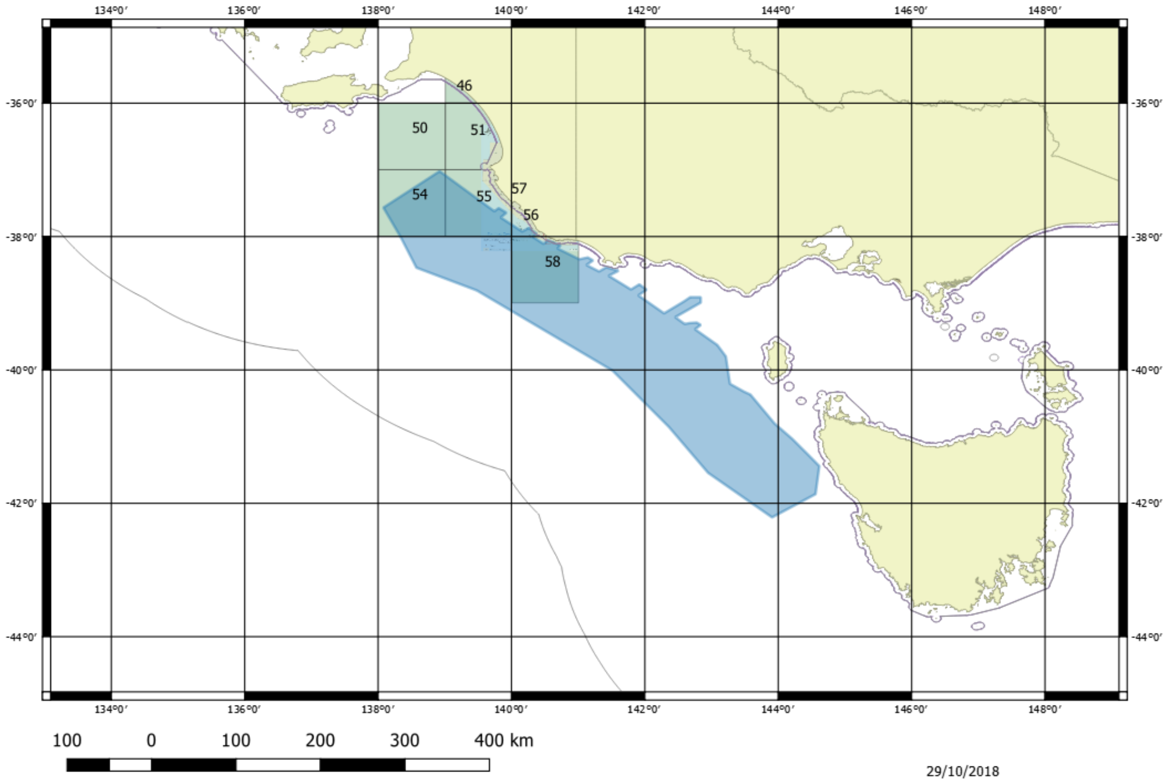


Figure 8. South Australian fisheries data requested from SARDI included records from within grid areas 54, 55, 56, 58 (green) which partially overlapped with the OBN and operational areas since 1 January 2008.

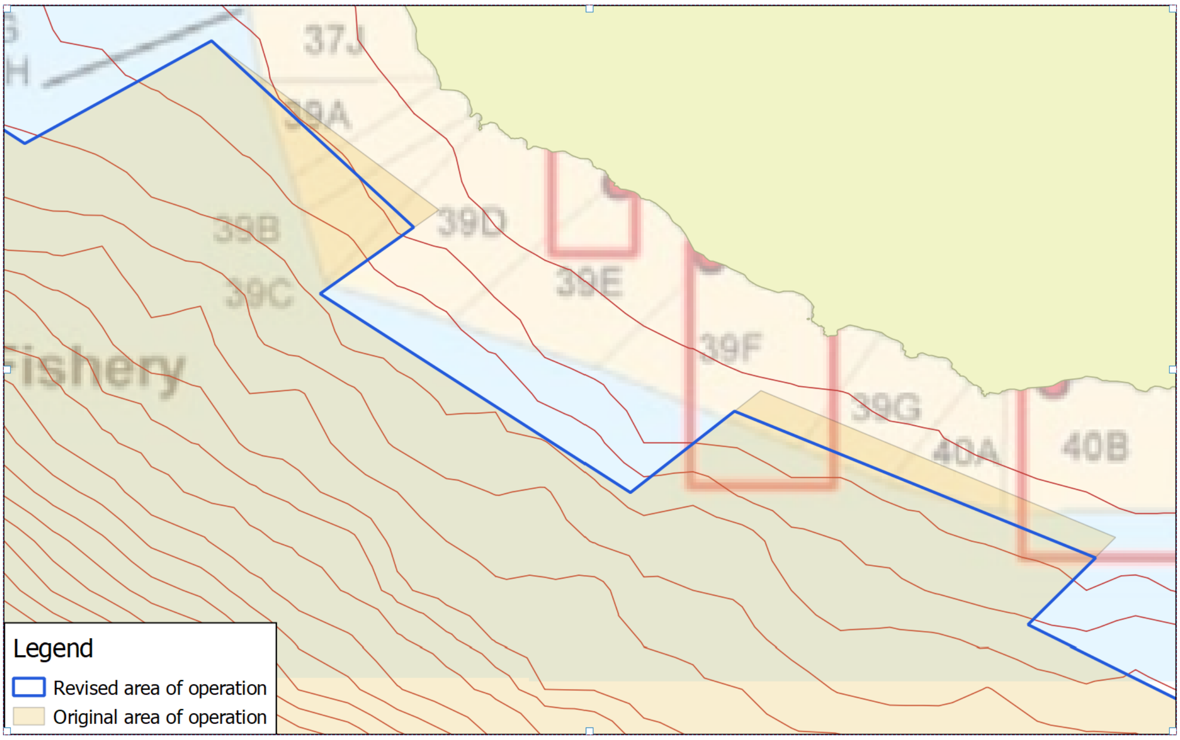


Figure 9. South Australian Southern Zone Abalone Fisher zones from which data was requested from SARDI included records from within reef codes 39A, 39B, 39C, 39D, 39F, 39G, 40A and 40B which partially overlapped with the OBN and operational areas since 1 January 2008.

4. DESCRIPTION OF FISHERIES

The location of the proposed seismic survey is within with areas of numerous State and Commonwealth fisheries. These fisheries use a range of fishing gear from relatively selective methods such as potting in the Rock Lobster fisheries, to less selective methods such as trawling. Species landed across the various fisheries include molluscs, crustaceans, teleosts (ray-fined fishes) and elasmobranches (cartilaginous fishes like sharks and rays). Fisheries that had no recent discernible effort in the original MSS area are indicated as light grey.

4.1. Commonwealth fisheries:

1. Southern and Eastern Scalefish and Shark Fishery (SESSF) which includes four sub-sectors that operate across southern Australia:
   a. Commonwealth Trawl Sector (CTS)
      i. Otter-board trawl gear – recent effort in area (Figure 107a, Figure 24)
      ii. Danish seine gear – a very small amount of recent effort in area Figure 107a, Figure 25)
   b. Shark Gillnet and Shark Hook Sector
      i. Shark Gillnet – recent effort in area (Figure 107b, Figure 36)
      ii. Shark Hook – recent effort in area (Figure 107b, Figure 37)
   c. Scalefish hook – recent effort in area (Figure 107c, Figure 46)
2. Southern Squid Jig Fishery – some recent effort nearby but outside of the survey area (Figure 107d, Figure 56)
3. Small Pelagic Fishery – a very small amount of recent effort in area (Figure 107e, Figure 61)
4. Eastern Tuna and Billfish Fishery – a very small amount of recent effort in area (Figure 107f, Figure 65)
5. Western Tuna and Billfish Fishery – a very small amount of recent effort in area (Figure 108a)
6. Skipjack Tuna Fishery (Eastern and Western) – there has been no fishing effort in this fishery since the 2008–09 season, and that took place of South Australia (Patterson et al., 2016) (Figure 108b)
7. Southern Bluefin Tuna Fishery – a very small amount of recent effort in area (Figure 108c, Figure 72)
8. Bass Strait Central Zone Scallop Fishery – no recent effort in area (Figure 108d)

4.2. Victorian fisheries:

9. Victorian Rock Lobster Fishery – recent effort in area
10. Victorian Giant Crab Fishery – recent effort in area
11. Ocean (General) Fishery – recent effort in area
12. Purse Seine (Ocean) Fishery– no effort
13. Trawl (Inshore) Fishery– no effort
14. Victorian Wrasse (Ocean) Fishery– some effort
15. Victorian Scallop (Ocean) Fishery– no effort

16. Victorian Abalone Fishery – Western Zone– no effort

4.3. Tasmanian fisheries:

17. Tasmanian Rock Lobster Fishery – recent effort in area
18. Tasmanian Giant Crab Fishery – no recent effort in area
19. Tasmanian Scalefish Fishery – recent effort in area (Table 13 and Figure 89)
20. Tasmanian Scallop Fishery unlikely any effort
21. Tasmanian Abalone Fishery – there is no catch or effort recorded from this fishery in the areas of interest.
22. Tasmanian Octopus Fishery – unlikely any effort

4.4. South Australian fisheries:

23. Giant Crab Fishery (Miscellaneous and Southern Rock Lobster Fisheries) – uncertain if there is any recent effort in area
24. Rock Lobster Fishery (Southern Zone) - recent effort in area (Figure 95)
25. Marine Scalefish Fishery - recent effort in area (Figure 99)
26. South Australian Sardine Fishery - no recent effort in area
27. Charter Boat Fishery - recent effort in area
28. Abalone Fishery (Southern Zone) - recent effort in area (Figure 102)

5. DESCRIPTION OF FISHING METHODS USED IN THE SURVEY AREA

5.1. Otter-board trawl (CTS)

There are two types of trawling that currently operate in southern as part of the CTS: otter-board trawl and Danish seine. These are termed as "active" fishing gears because they are towed through the water to catch fish.

Otter-board trawls come in a wide variety of configurations, but the typical set up is described. Otter-board trawls are towed behind the fishing vessel using two long steel cables called "warps" (Figure 10a). Warps are set and hauled using hydraulic net drums on the deck of the vessel. At the other end, each warp is attached to an otter-board, which are large, rectangular steel 'boards' that are attached at an angle designed to provide the outward force needed to spread the mouth of the net. While being towed, otter-boards can spread as wide as 100–120 m. The otter-boards connect to the net via sweeps and bridles, which act to herd the fish into the wings, then the mouth of the net[3], and eventually to the cod-end. The net is widest at its mouth and tapers towards the cod-end (the closed end or bag of the net), where the fish accumulate. The vertical opening of the mouth is maintained using floats on the headline. The lower edge of the net is weighted and uses 'bobbins' or 'rollers' to help the net move across the sea bed and protect it from damage (Figure 10c). Otter-board trawls can also be fished off the bottom to target schools of pelagic fish. When used for this purpose, they are called "mid-water" trawls (Figure 10b).

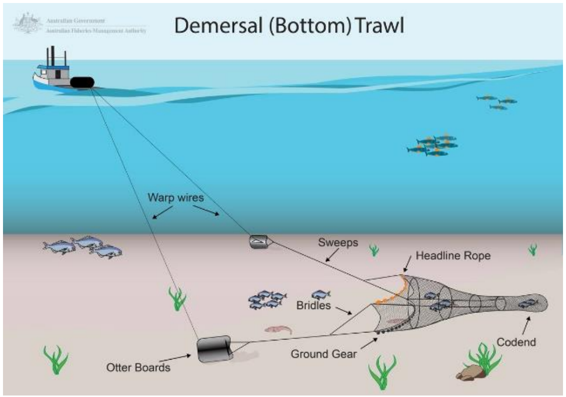
CTS otter-board trawl vessels are typically 18–28 m long, weigh 50–150 tonnes and are powered by 250–700 HP engines (Figure 10d). These vessels are generally operated by a skipper and two to four

[3] This report uses the term "net" to refer to the mesh part of the gear and the term "trawl" to refer to the net, headline, floats and ground gear when assembled.

crew members. The net is towed behind the boat at speeds of 2.0–3.5 knots depending on current and ocean conditions and the species of fish targeted. Tows (fishing time) range from very short (5–10 minutes) to several hours. Once the cod-end has been hauled aboard, it is untied, and the catch is spilled onto the deck (Tomkin, 1998) and sorted. Otter-board trawl mesh sizes vary according to target species but in eastern Bass Strait they are ≥90 mm[4].

Typical CTS otter-boards measure 3–4 m^2 in area, and weigh about 700 kg each. Warps usually comprise 16–22 mm wire cable[5] and are fished using a 1:3 ratio with depth (i.e. 100 m deep = 300 m warp length when fishing). These warps typically have a breaking strain of 14–26 tonnes (Noble, 2006). The sweeps, which connect the net to the otter-boards, typically comprise 18–20 mm wire rope with a breaking strain of 16–20 t (Noble, 2006). Ground gear can be 16 mm chain and/or 4–8 inch (100 mm-200 mm but always referred to in inches) rubber bobbins. An average set of trawl gear (net, ground gear, bridles) weighs about 1,000 kg.

a



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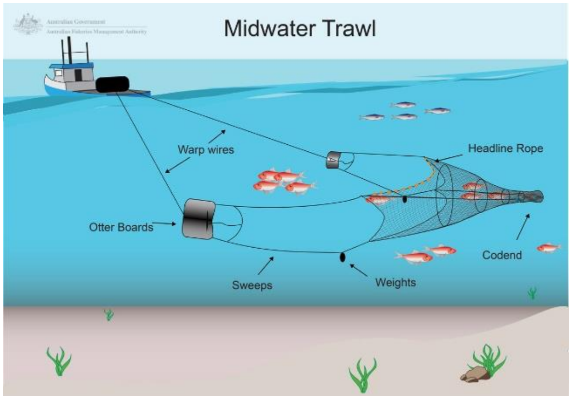


c

d

Figure 10 Illustrations of an (a) otter-board trawl (AFMA, 2018a) and (b) midwater trawl and images of (c) typical trawl ground rope and (d) a typical trawl vessel.

5.2. Danish seine (CTS)

CTS Danish seine vessels are typically 15–20 m long, and powered by 250–300 HP engines. They are usually crewed by one skipper and one or two deckhands (Figure 11b). Danish seine nets are

[4] Measured internally from the edge to edge of a stretched mesh.

[5] Most fishing vessels use 6*19 general purpose round strand galvanised wire rope. All breaking strains stated for otterboard trawling wire rope are for this specification unless stated otherwise.

conical in shape with two long wings, a bag where fish collect and warps that connect the net to the vessel and to surround an area fished (Figure 11a). Unlike otter trawls, Danish seines have no otter-boards, and they are not towed behind the boat, rather set in a circle over relatively flat sea beds and hauled slowly back to the vessel, only moving a distance of about 1 nm while it surrounds a large, pear shaped area. A Danish seine shot usually lasts around 70 minutes, and can be described by three distinct phases (Koopman *et al* 2010), setting, towing and retrieval. The setting phase of the Danish seine trawl is of much longer duration than for an otter trawl. For the first ~45 minutes of the shot the tow ropes and wings of the net are let out and the net sinks to the sea floor; the codend only moves very slowly through the water during this phase. The shoulders and wings of the net are vertically flat for the first 15 minutes, before becoming concaved as the net starts to move. The towing phase is characterised by an increase in the codend speed, and therefore water flow through the net as the ropes are hauled back onto the vessel. The wings of the net are bowed over, and are being pulled forwards, as well as being drawn in towards the opposite wing. It is during this phase that most fish are herded towards the back of the net. As the retrieval phase begins, the wings begin to lift off the sea floor. After about an hour, fish have stopped entering the net apart from a few fish that are caught in higher sections of the net, and the foot-line in the shoulder comes off the seafloor. The net is tight and meshes fully stretched because of the pressure of being hauled in, and the weight of the fish in the codend. After a further ten minutes, the codend is on the surface, and usually hauled onboard within 2 or 3 minutes.

Danish seine warps are initially 22 mm lead core polypropylene rope with a breaking strain of 8.0 t (Noble, 2006), but taper down to lighter 12 mm polypropylene rope with a breaking strain of 3.0 t (Noble, 2006) under the net, with the same 22 mm rope at the other end of the gear (Figure 11c). Mesh size used depends on the target species and can be as small as 38 mm stretched diameter, but more typically 60–70 mm (Figure 11d).

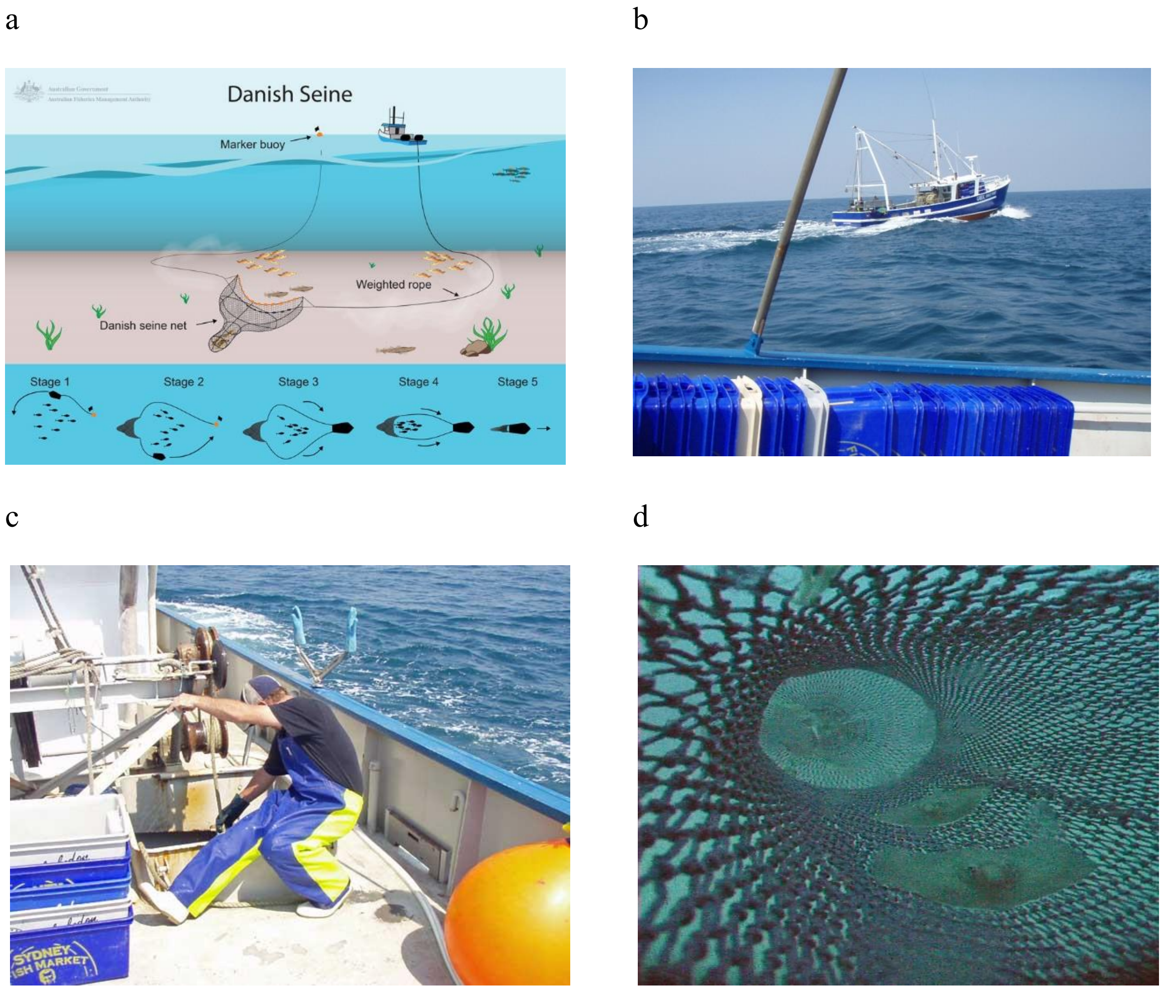


Figure 11 (a) Illustration of a Danish Seine shot (AFMA, 2018a), (b) a typical Danish seine vessel, (c) the ropes being hauled onboard, and (d) a view looking done the net into the codend.

5.3. Demersal gillnets (SGSHS, Victorian Ocean General Fishery, Tasmanian Scalefish Fishery, South Australian Marine Scalefish Fishery)

Demersal gillnets are a "passive" fishing gear (they are not towed — the fish have to swim into the gear) comprising a series of long panels of diamond shaped mesh anchored at each end, and weighted along the bottom rope to keep the net on the sea floor. It is held upright by a series of floats (Figure 12a). Used in the SESSF mainly to target Gummy Sharks, the uniform sized (6 inch) meshes on a gillnet (Figure 12d) make them highly selective for a particular size of shark. Sharks that are smaller than the mesh can pass through, while larger sharks tend to "bounce" off the net without getting meshed. Operators in the SGSHS can use gillnets up to 6,000 m long in Bass Strait. Many operators divide their maximum legal net length into two or three fleets, which can either be fished together or separately.

Gillnets used in the SGSHS generally have the headline (top horizontal rope) set 2.0 m above the seafloor. The headline is typically a 16 mm polypropylene rope floated using small floats (Figure 12b). The monofilament net is connected to a ground rope on the lower horizontal edge. The ground rope is usually a 14 mm weighted (lead core) polypropylene rope. At either end of the gillnet, a 9 mm down-line with a breaking strain 2.0 t (Noble, 2006) runs from floats that indicate the position of the net on the surface, to 2.0 m of chain attached to a 10–15 kg "J" anchor or lead weights (Figure 12c). Depending on tide and sea conditions there are often three or four other anchors along the ground rope. The chain is attached to the anchor mid-way down the anchor shaft, and a lighter break-away cord is usually used.

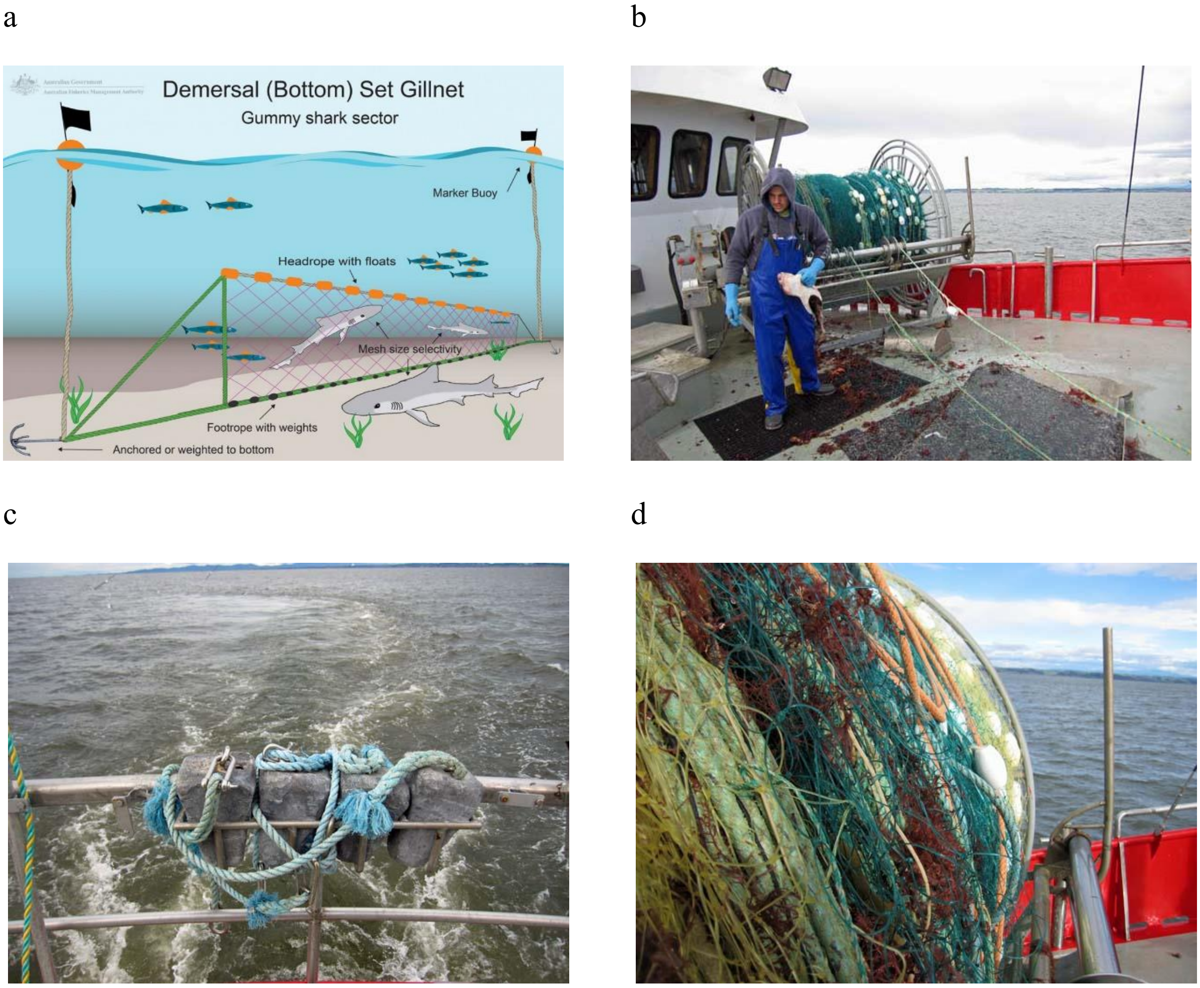


Figure 12 (a) Illustration of a demersal gillnet (AFMA, 2018a), (b) a typical net drum, (c) lead weights, and (d) close-up of a gillnet.

5.4. <u>Demersal longline (SGSHS and SFHS, Victorian Ocean General Fishery, Tasmanian Scalefish Fishery, South Australian Marine Scalefish Fishery)</u>

Demersal longlines are also a passive fishing gear consisting of a long mainline laid along the seabed, to which hundreds or thousands of baited hooks are attached at regular intervals (~1.4 m) via short lines (30 cm) called “snoods”. In the SGSHS, longlines are typically 1.5 to 5.0 km in length (Figure 13) with less than 15,000 hooks. As the mainline is set from the stern of the vessel, each hook is baited by either hand or a baiting machine and released. The mainline is marked by a buoy with lights and can be anchored at each end. Some vessels use radio beacons to be able to find gear in low visibility or if it drifts in heavy current.

Demersal longline gear is much lighter than otter-board trawl or Danish Seine gear. Downlines (ropes connecting floats and the mainline) are generally made of 8–10 mm polypropylene with a 1.0–2.0 t breaking strain (Noble, 2006). Mainlines are thinner (e.g. 7 mm) but are more abrasion resistant. Snoods are usually monofilament with very low breaking strain (approximately 50 kg). Anchors are only large enough to manage onboard by hand (~15–25 kg). The number of anchors used depends on many factors including, currents, sea condition, ground fished, and species targeted.

Like other fishing vessels, longliners may lay-up at anchor during bad weather or while fishing gear soaks (fishes). Auto longlining is a variation of demersal longlining in which some of the functions (for example baiting the hooks) are automated. Many "autoliners" set, haul and steam between lines on a continual basis.

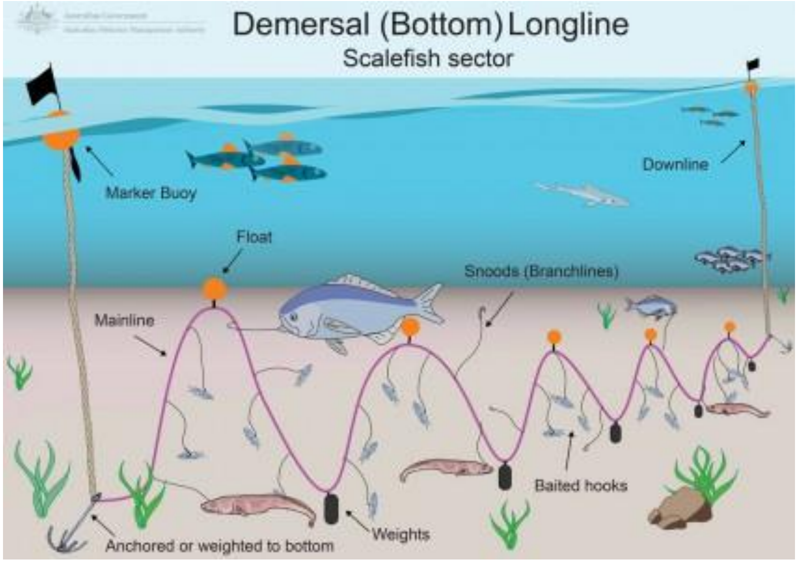


Figure 13 Illustration of a demersal longline: (AFMA, 2018a)

5.5. Pelagic longline (ETBF)

Pelagic longlines are like demersal longlines except they are free-floating near the surface. They are a passive fishing gear consisting of a long mainline suspended under floats, with hundreds or thousands of baited hooks are attached at regular intervals via snoods (Figure 14). Radio beacons are attached to the floats to allow the vessel to track its movement. ETBF vessels generally fish in deep water which prohibits anchoring. They more often steam between lines, or drift while waiting to haul.

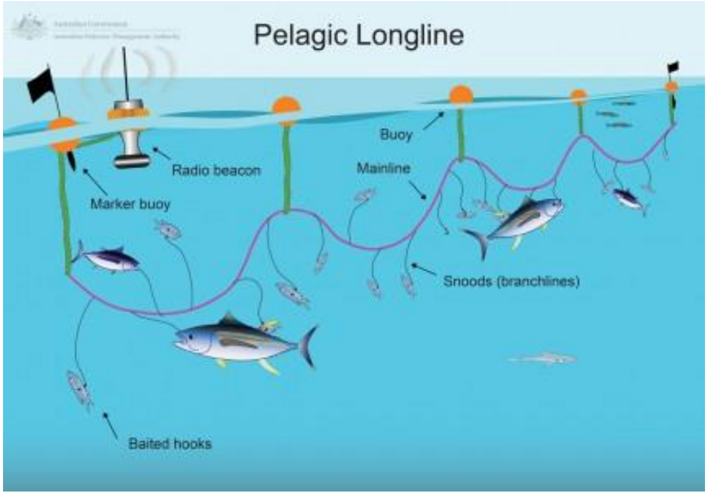


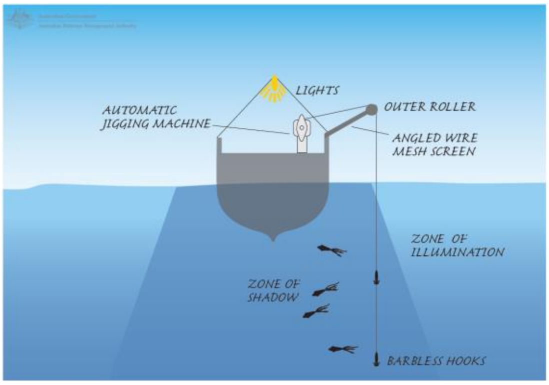
Figure 14 Illustration of a pelagic longline: (AFMA, 2018a)

5.6. Squid jig (Southern Squid Jig Fishery, Victorian Ocean General Fishery, Tasmanian Scalefish Fishery, South Australian Marine Scalefish Fishery)

Squid jigging typically occurs at night using large lights that illuminate the waters around a boat (Figure 15). Once a suitable site has been chosen, it is common for vessels to deploy a drogue or sea anchor to reduce the vessel's drift while fishing. The light attracts small marine creatures and in turn the squid are attracted to the concentration of these prey species. One or more lines of hooks are then jigged up and down in the water column using a rotating elliptical spool. The jigging devices are fully automated running on a timed cycle of setting, jugging and then hauling. Squid attack the jigs as they are being retrieved and become caught on the barbless hooks. As the squid are hauled onto the boat the barbless hooks allow them to easily fall off the jig into a holding container.

Jig vessels would sometimes use anchors during the day that are typical of those described for other fisheries; 20–22 mm polypropylene rope with a breaking strain of 7–11 t (Noble, 2006). The line used for the squid jig is monofilament with a low breaking strain of 100–200 kg.

a



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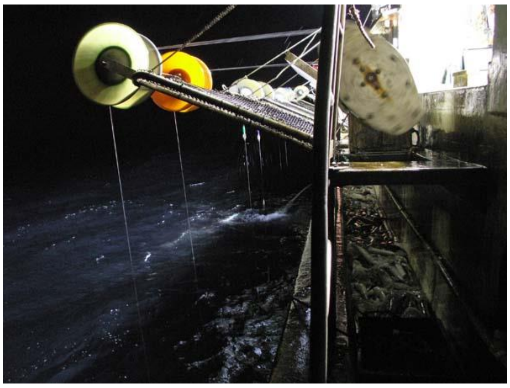


Figure 15 (a) Illustration of a squid jig setup (AFMA, 2018a), and (b) photo of automated squid jigs in operation (photo credit: Corey Green).

5.7. Minor line (ETBF, Victorian Ocean General Fishery, Tasmanian Scalefish Fishery, South Australian Marine Scalefish Fishery, Victorian Wrasse Fishery)

Minor lines is a general term to describe a range of line fishing methods that use a small number of hooks (Figure 16). Minor line methods include trolling, poling, rod and reel (often call hand-lining). Hooks are either baited or on lures or jigs and could either be fished near the bottom using a lead weight, slowly dragged through the water (trolling), of dragged through the water using the action of the rod or reel.

In the ETBF, Minor line methods are used to target large pelagic species such as tuna, but also smaller pelagic species to be used as bait.

Hand lines are used in the Victorian Ocean Fishery to target finfish including Snapper. There is a limit of six lines — each with three hooks — per licence. Handlines are usually lowered and retrieved using fishing rod and reel equipped with 20 lb breaking strain monofilament of braided nylon mainline and 40–50 lb leader. Hand lines are usually fished from small 6–8 m vessels undertaking day trips. Vessels may anchor while fishing, and typically use a reef anchor attached to 3–5 m of chain (typically 8 mm link) and 12 mm polypropylene rope.

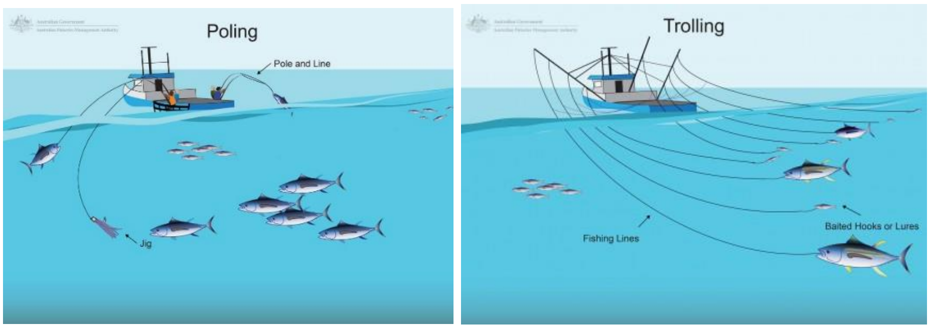


Figure 16 Illustration of minor line methods of poling and trolling: (AFMA, 2018a)

5.8. Purse seine (SPF, Victorian Ocean Purse Seine Fishery)

Purse seines are used in the Commonwealth managed Small Pelagic Fishery. Purse seines are generally used to target schools of pelagic fish. A purse seine is comprised of a long wall of net framed by float line and lead line that is set in a circle to surround a school of fish, and then closed at the bottom using wire threaded through the bottom of the net (FAO 2001–2013; Figure 17). The catch is then brought onboard with the net, lifted out with small nets or pumped out. The fishing gear generally does not touch the sea floor.

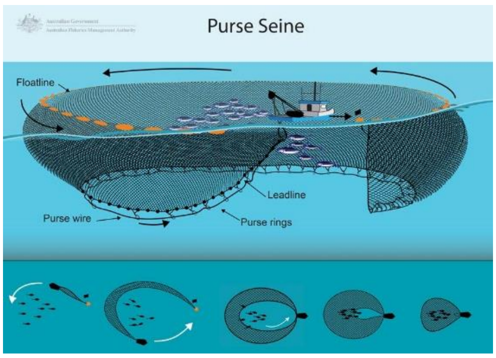


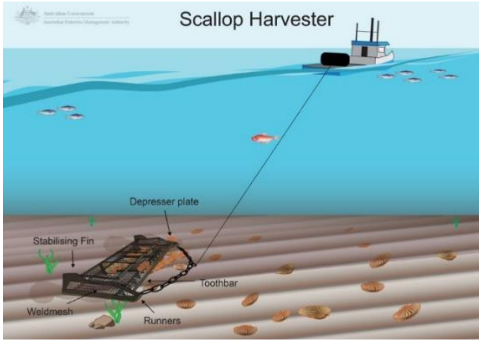
Figure 17 Illustration of a purse seine in operation (AFMA, 2018a)

5.9. Scallop dredge (Victorian Ocean Scallop Fishery, Tasmanian Scallop Fishery, BSCZSF)

The Victorian Scallop Fishery extends 20 nm from the Victorian coast line. Scallops are caught using a steel dredge that is towed by the vessel along muddy to coarse sand substrates (Figure 18a).

The average scallop vessel is 18–25 m long, weighs ~100 t and is powered by 200–400 HP engines. Scallop dredges are a steel cage that weigh about 600 kg (Figure 18b). They have teeth (tooth bars) on the leading edge that range 75–100 mm long, which enter the benthos about half an inch (12 mm), scooping scallops into the basket. The gear is towed behind the vessel at a speed of ~3 knots using warps of 16–8 mm steel core (6*19 ply) with a breaking strain of 14–16 t (Noble, 2006).

a



b

Figure 18 Illustration (AFMA, 2018a) and photo of a scallop dredge.

5.10. Rock Lobster / Giant Crab pots (Victorian, South Australian and Tasmanian Rock Lobster and Giant Crab fisheries)

Pots are a form of rock lobster traps that are baited and set individually, usually over rocky reef. A variety of baits are used, and include barracouta heads, salmon, carp and wrasse. Cray pots used in Victoria are usually 'bee hived' in shape, with a steel frame encased in with either cane or wire mesh (Figure 19a). Maximum dimensions are 150 cm x 150 cm x 120 cm high, but are usually smaller than that and weigh ~ 15 kg each. Pots are attached to a surface float via 10–12 mm polypropylene rope. They are set by being pushed overboard, and retrieved using hydraulic pot hauler (Figure 19b).

a

b

Figure 19. Photos showing (a) close up of cray pots, and (b) the retrieval of cray pots using the pot hauler.

5.11. Hand harvest

Abalone are caught by hand while diving, usually with the use of hookah. Abalone inhabit rocky reefs, and are removed using an abalone knife. Boats used in the fishery are generally small (6–8 m) and do not anchor while working. Abalone divers generally make single day trips. Abalone divers are generally restricted to depths less than 30 m.

a

b

Figure 20. Photos showing (a) close up of hand harvest of abalone, and (b) abalone diver operating on hookah supplied air from a surface vessel.

6. FISHING SECTORS AND SEISMIC SURVEY OVERLAP

6.1. Southern and Eastern Scalefish and Shark Fishery (SESSF)

The SESSF extends from Cape Leeuwin in Western Australia to Fraser Island in Queensland (Figure 21). This Commonwealth managed fishery is the main provider of fresh fish to the Melbourne and Sydney markets. The SESSF gross value of production (GVP) was about $82 million in the 2016–17 financial year but catches have declined significantly from historical levels primarily due to a reduction in fishing effort (Figure 22), largely associated with a 2006 Commonwealth Government led *Structural Adjustment* which removed 50% of fishing concessions, but also from greatly reduced catches of Orange Roughy and Blue Grenadier (Patterson *et al.*, 2018).

AFMA manages fisheries to maintain stocks at ecologically sustainable levels, while maximising the net economic returns to the Australian community (DAFF, 2007). Main management measures used in the SESSF include limited entry, gear restrictions, closed areas and Total Allowable Catch (TAC) limits. Fishing licenses are required for fishermen to operate in the SESSF and there are dormant (unused) licenses in most sectors. TACs are set each year based on outcomes of stock assessments conducted for each quota species. Statutory fishing right (SFR) quota units are converted to tonnes of quota each year depending on the annual TAC set.

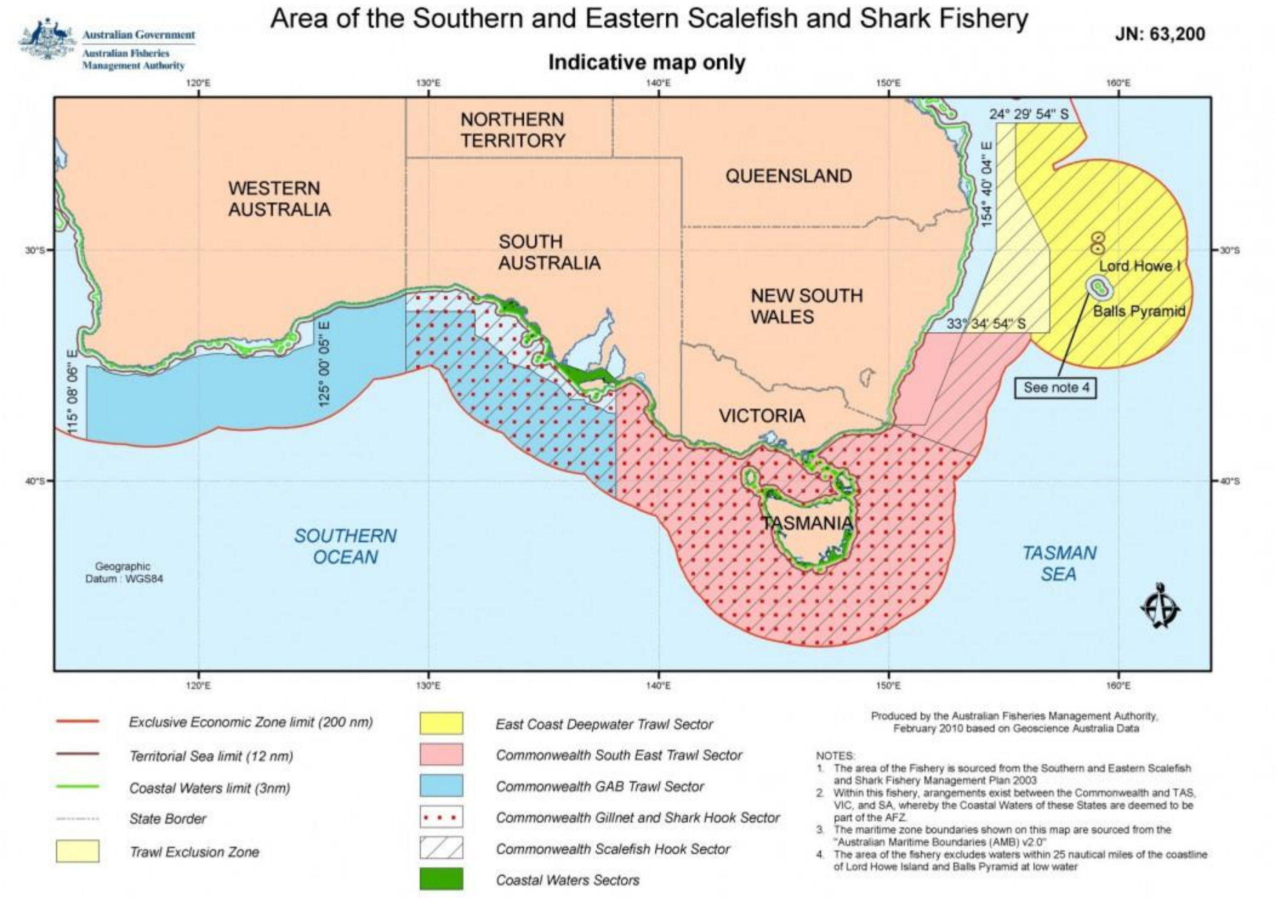


Figure 21 Area of the Southern and Eastern Scalefish and Shark Fishery (AFMA, 2018a).

More than 100 species are regularly landed in the SESSF but only the main species are managed under quotas. At present, there are 34 fish stocks subject to TACs (Table 3). Only those in bold are generally found in the vicinity of proposed seismic survey area.

The SESSF is comprised of five sectors: the Commonwealth Trawl Sector (CTS), Great Australian Bight Trawl Sector (GABTS), East Coast Deepwater Trawl Sector (ECDTS), Gillnet and Shark Hook Sector (SGSHS) and Scalefish Hook Sector (SHS) (Figure 21). Of these, only the CTS, SGSHS and SHS sectors operate within the area of the proposed survey — together, the SGSHS and the SHS sectors are referred to as the Gillnet, Hook and Trap Fishery (GHAT). Total landings by the CTS and SHS in 2017–18 was 8,631 t (Patterson *et al.*, 2018). GVP of the 2016–17 catch by the CTS and SHS was $46.42 million. The SGSHS landed 2,216 t of shark during 2017–18 and had a GVP of $20.23 million during 20165–17.

Table 3. List of 2018–19 TACs (whole fish unless otherwise stated) for SESSF quota species (AFMA, 2018b). Species that are likely to be caught in the area of the proposed seismic survey area are highlighted.

Species	TAC (t)	Species	TAC (t)
Alfonsino	1,017	Orange Roughy – (GAB)	50
Bight Redfish (GAB)	800	Orange Roughy – (Cascade)	500
Blue Eye Trevalla	462	Orange Roughy – (East)	698
Blue Grenadier	8,810	Orange Roughy – (South)	53[6]
Blue Warehou	118	Orange Roughy – (West)	60
Deepwater Flathead (GAB)	1,128	Oreo (smooth Cascade)	150
Deepwater Shark (east)	23	Oreo (smooth other)	90
Deepwater Shark (west)	264	Oreo (basket)	185
Elephant Fish	114	**Pink Ling**	1,117
Flathead	2,507	Redfish	100
Gemfish East	100	**Ribaldo**	430
Gemfish West	200	Royal Red Prawn	381
Gummy Shark	1,763[7]	**Sawshark**	430
Jackass Morwong	505	**School Shark**	215
John Dory	263	School Whiting	820
Mirror Dory	235	**Silver Trevally**	307
Ocean Perch	241	**Silver Warehou**	600

6.2. Commonwealth Trawl Sector

The CTS is one of the oldest commercial fisheries in Australia, with over a 100-year catch history. The main fishing gears used in this sector are otter-board trawl and Danish seine nets. The sector's area of operation extends from Cape Jervis in South Australia around the Victorian, Tasmanian and NSW coastlines northward to Barrenjoey Point (Figure 21). During the 2017–18 fishing season there were 32 otter-board trawl and 18 Danish seine vessels actively operating in the CTS (Patterson *et al*, 2018).

Total annual catch (fishery wide) in the CTS peaked in 1990 at just over 60,000 t, but fell to 20,000–30,000 t during the late 1990s (Figure 22) mainly as a result of overfishing Orange Roughy. Catches again fell during 2002–2007 from about 30,000 t to its current level of below 10,000 t.

SETFIA is the industry association for CTS operators, representing more than 80% of the catching and quota-owning sector through voluntary membership. Contact details for SETFIA are provided in Table 20.

Overlap between CTS grounds and the area of the proposed seismic survey area

The waters west around King Island are fished by the otter trawl sector (Figure 24), and there was some effort by the Danish seine sector in the revised MSS area however this was likely a reporting or data entry error as Danish seine effort is generally restricted to flat sandy bottom in water less than 200 m deep (Figure 25). Because of the small number of Danish seine vessels contributing to the data, data from otter trawl and Danish seine sectors are combined. Historical fishing effort shows some otter trawl effort along the shelf break (Figure 23), but little on the shelf in the areas of interest.

[6] Plus 31 t incidental

[7] Trunk weight

Logbook data revealed that the area around the proposed seismic survey is very important for fishing by the CTS, particularly those using otter trawl gear. Since 2008, between 10 and 18 CTS vessels (out of 32 active otter trawl vessel; Patterson *et al*, 2018) have recorded fishing within the revised MSS area (Figure 26). Annual effort recorded by the CTS from the revised MSS area was as high as 3,000 shots during 2010 but only about 1,750 shots during 2017. Annual landings recorded from the revised MSS area ranged about 1,890 t in 2014 to about 870 t during 2014 (Figure 27). Estimated annual values of the catch in area of operation ranged $3,229,670 and $6,292,927 (Figure 28). Over the 10 year period of 2008–2009 to 2017–2018, a total of 12,405 t of fish was caught by the CTS in the revised MSS area, valued at $44.6 million (Table 4). Catch was dominated by slope dwelling species including Blue Grenadier (20%) and Silver Warehou (17%) and the cephalopod Gould's Squid (12%) (Table 4, Figure 31). Other main species Pink Ling and Mirror Dory.

Effort by the CTS in the revised MSS area has been highest in January, April and May, but also in October and November, and lowest from July to September (Figure 29). Total catch have been highest in March to May (Figure 30).

The area of operation transects the Zeehan and Nelson Commonwealth Marine Reserves (Figure 32). The Nelson and most of the Zeehan Commonwealth Marine Reserves are classified as Special Purpose Zones (IUCN VI) in which commercial fishing is prohibited, while the inshore section of the Zeehan Commonwealth Marine Reserves is classified as a Multiple Use Zone (IUCN VI). Some commercial fishing is allowed in the Multiple Use Zone, but use of Danish seine, demersal trawl and scallop dredge are prohibited (National Parks, 2013).

Trawl vessels cannot fish deeper than a closure known as the 'Deepwater Trawl Closure'. This closure aims to be at the 700 m isobath, but varies significantly in depth in reality (Figure 32). The lack of trawl fishing outside this line will have been captured in data requests.

Likelihood of fishing grounds developing in the future

Fishing effort in the CTS has been more limited by quotas (TAC's) than the limited number of fishing licenses. Improved technology and exploration saw expansion of fishing grounds over the decades since the 1980s, but subsequent to several Government-led structural adjustments and closures of many areas to trawling during the mid-2000s, there has been some contraction of fishing effort on both the shelf and shelf break. Figure 22 shows that in recent years, effort in the otter-board trawl fleet fell to the lowest levels on record in 2016 and increased slightly in 2017 (apart from 1985 when logbooks were introduced), while Danish seine effort remains relatively high. The fishing grounds around the survey area are categorised as having low, medium and high fishing effort, and while there is some Danish seine effort recorded from the revised MSS area, this is likely to be a recording error. While the catch of some CTS species is limited by TACs, the fishery has been unable to catch that TAC in recent year for unknown reasons that are now being investigated. Thus, while there is a significant amount of CTS catch and effort recorded from within the area of the seismic survey, it is unlikely that this will increase to any appreciable extent in the near future.

Table 4. CTS effort, catch, catch value and main species caught in the AFMA data area. Original data source: AFMA.

Years included	2008–2017
Number of different vessels	31
Total shots	22,030
Total catch (t)	12,405 t
Total value	$44,554,333
Main species caught	Blue Grenadier (20%) Silver Warehou (17%) Gould's Squid (12%)
Fishing methods used	Otter trawl Danish seine

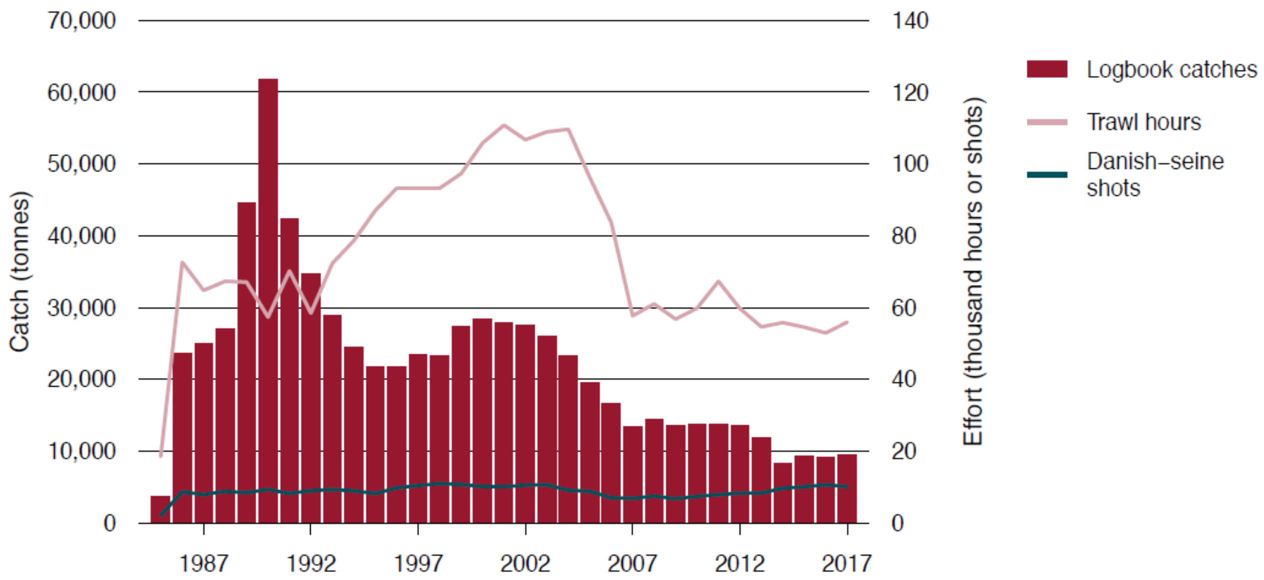


Figure 22. Total catch and effort by the CTS during 1985–2017 (Patterson *et al*, 2018).

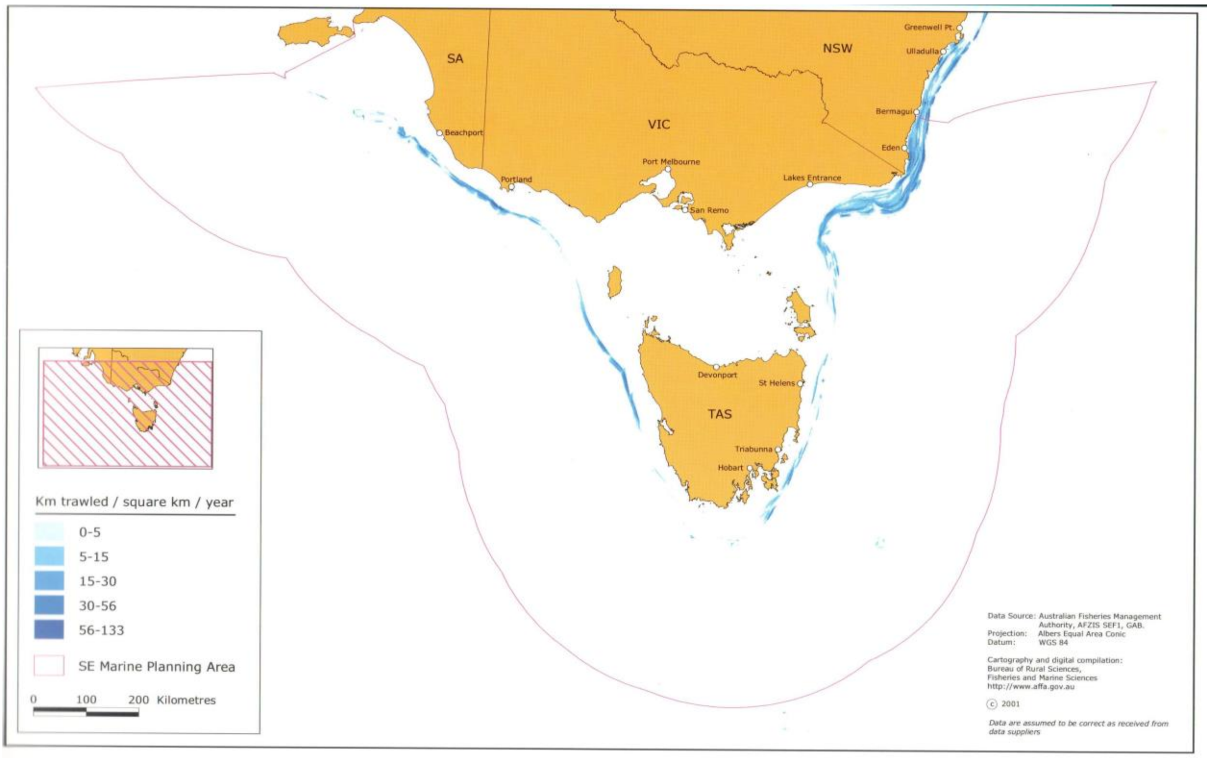


Figure 23 Fishing effort (km trawled/square km/year) by CTS otter trawl in south east Australia 1995 – 99 (Larcombe *et al*, 2002).

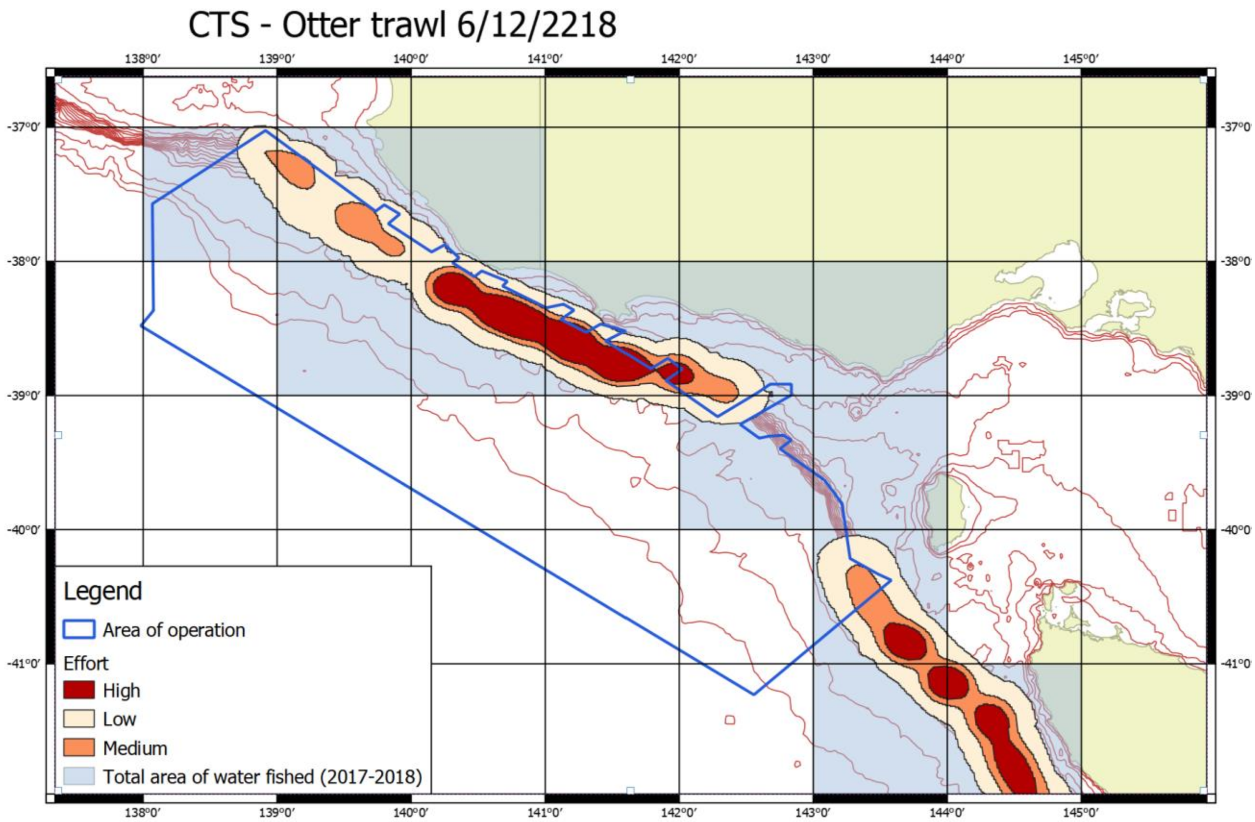


Figure 24. Relative fishing intensity by the CTS using otter trawl in relation to the revised MSS area during 2017–18. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

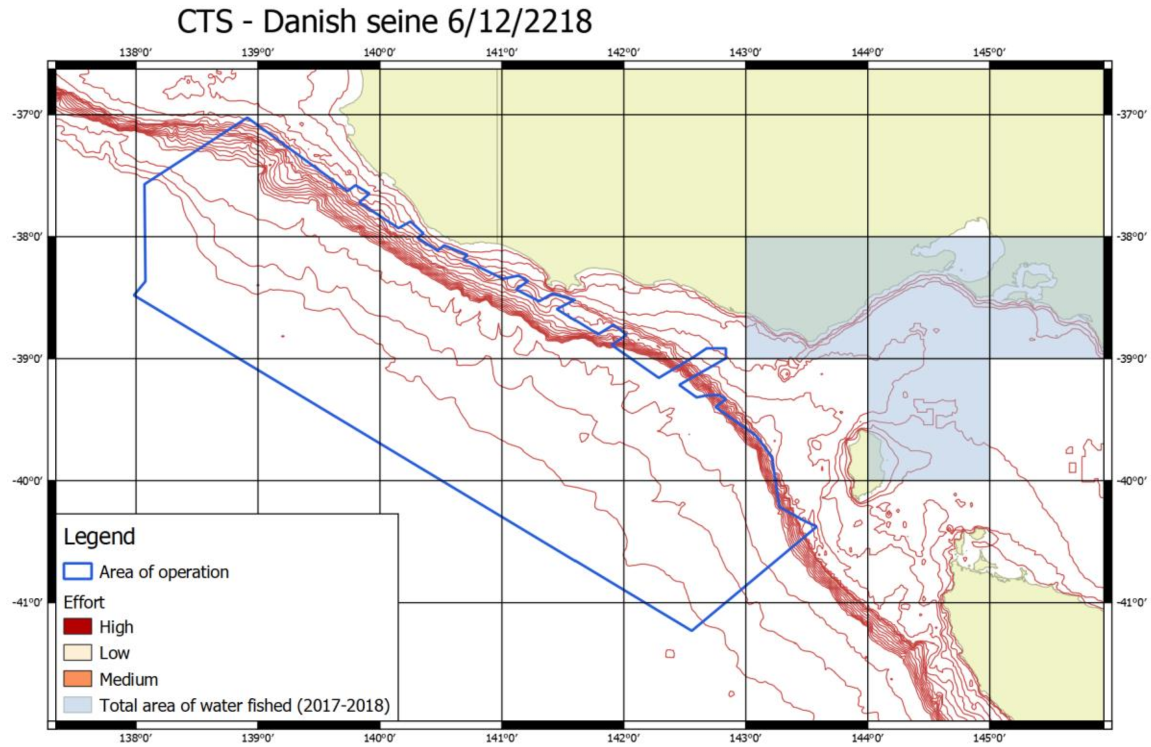


Figure 25 Relative fishing intensity by the CTS using Danish seine nets in relation to the revised MSS area during 2017–18. Note that effort comprising data of less than 5 vessels has been removed. Data provided ABARES. Original data source: AFMA.

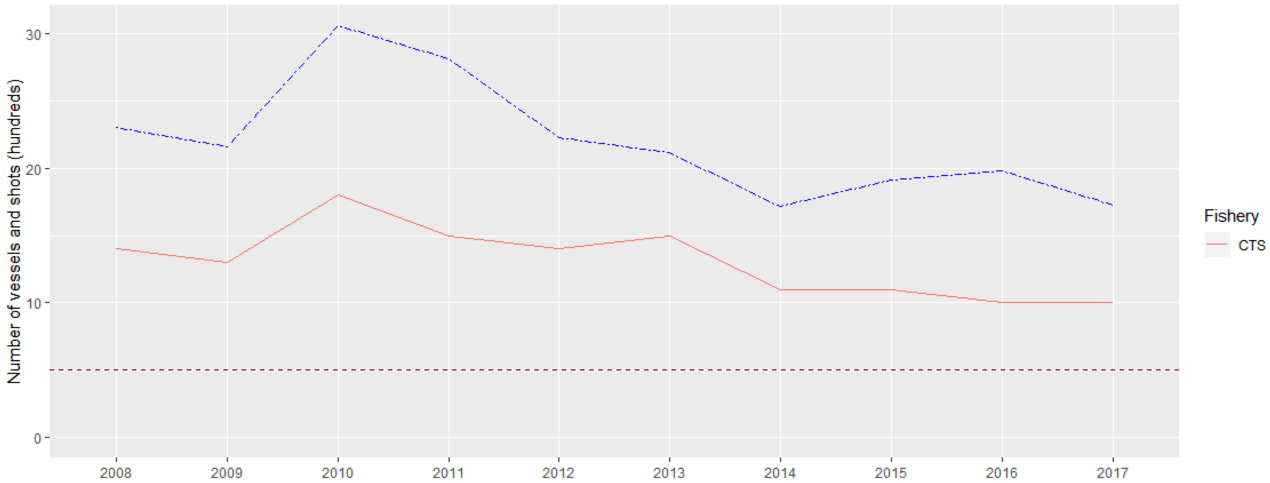


Figure 26. Number of vessels that recorded effort (red solid line) and number of shots recorded (hundreds, blue dashed lines) within the revised MSS area in each financial year from 2008-2009 to 2017-2018 for otter trawl and Danish seine vessels in the CTS. Note the minimum number of vessels in any one year was 10. The horizontal red line intercepts the y-axis at 5. Note that data from otter trawl and Danish seine vessels cannot be separated without compromising the 5-boat rule. Original data source: AFMA.

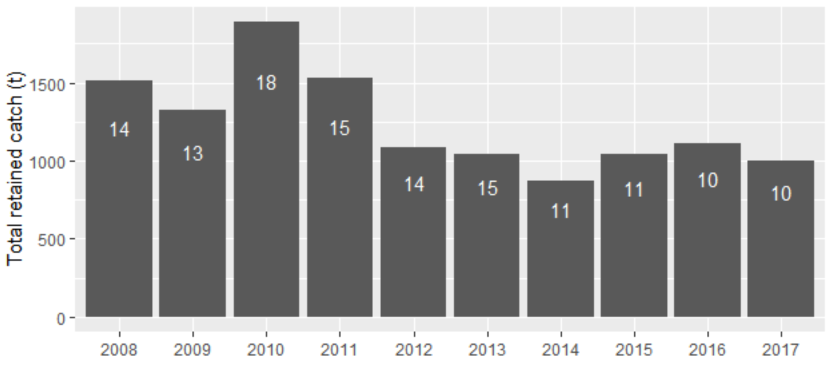


Figure 27. Annual retained catch within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by the otter trawl and Danish seine vessels in the CTS. Note the minimum number of vessels in any one year was 10. Number of vessels is annotated on bars. Original data source: AFMA.

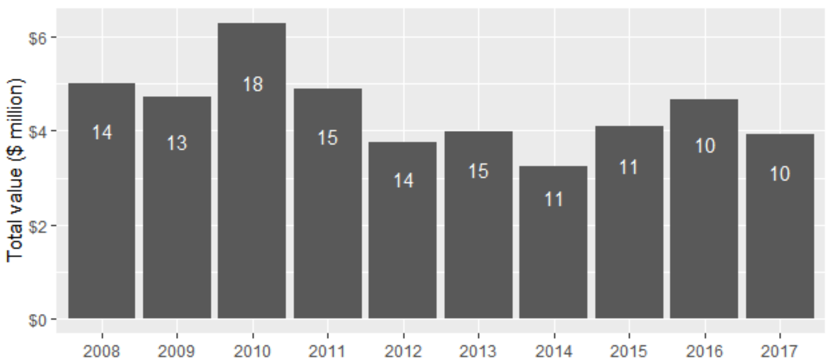


Figure 28. Estimated annual value (million) of fish landed within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by the otter trawl and Danish seine vessels in the CTS. Note the minimum number of vessels in any one year was 10. Number of vessels is annotated on bars. Original data source: AFMA.

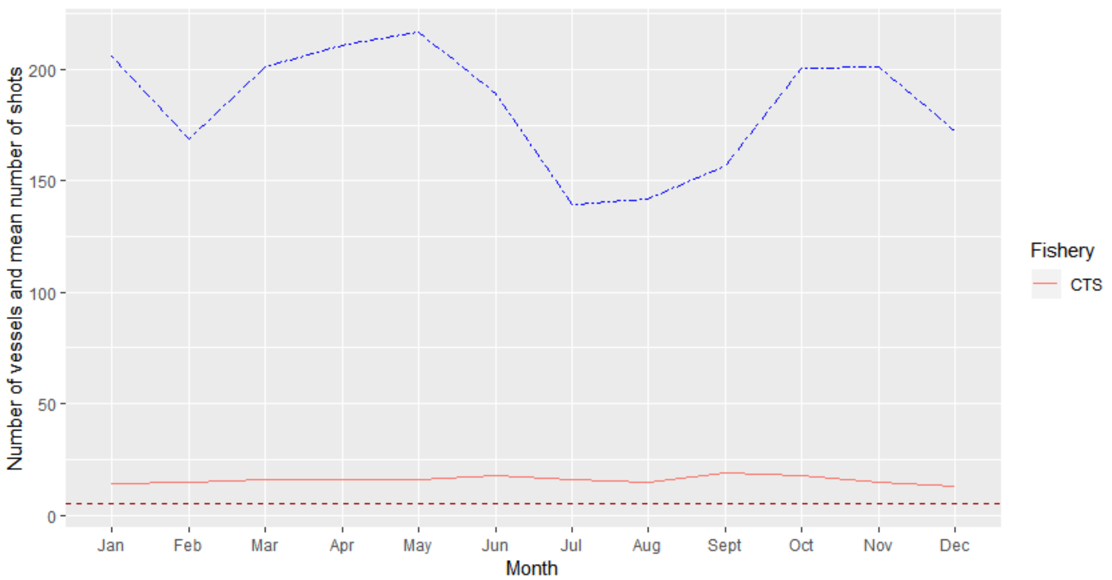


Figure 29. Number of vessels that recorded effort (red solid line) and average number of shots recorded (blue dashed lines) each month within the revised MSS area from 2008–2009 to 2017–2018 for otter trawl and Danish seine vessels in the CTS. Note the minimum number of vessels in any one month was more than 5. The horizontal red line intercepts the y-axis at 5. Note that data from otter trawl and

Danish seine vessels cannot be separated without compromising the 5-boat rule. Original data source: AFMA.

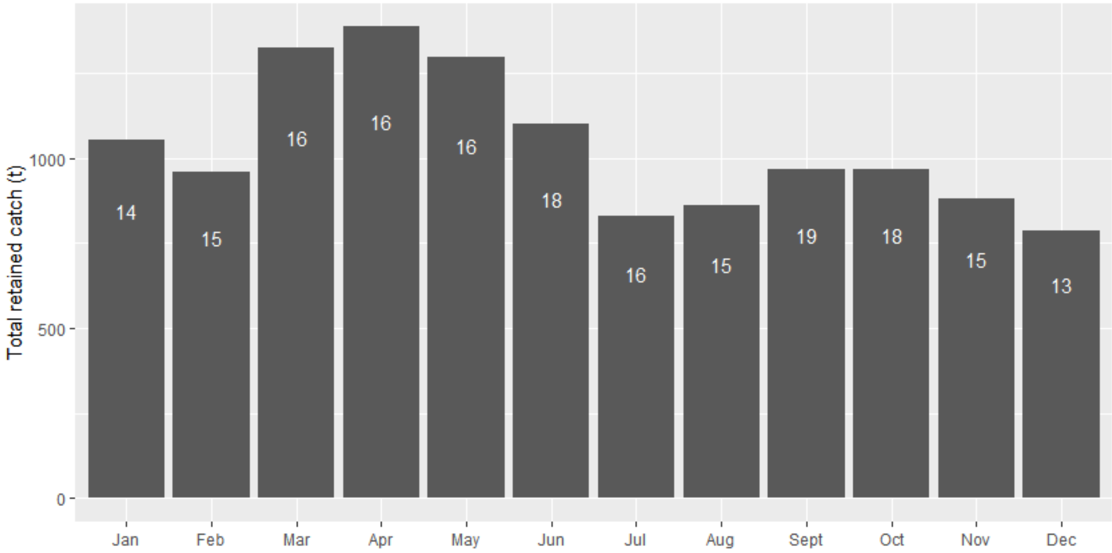


Figure 30. Total monthly (2008–2009 to 2017–2018) retained catch by the CTS in the revised MSS area. Note the minimum number of vessels in any one month was 13. Number of vessels is annotated on bars. Original data source: AFMA.

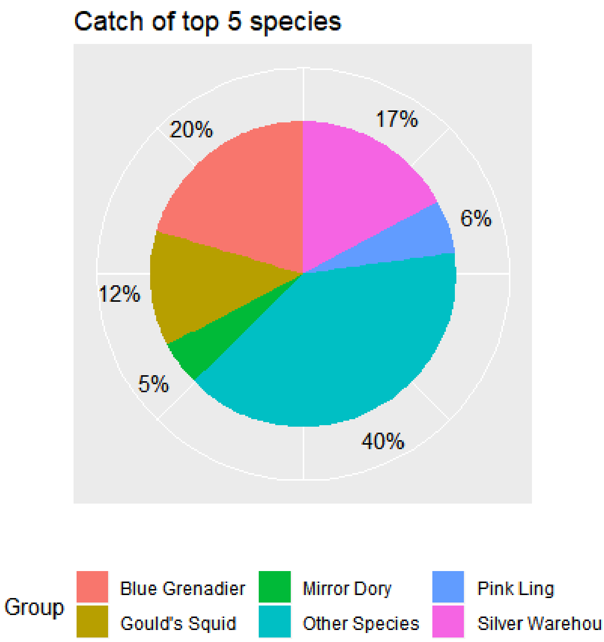


Figure 31. Main species caught by the CTS in the revised MSS area. Note the minimum number of vessels in any species was 18. Original data source: AFMA.

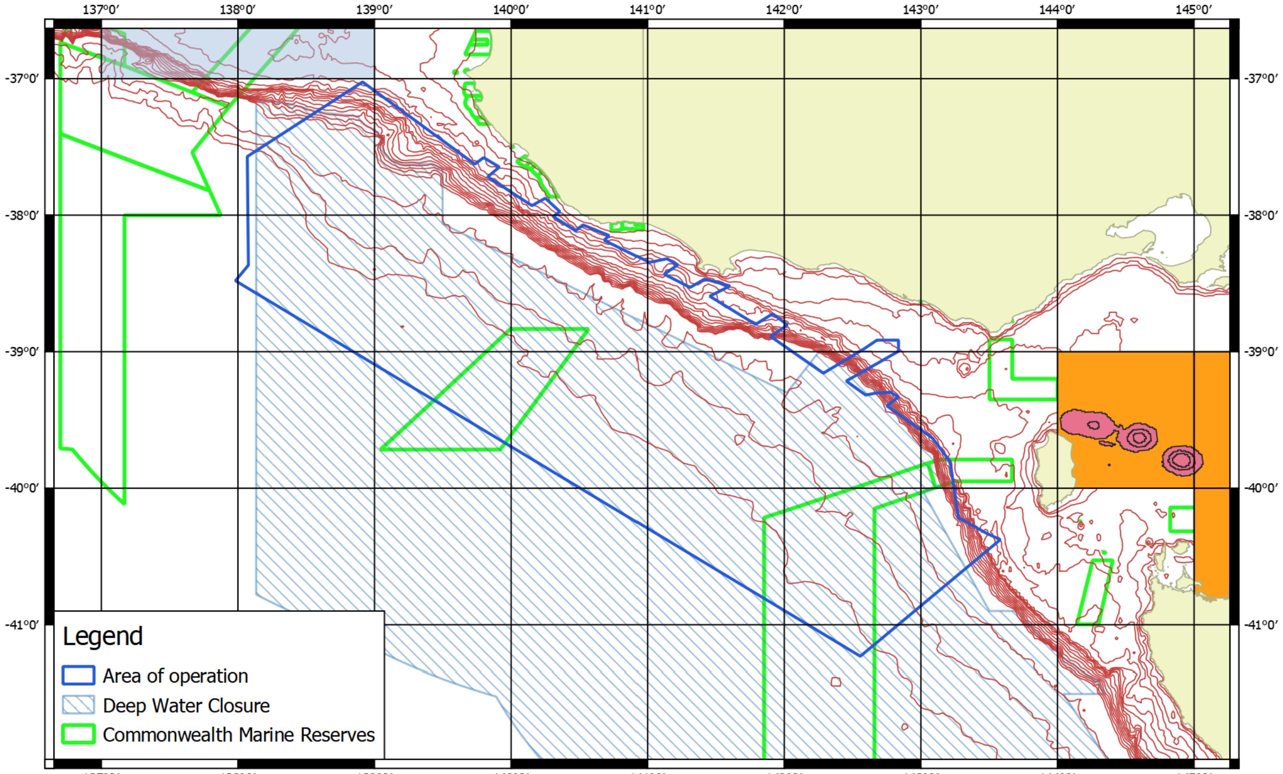


Figure 32. Deepwater closure and Commonwealth Marine Reserves in the revised MSS area.

6.3. Shark Gillnet and Shark Hook Sector (SGSHS)

The SGSHS extends from the South Australian / Western Australian border to the Victorian / NSW border (Figure 33). The SGSHS targets Gummy Shark using demersal gillnets and demersal longlines (including auto-longlines) and is restricted to waters shallower than 183 m. Both gear types were used in one degree boxes that overlap with the revised MSS area during 2017–18 (Figure 36, Figure 37), and there has also been historical records of effort in that area (Figure 35).

These SGSH sectors landed 2,216 t of shark in 2017–18, and had a GVP of $20.23 million in 2016–17 (Patterson *et al*, 2018). During 2017–18 there were 38 active SGSHS vessels operating gillnets and 38 vessels using demersal longlines (Patterson *et al*, 2018).

Overlap between SGSHS grounds and the area of the proposed seismic survey area

Catch in the SGSHS peaked at more than 4,000 t during 1986, and effort peaked in the following year at about more about 120,000 km-lifts (Figure 34). Catch and effort has decrease considerably since, mainly due to declining stocks of School Shark, conservative School Shark management arrangements to promote recovery of that species, and removal of effort through Government-led structural adjustments and closures. Despite this decrease, Gummy Shark landings have increased from 1,288 t in 2012–2013 to 1,744 t in 2017–2018.

Figure 36 and Figure 37 shows there was effort around the revised MSS area using both demersal gillnets and demersal longlines. A summary of catch and effort from the revised MSS area by shark gillnet and shark longlines combined is shown in Table 5. Over 2008–2009 to 2017–2018, a total of 43 different SGSHS vessels fished in the revised MSS area. From 1,124 shots, 208 t with an estimated value of $1.323 million was caught from the revised MSS area. Main species caught were Gummy Shark (68%), School Shark (18%), and Common Sawshark (4%) (Table 5 and Figure 43).

The number of vessels fishing in the area of operation in any one year since 2008 ranged 9 to 15 (Figure 38). Annual effort in the revised MSS area doubled between 2011 and 2013, and has since remained relatively high. Annual catch has increased from 10–20 t during 2008–2009 to 2015–2016 to more than 35 t in 2017–2018 (Figure 39). Because of the small number of species dominating the catch, annual value closely follows catch in increasing from about $100,000 to more than $200,000 in 2017–2018 (Figure 40).

Monthly effort in the SGSHS was highest from April to June, and lowest in July to September (Figure 41). Mean monthly effort ranged 4 shots per month in July to 20 shots per month in June. Catch weight was also highest in June and lowest in July (Figure 42).

Likelihood of fishing grounds developing in the future

Of the 61 shark gillnet and 13 hook fishing permits available, only 38 gillnet and 38 hook vessels were used during 2017–18, offering considerable latent effort in the fishery (Patterson *et al*, 2018). However, 91% of the Gummy Shark TAC was caught during that season, and would likely be a limiting factor in the expansion of effort. Given that most of the TAC for Gummy Shark is caught, it is unlikely that there will be a significant increase in fishing effort in that area in the near future.

There are two industry associations that represent SGSHS, the Sustainable Shark Fishing Association and the Southern Shark Industry Alliance. Contact details for these industry associations are provided in Table 20.

Table 5. SGSH effort, catch, catch value and main species caught within the AFMA data area. Original data source: AFMA.

Years included	2008–2017
Number of different vessels	43
Total shots	1124
Total catch (t)	208 t
Total value	$1,323,354
Main species caught	Gummy Shark (68%)
	School Shark (18%)
	Common Sawshark (4%)
Fishing methods used	Gillnet
	Longline

Figure 33 Shark Hook and Gillnet Sector (AFMA, 2018a).

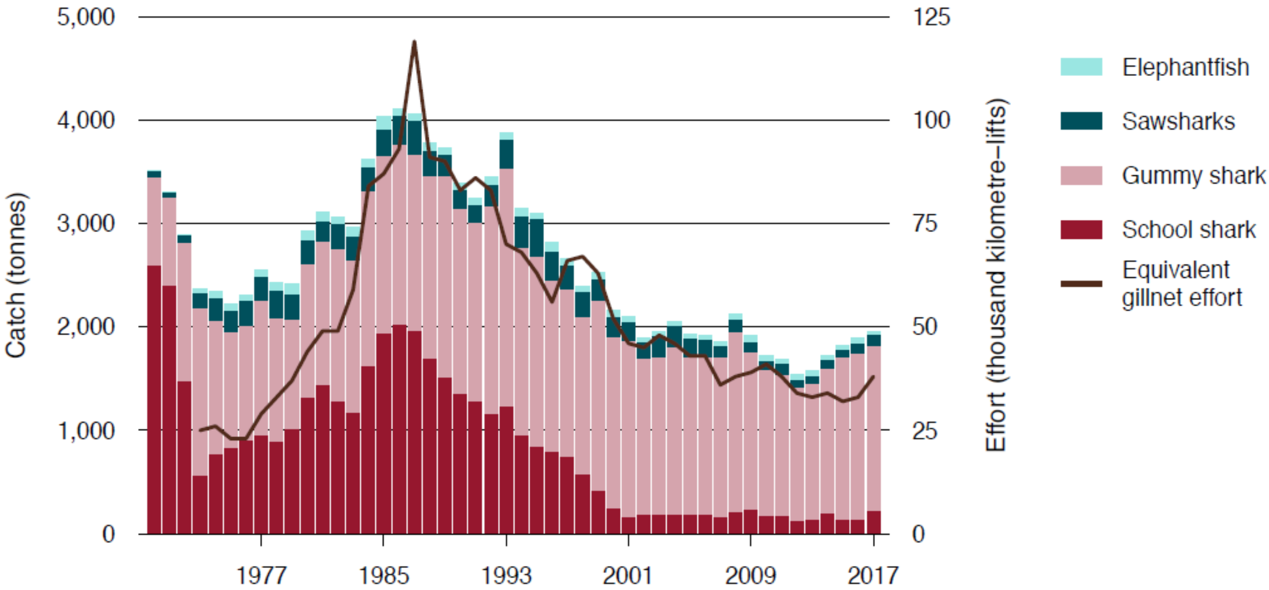


Figure 34. Catch and effort in the SGSHS 1970–17 (Patterson *et al*, 2018)

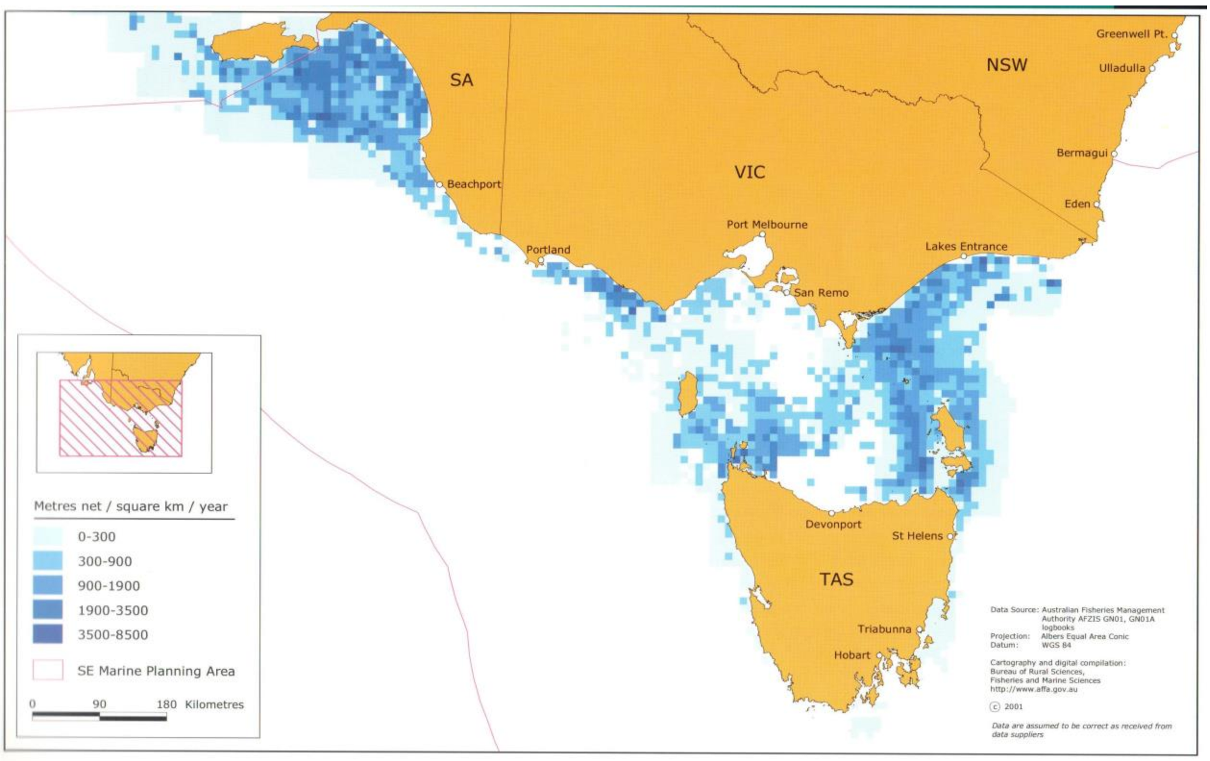


Figure 35. Fishing effort (metre of net/square km/year) of the Commonwealth Gillnet Fishery in south east Australia 1995 – 99 (Larcombe *et al*, 2002).

GHAT - Shark Gillnet 6/12/2218

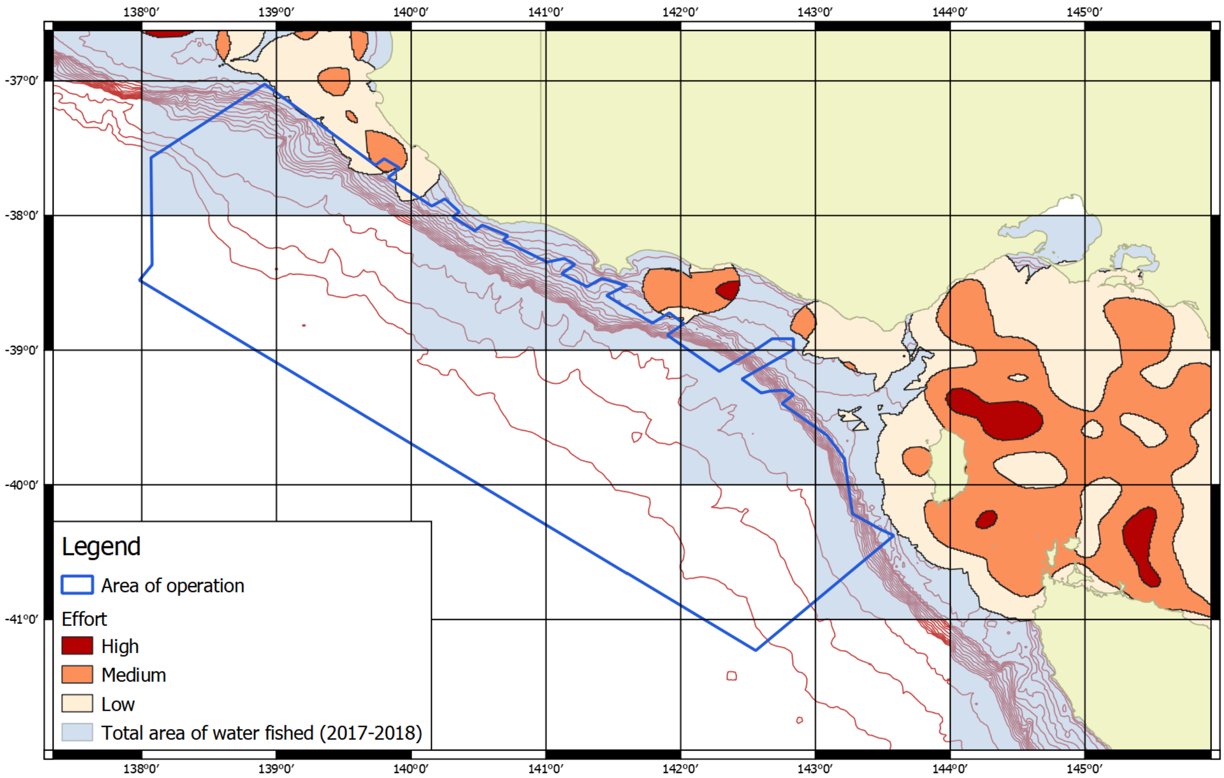


Figure 36. Relative fishing intensity by the Shark Gillnet Sector during 2017–2018 in relation to the revised MSS area. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

GHAT - Shark Longline 6/12/2218

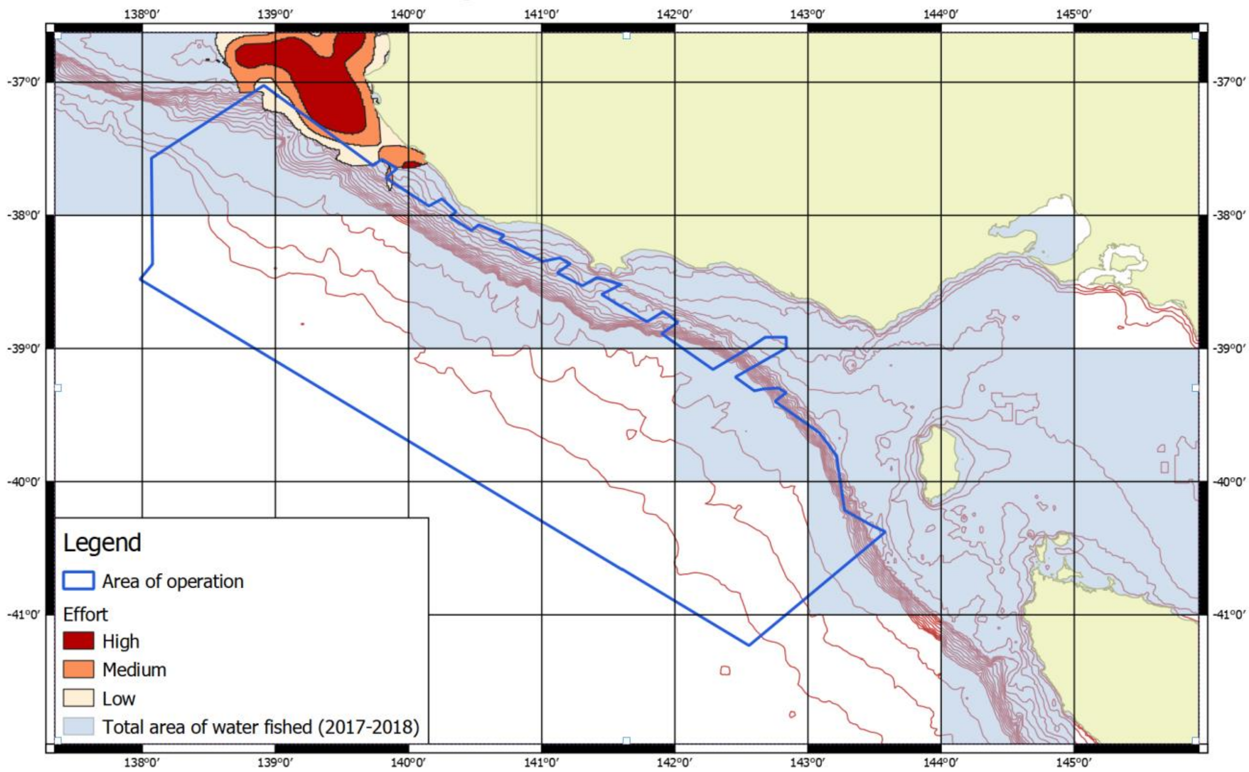


Figure 37. Relative fishing intensity by the Shark Hook Sector in relation to the revised MSS area during 2017–2018. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

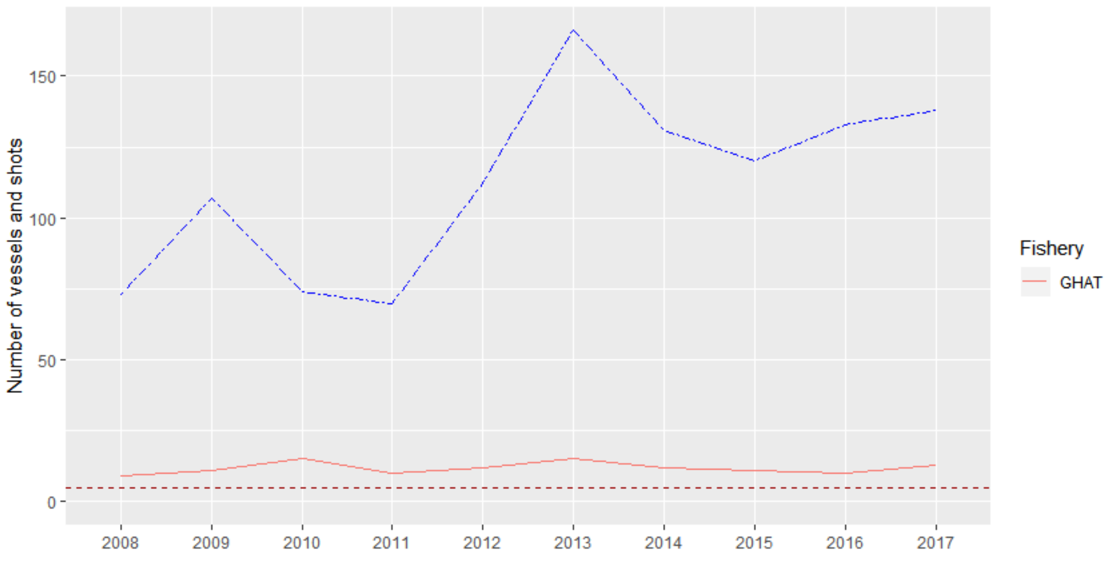


Figure 38. Number of vessels that recorded effort (red solid line) and number of shots recorded (hundreds, blue dashed lines) within the revised MSS area in each financial year from 2008-2009 to 2017-2018 by the Shark Gillnet and Shark Hook vessels in the GHAT. Note the minimum number of vessels in any one year shown was 9. The horizontal red line intercepts the y-axis at 5. Original data source: AFMA.

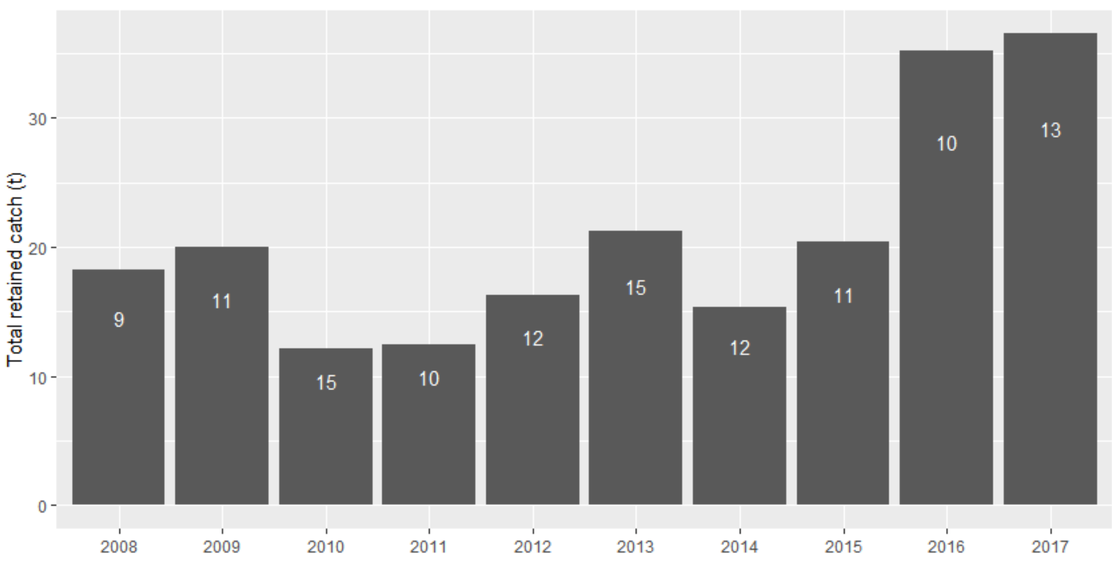


Figure 39. Annual retained catch within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by the Shark Gillnet and Shark Hook vessels in the GHAT. Note the minimum number of vessels shown in any one year was 9. Number of vessels is annotated on bars. Original data source: AFMA.

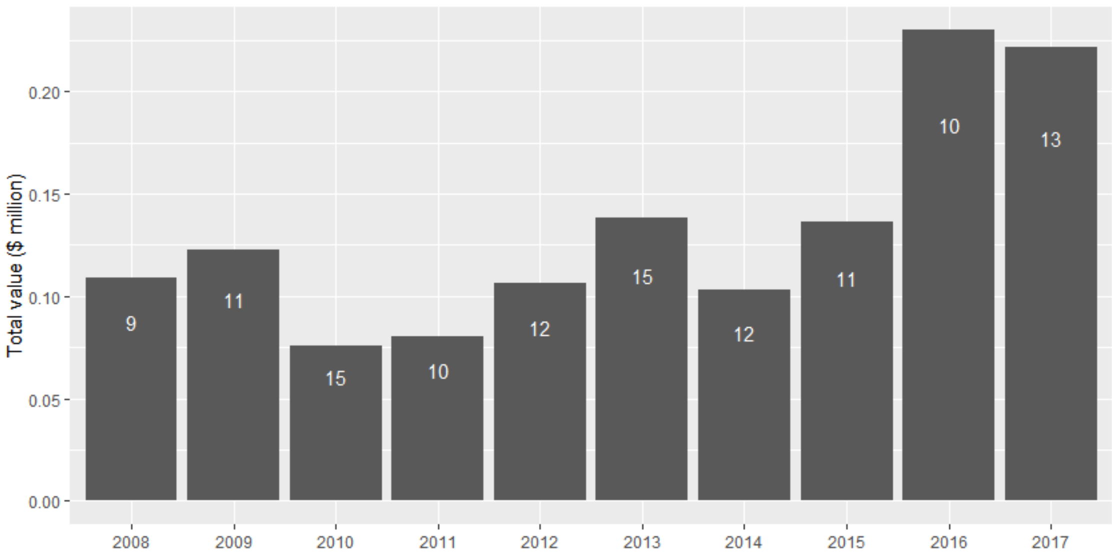


Figure 40. Estimated annual value ($ million) of fish landed within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by Shark Gillnet and Shark Hook vessels in the GHAT. Note the minimum number of vessels shown in any one year was 9. Number of vessels is annotated on bars. Original data source: AFMA.

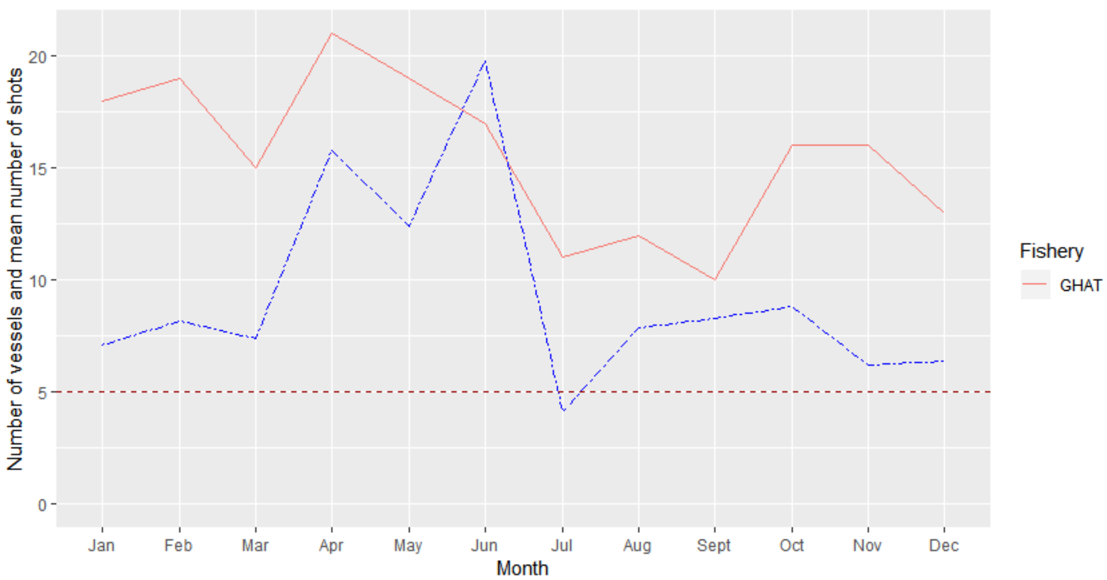


Figure 41. Number of vessels that recorded effort (red solid line) and mean number of shots per month (blue dashed lines) within the revised MSS area in each month from 2008–2009 to 2017–2018 by the Shark Gillnet and Shark Hook subsectors of the GHAT. Note the minimum number of vessels shown in any one year was 10. Number of vessels is annotated on bars. Original data source: AFMA.

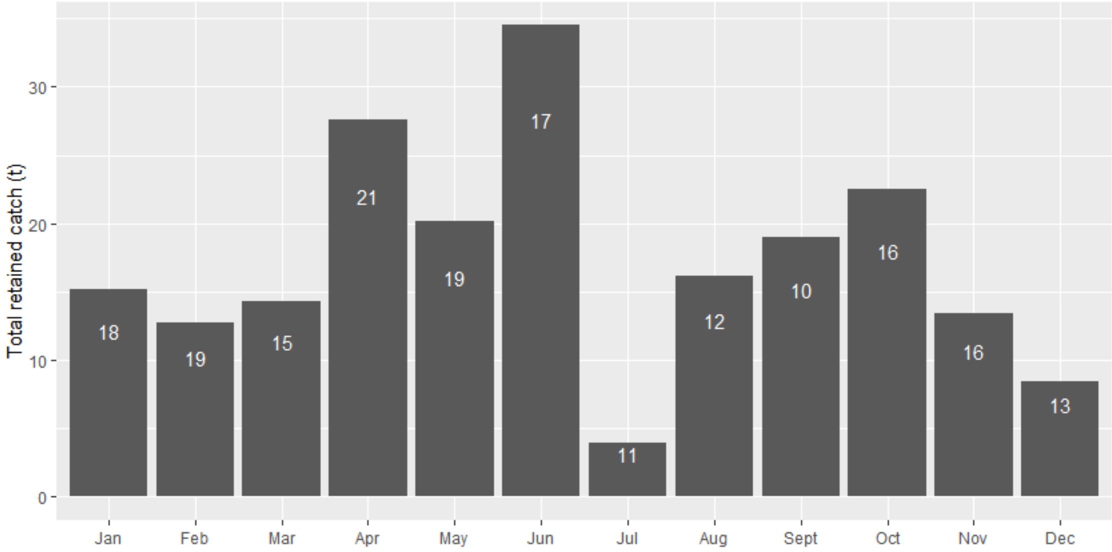


Figure 42. Total monthly (2008–2007 to 2017–2018) retained catch by the Shark Gillnet and Shark Hook sectors of the GHAT in the revised MSS area. Note the minimum number of vessels shown in any one year was 11. Number of vessels is annotated on bars. Original data source: AFMA.

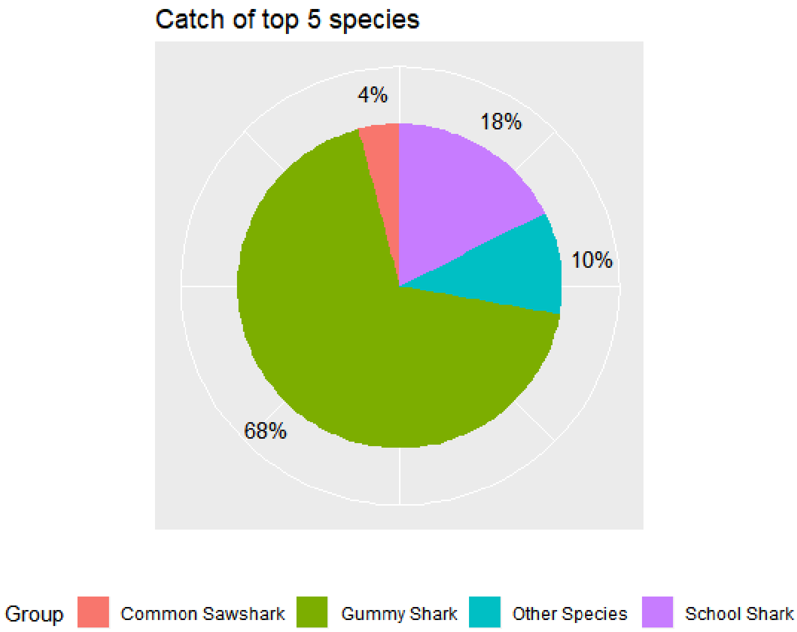


Figure 43. Main species caught during 2008–2017 in the revised MSS area in each financial year from 2008–2009 to 2017–2018 by the Shark Hook and Shark Gillnet subsectors of the GHAT. Note the minimum number of vessels shown in any one year was 20. Original data source: AFMA.

6.4. Scalefish Hook Sector (SHS)

The SHS extends from the South Australian / Western Australian border, around south-east Australia and up the east coast to latitude 24°29′54″S (Figure 44). The SHS targets Pink Ling and Blue-eye Trevalla using demersal longlines (including auto-longline) and droplines, and the use of auto-longline is restricted to waters deeper than 183 m. The SHS operated in 1-degree boxes that overlap with the revised MSS area during 2017–2018 (Figure 46).

This sector landed about 650 t of fish in 2017–2018 (Figure 45), and had a GVP of $6.41million in 2016–17 (Patterson *et al*, 2018). During 2016–17 there were 29 active SHS vessels operating in the fishery from the 37 boat SFRs allocated (Patterson *et al*, 2017).

Overlap between SHS grounds and the area of the proposed seismic survey area

From 2008–2017, 26 SHS vessels caught 471 t of fish from the revised MSS area valued at about $3.8 million from 590 longline, auto-longline and dropline shots (Table 6). Main species caught were Blue-eye Trevalla (51%), Pink Ling (21%) and Hapuka (10%).

Catch in the SHS peaked at just over 1,500 t during 2004, and effort peaked in the following year at about more about 10,000,000 hook-lifts (Figure 45). Catch and effort has decreased considerably since 2005 largely due to decreasing TACs and removal of effort through Government-led structural adjustments and closures.

The number of fishers that recorded effort in the revised MSS area ranged 5–10 during 2009–2010 to 2017–2018, and there were less than 5 fishers in 2008, so the data for that year has been omitted (Figure 47). Annual catch ranged from just over 80 t in 2009–2010 to just 10 t in 2011–2012, but in most years ranged 40 t to 60 t (Figure 48). The value of the catch was nearly $700,000 in 2009–2010, but only about $90,000 in 2011 (Figure 49).

Most effort during 2008–2009 to 2017–2018 took place during March–April and October–November (Figure 50). February and November were the months over that time period with the highest catches (Figure 51).

Likelihood of fishing grounds developing in the future

While there were 8 inactive boat SFRs in the fishery during 2017/18 which potentially harbours considerable latent effort, (Patterson *et al*, 2018), in the 2017–18 season, of the two main target species of the SHS, 74% of the Blue-eye Trevalla and 82% of the Pink Ling TAC was caught. The TACs would likely be a limiting factor in the expansion of effort, however considerable latent effort has become active since 2016–17 when there were only 17 active Scalefish Hook Vessels.

Table 6. SHS effort, catch, catch value and main species caught within the AFMA data area. Original data source: AFMA.

Years included	2008–2017
Number of different vessels	26
Total shots	590
Total catch (t)	471 t
Total value	$3,772,730
Main species caught	Blue-eye Trevalla (51%) Pink Ling (21%) Hapuka (10%)
Fishing methods used	Auto-longline Dropline Longline

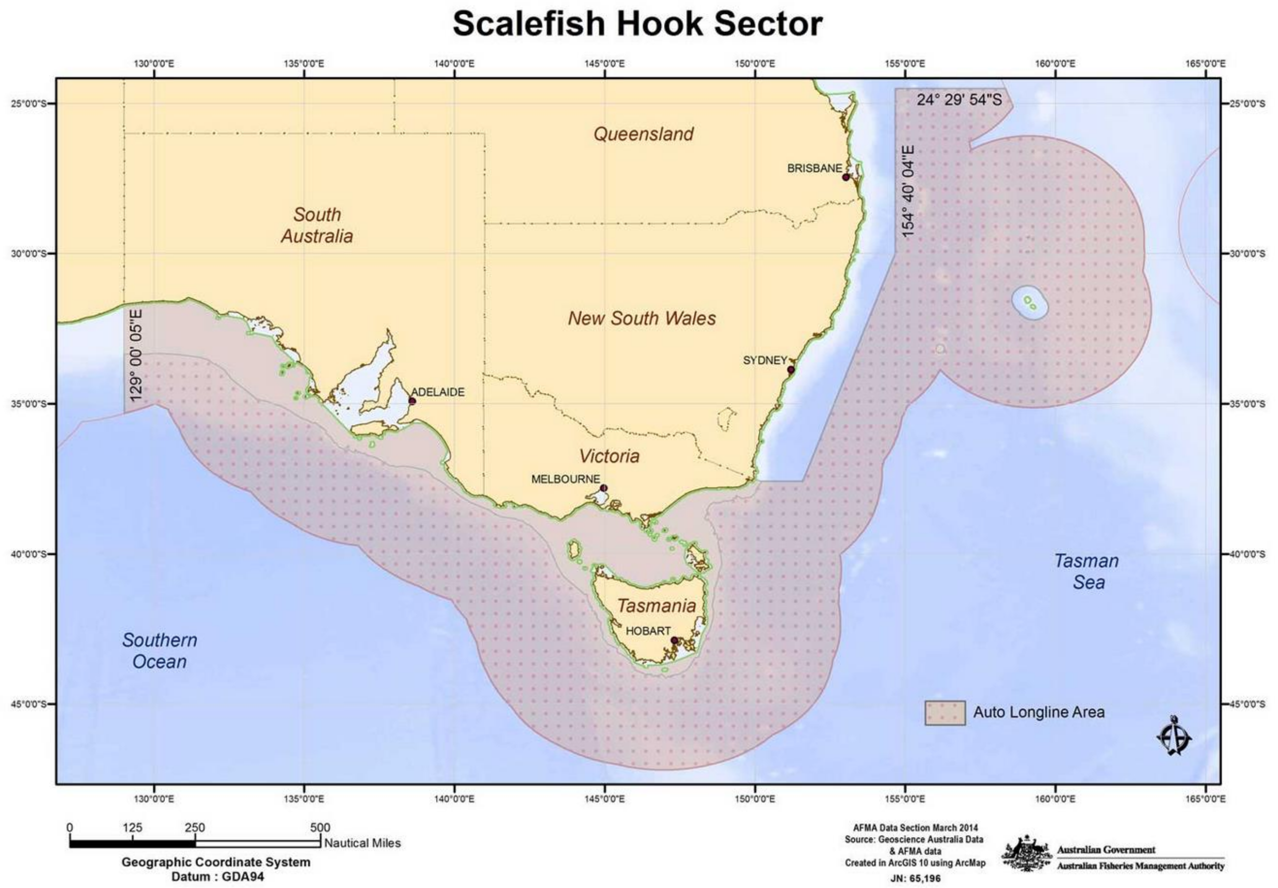


Figure 44. Scalefish Hook Sector (AFMA, 2018a).

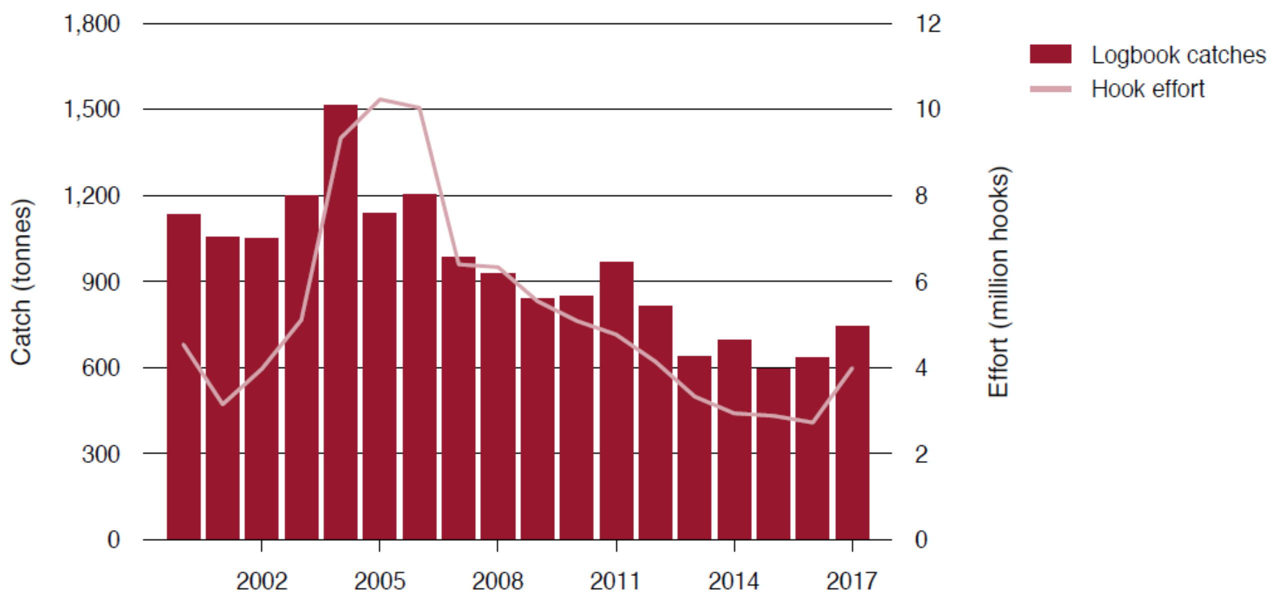


Figure 45. Catch and effort in the SHS 1970–17 (Patterson *et al*, 2018)

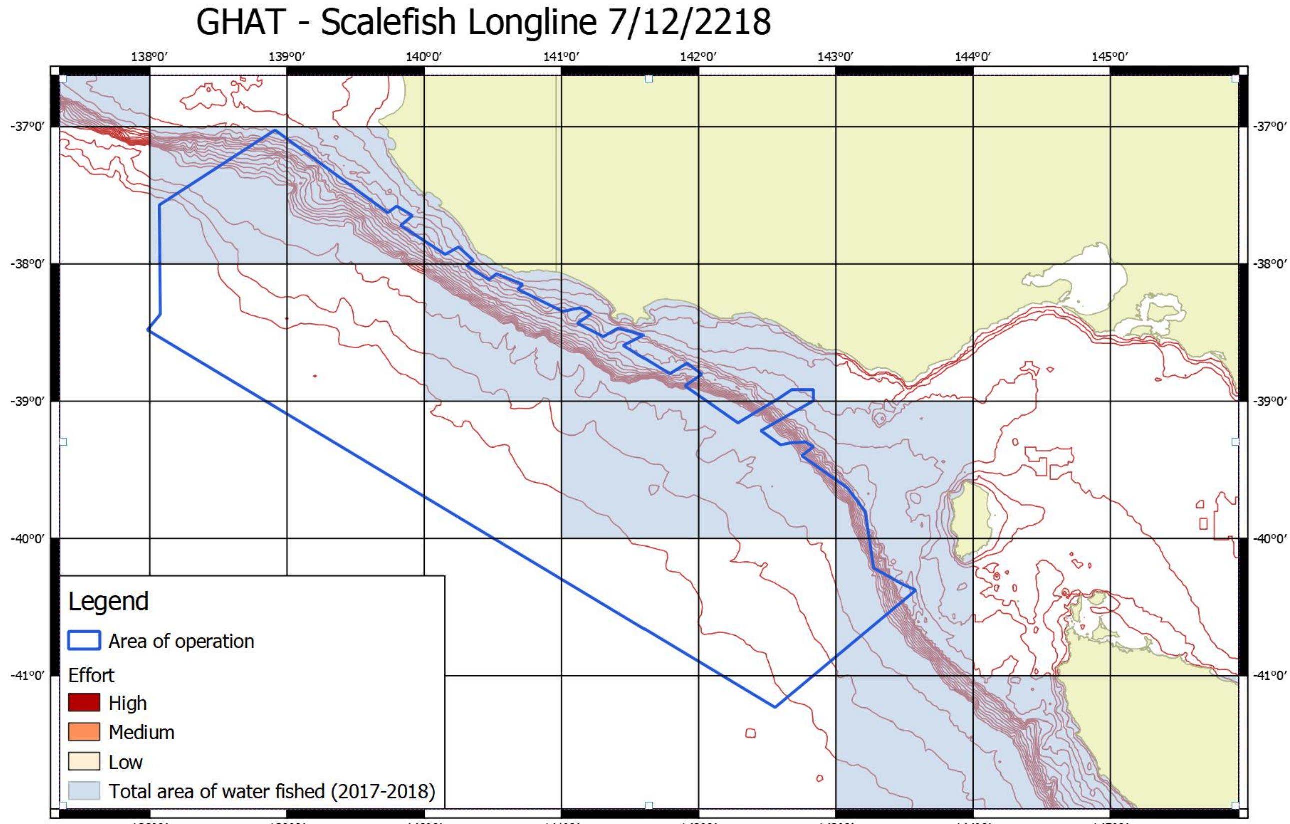


Figure 46. Area fished by the Scalefish Hook Sector in relation to the revised MSS area during 2017–18. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

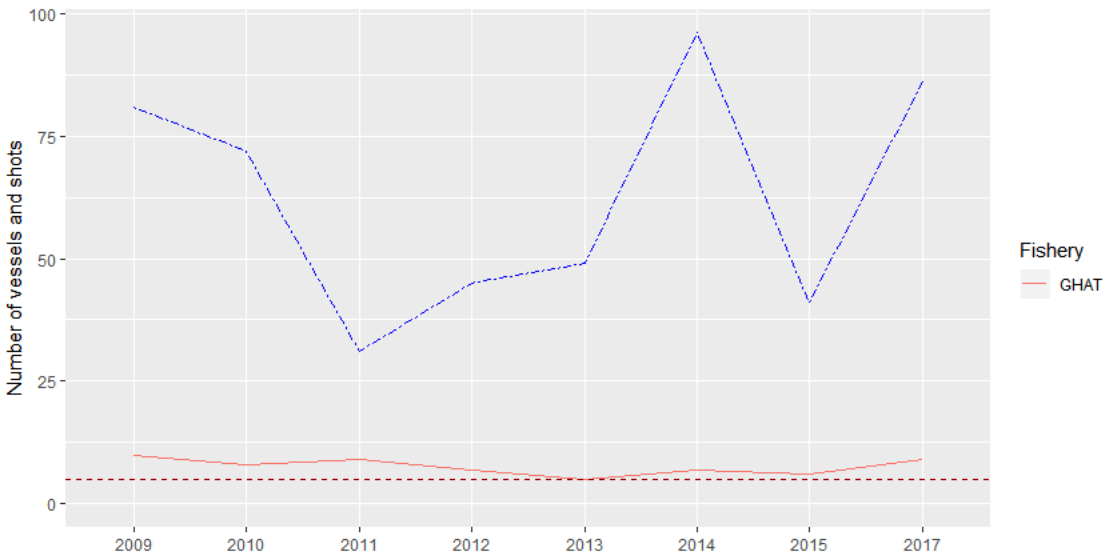


Figure 47. Number of vessels that recorded effort (red solid line) and number of shots recorded (hundreds, blue dashed lines) within the revised MSS area in each financial year from 2008-2009 to 2017-2018 by Scalefish Hook vessels in the GHAT. Note the minimum number of vessels in any one year shown was 5, and the 2008–2009 data point was omitted to maintain confidentiality. The horizontal red line intercepts the y-axis at 5. Original data source: AFMA.

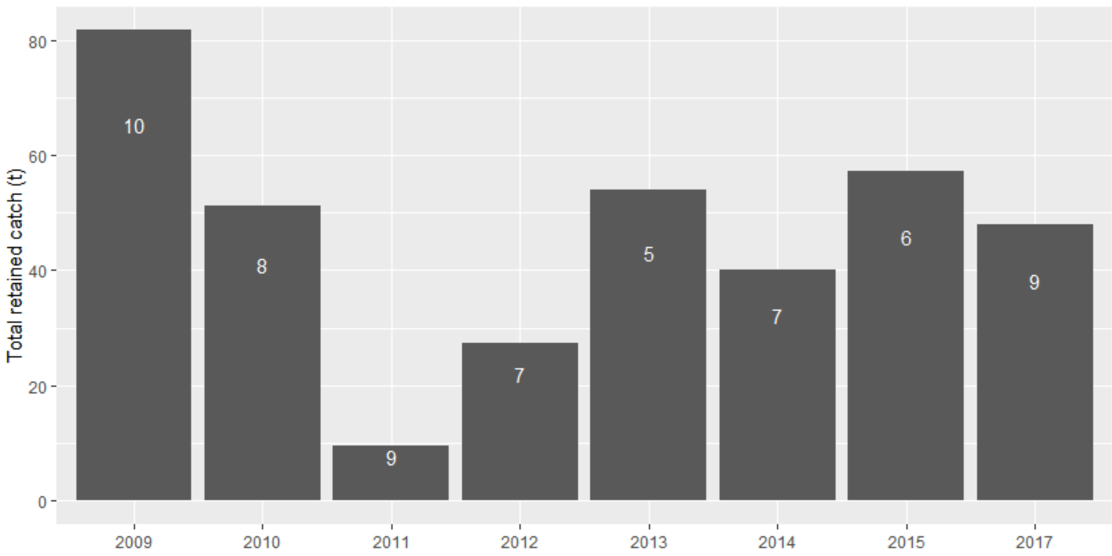


Figure 48. Annual retained catch within the revised MSS area in each financial year from 2008-2009 to 2017-2018 by the Scalefish Hook vessels in the GHAT. Note the minimum number of vessels shown in any one year was 5, and the 2008–2009 data point was omitted to maintain confidentiality. Number of vessels is annotated on bars. Original data source: AFMA.

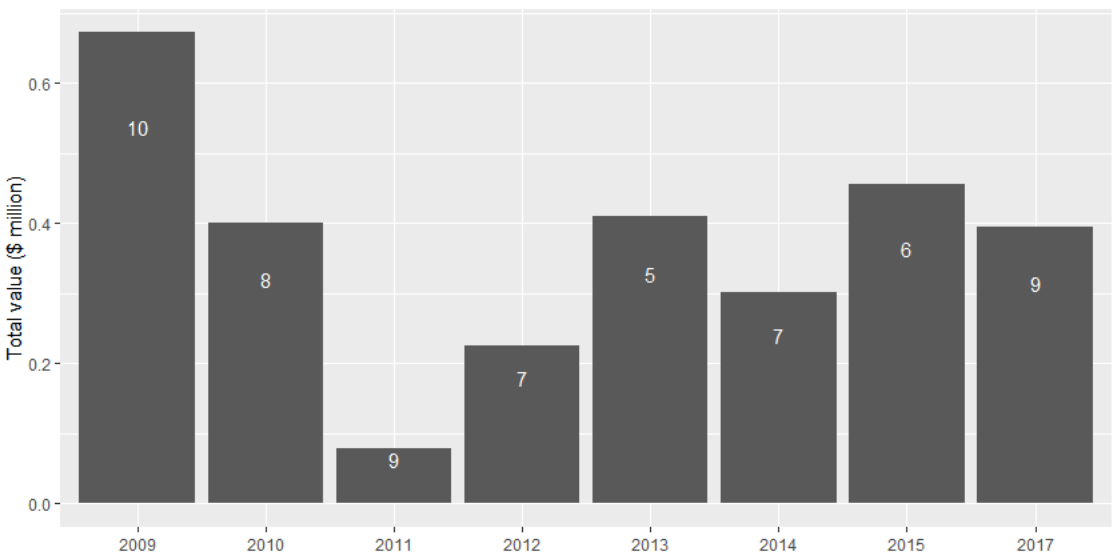


Figure 49. Estimated annual value ($ million) of fish landed within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by Scalefish Hook vessels in the GHAT. Note the minimum number of vessels shown in any one year was 5, and the 2008–2009 data point was omitted to maintain confidentiality. Number of vessels is annotated on bars. Original data source: AFMA.

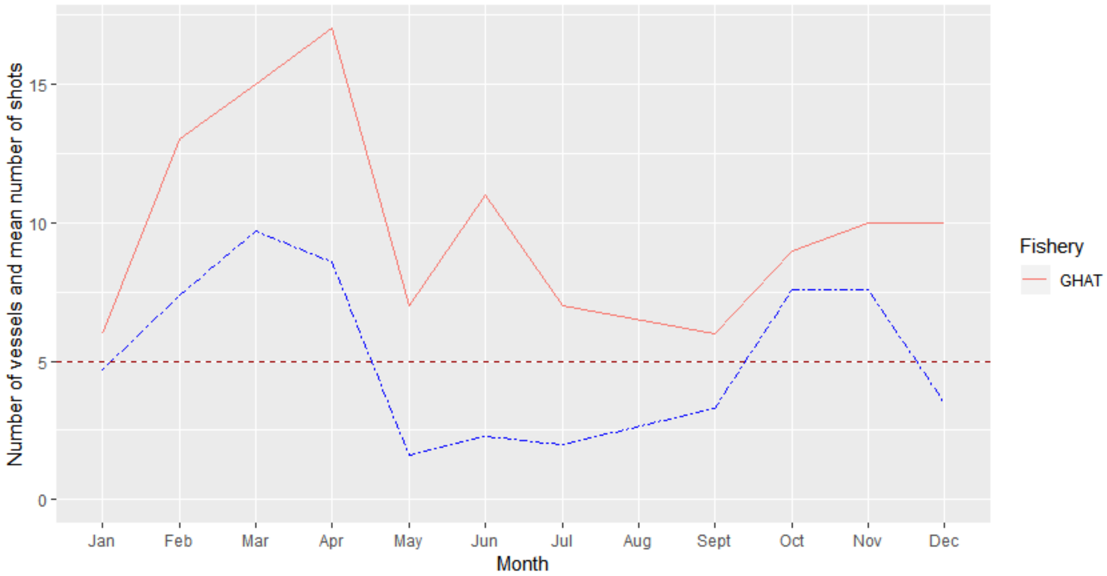


Figure 50. Number of vessels that recorded effort (red solid line) and number of shots recorded (hundreds, blue dashed lines) within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by Scalefish Hook vessels in the GHAT. Note the minimum number of vessels in any one year shown was 6, and the August data point has been omitted to protect confidentiality. The horizontal red line intercepts the y-axis at 5. Original data source: AFMA.

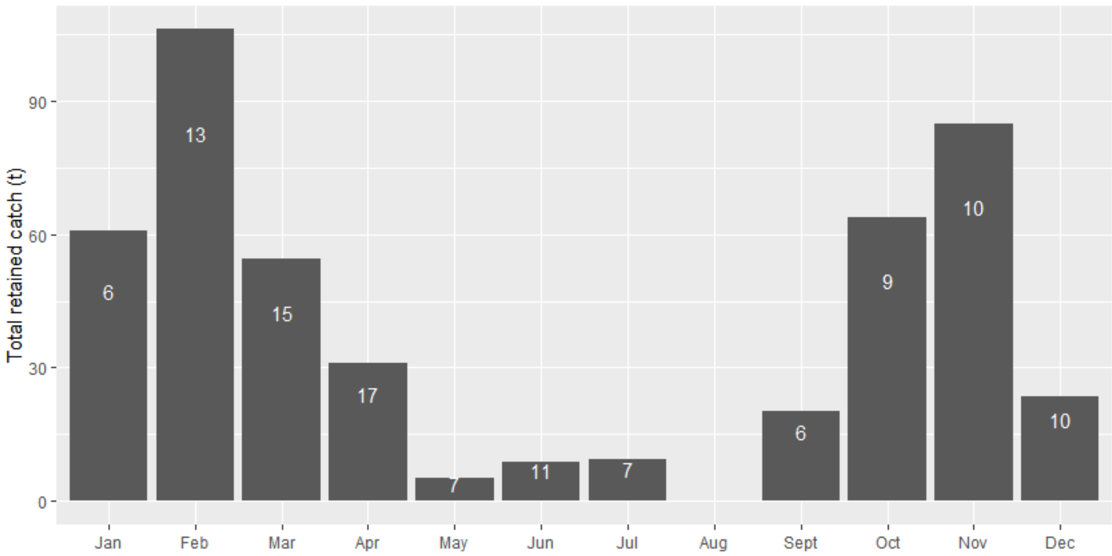


Figure 51. Total monthly (2008–2007 to 2017–2018) retained catch by the Scalefish Hook sectors of the GHAT in the revised MSS area. Note the minimum number of vessels shown in any one year was 6, and the August data point has been omitted to protect confidentiality. Number of vessels is annotated on bars. Original data source: AFMA.

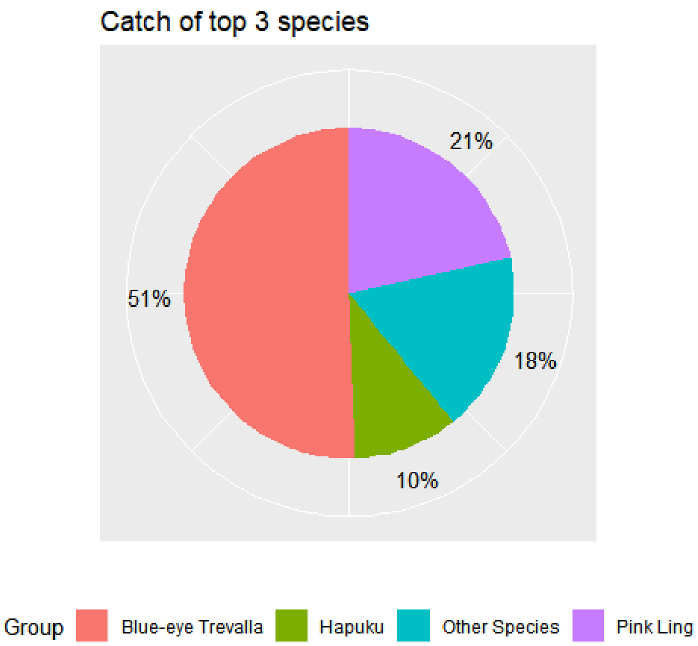


Figure 52. Main species caught by the GHAT (Scalefish Hook Sector) during 2008–2017 in the revised MSS area in each financial year from 2008-2009 to 2017-2018. Note the minimum number of vessels shown in any one year was 14. Number of vessels is annotated on bars. Original data source: AFMA.

6.5. Southern Squid Jig Fishery

The SSJF operates in Commonwealth waters off South Australia, Victoria, Tasmania, New South Wales and parts off Queensland (Figure 53), with most of the fishing effort occurring off the south-east of Australia. This fishery targets a single species — Gould's Squid — using either hand operated or mechanically powered jigs (Patterson *et al*, 2018).

Both fishing effort and the number of vessels participating in the fishery have declined significantly since 1996 (Figure 54). Poor domestic prices and high fuel costs have resulted in many operators choosing to avoid fishing for squid (Wilson *et al*, 2009), and consequently, there were only eight active vessels out of 36 concessions (80% latency) used during 2017 (Patterson *et al*, 2018). Together they landed 213 t of squid with a GVP of $0.57 million (Figure 55).

Overlap between SSJF Grounds and seismic survey footprint

Some fishing effort was reported in the SSJF during 2017–2018 from the revised MSS area(Figure 56) but for that year, the small number of operators means that a detailed map of effort cannot be presented because it would contravene the privacy policy. From 2008–2019 to 2017–2018, 11 vessels recorded 43 days fishing in the revised MSS area, catching 73 t of Gould's Squid valued at about $148,000 (Table 7).

Catch and effort in the SSJF is highly variable both spatially and temporally, and there was only two years in which 5 vessels fished in the revised MSS area (Figure 57). Annual catch in the revised MSS area for those two year were 11 t in 2010 and 2 t in 2011 (Figure 58), valued at just over $20,000 and $4,000 respectively (Figure 59).

The SSJF is highly seasonal, with most catch and effort from January–June, however monthly data from the revised MSS area cannot be reported because it would contravene the 5 boat rule.

Likelihood of fishing grounds developing in the future

The development of this fishery will depend on squid prices and the cost of fishing in Australia. Being short lived, squid are a "boom or bust" fishery, and if environmental conditions are right, fishing effort could increase greatly in a short amount of time. Very recent anecdotal information suggests that the price for Gould's Squid has increased, and this has resulted in a significant increase in effort in the fishery in recent years. It is uncertain if this effort is taking place inside the areas of interest.

There is no SSJF Fishery Association but we have provided contact details for some operators in the fishery Table 21.

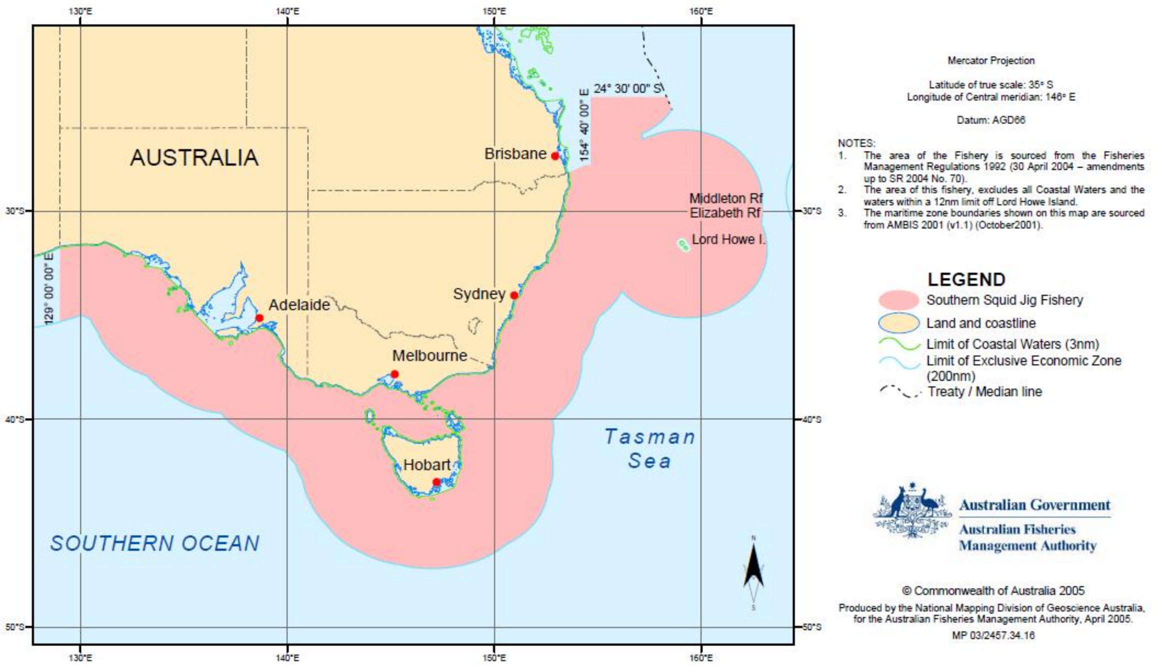
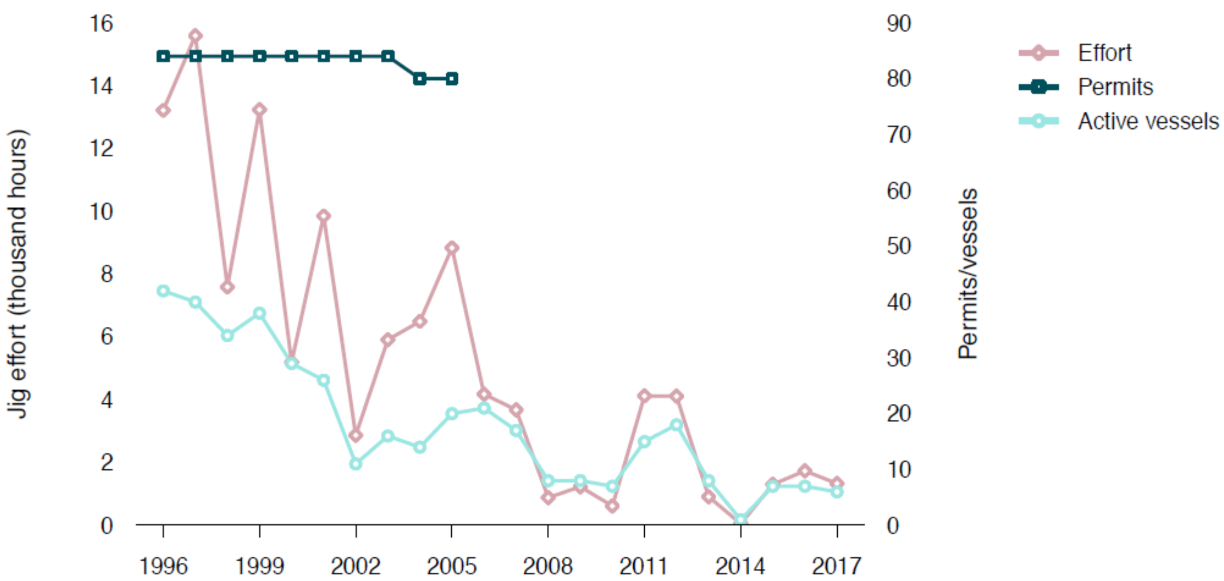
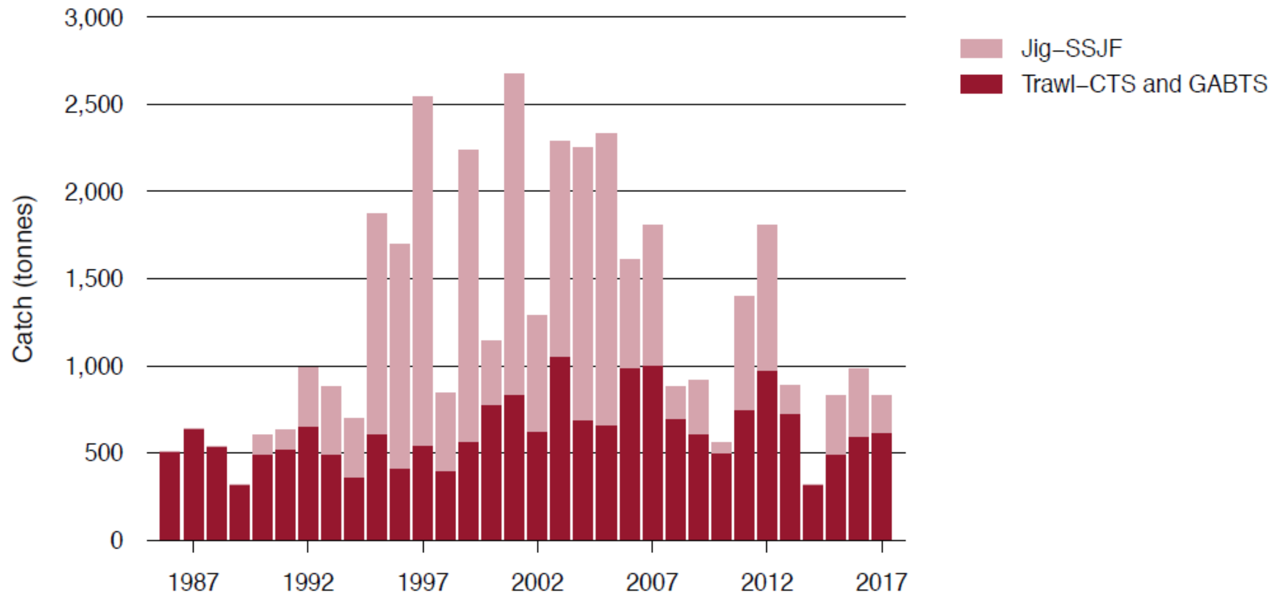


Figure 53 Area of the Southern Squid Jig Fishery (AFMA, 2018a).



Note: Permits were replaced by gear statutory rights in 2005.

Figure 54. Number of permits, active vessels and fishing effort by the SSJF from 1996–2016 (Patterson *et al*, 2018).



Notes: **CTS** Commonwealth Trawl Sector. **GABTS** Great Australian Bight Trawl Sector. **SSJF** Southern Squid Jig Fishery.

Figure 55. Catch and effort by the SSJF, CTS and GABTS from 1986–17 (Patterson *et al*, 2018).

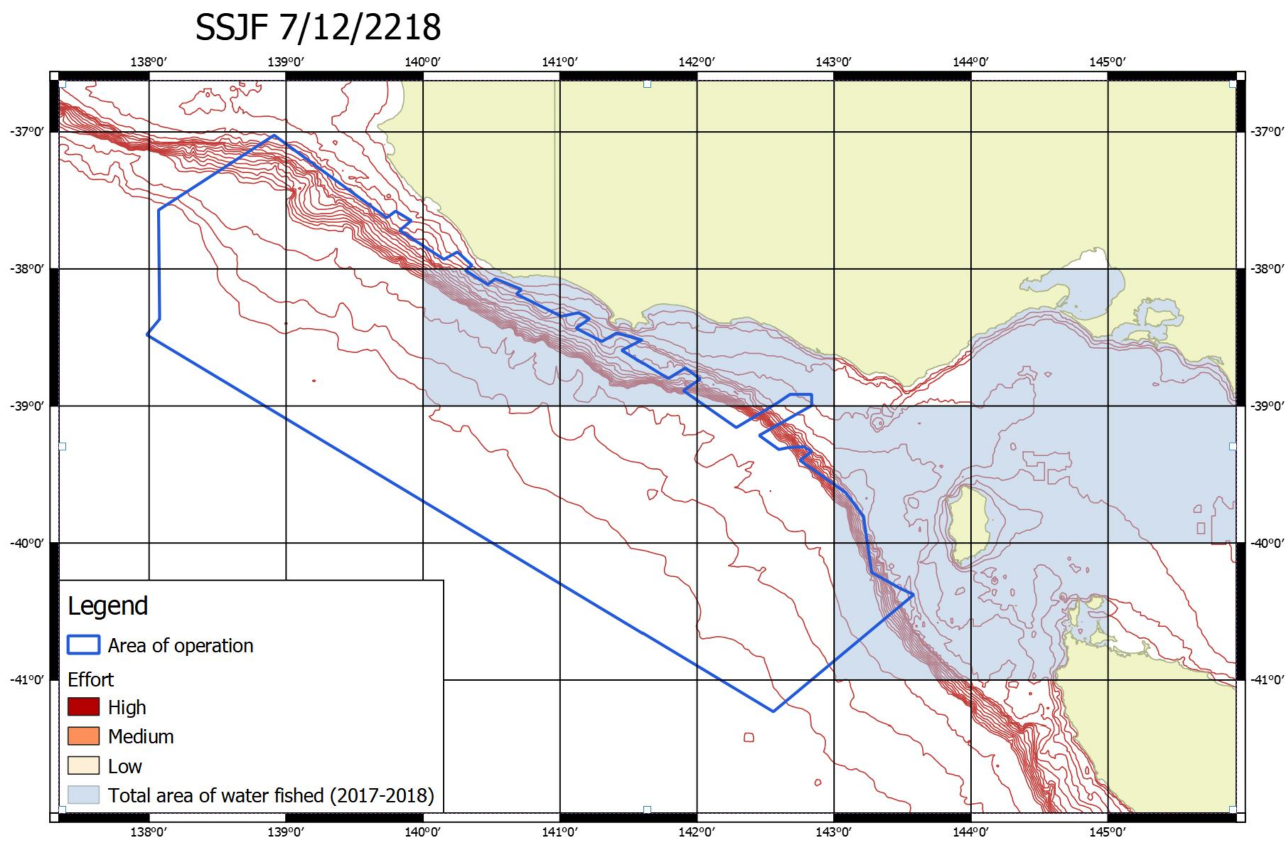


Figure 56 Area fished by the Southern Squid Jig Fishery in relation to the revised MSS area during 2017. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

Table 7. SSJF effort, catch, catch value and main species caught within the AFMA data area. Original data source: AFMA.

Years included	2008–2017
Number of different vessels	11
Total days fished	43
Total catch (t)	73
Total value	$147,971
Main species caught	Gould's Squid
Fishing methods used	Squid jig

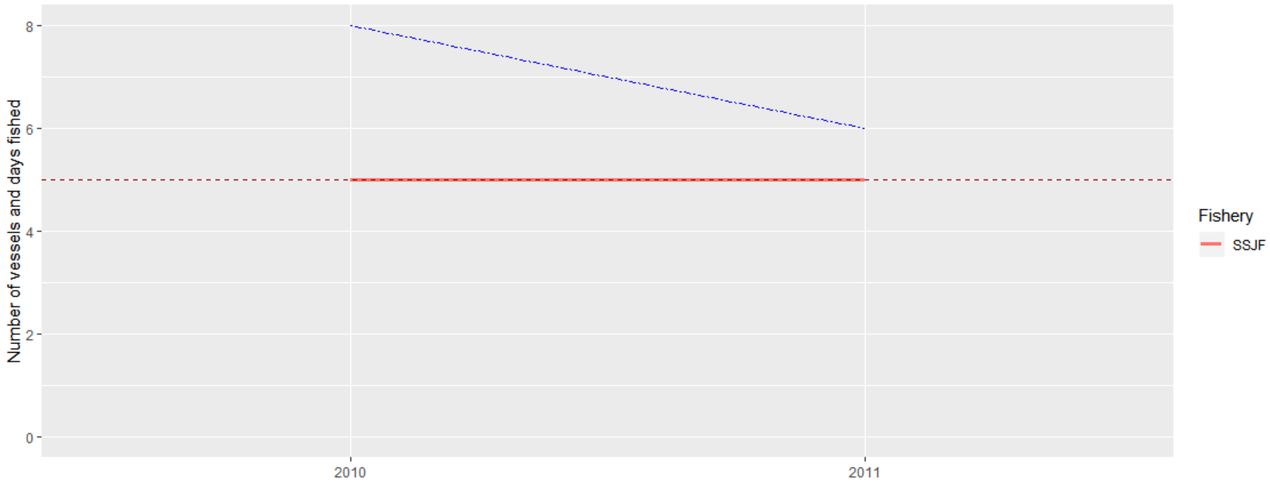


Figure 57. Number of vessels that recorded effort (red solid line) and number of days fished recorded (blue dashed lines) within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by the Southern Squid Jig Fishery. Note the minimum number of vessels in any one year shown was 5, and data from some years were omitted because they comprised less than 5 vessels. The horizontal red line intercepts the y-axis at 5. Original data source: AFMA.

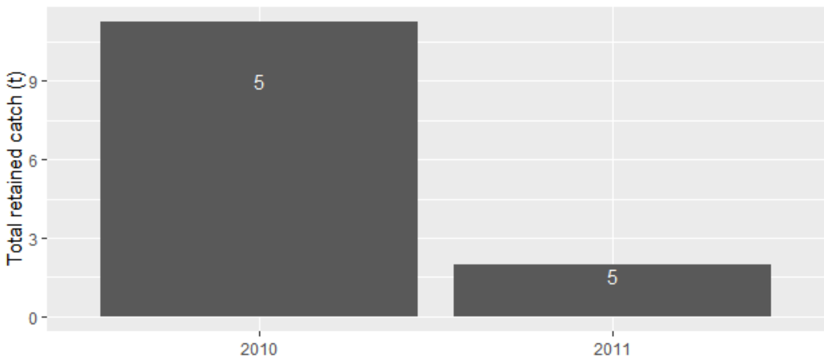


Figure 58. Annual catch weight within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by the Southern Squid Jig Fishery. Note the minimum number of vessels shown in any one year was 5, and missing values were omitted because they comprise of less than 5 vessels. Number of vessels is annotated on bars. Original data source: AFMA.

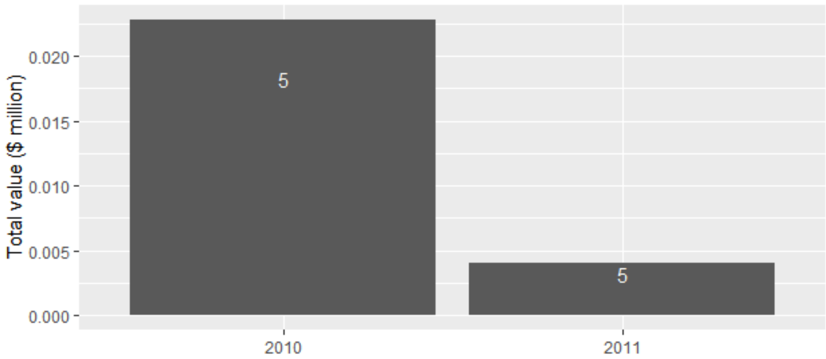


Figure 59. Annual catch value ($ million) within the revised MSS area in each financial year from 2008–2009 to 2017–2018 by the Southern Squid Jig Fishery. Note the minimum number of vessels shown in any one year was 5, and missing values were omitted because they comprise of less than 5 vessels. Number of vessels is annotated on bars. Original data source: AFMA.

6.6. Small Pelagic Fishery

The SPF operates in Commonwealth waters off southern Western Australia, South Australia, Victoria, Tasmania, New South Wales and parts of Queensland (Figure 60), with most of the historic fishing effort occurring off the east and west coasts of Tasmania (Patterson *et al*, 2018). This fishery targets four species: Australian Sardine (*Sardinops sagax*), Blue Mackerel (*Scomber australasicus*), Jack Mackerel (*Trachurus declivis*) and Redbait (*Emmelichthys nitidus*). Fishing was historically done using purse seine nets, but this method has largely been replaced by midwater trawling.

Because of a lack of market and processing facilities, total catch in the SPF decreased from almost 42,000 t in 1986–87 to very low levels during the 2000s. The introduction of a factory trawler into the fishery from 2014–2017 led to increased catches, however the factory trawler has since left the fishery, but a smaller vessel is operating out of southern NSW. Of the 30 fishing entities that held quota SFRs in 2017–18, there were only two active purse seine vessels and one midwater trawl vessel (Patterson *et al*, 2018). In that year there was 152 purse seine search hours and 223 midwater trawl shots recorded, together catching about 5,713 t of the 48,900 t TAC (Patterson *et al*, 2018). The value of the catch cannot be reported to protect confidentiality.

Overlap between SPF Grounds and Seismic survey footprint

Less than 5 SPF vessels fished the revised MSS area during 2008–2017, and so catch, effort and value of the fishery in the area cannot be reported. The most significant catch in this fishery is currently taken by a vessel that fishes exclusively off NSW (Figure 61).

Likelihood of fishing grounds developing in the future

The lack of a market and processing facilities have resulted in low effort and catches in the fishery. These increased temporarily with the introduction of factory vessels into the fishery, but the subsequent ban on "super trawlers" (those over 130 m length) and a breakdown of commercial terms between a vessel and quota owner saw it leave the fishery. Given the experience of factory trawlers in the SPF, it is unlikely that there will be re-investment in this area in the near future.

The SPF fishery is represented by the Small Pelagic Fishing Industry Association whose contact is listed in Table 20.

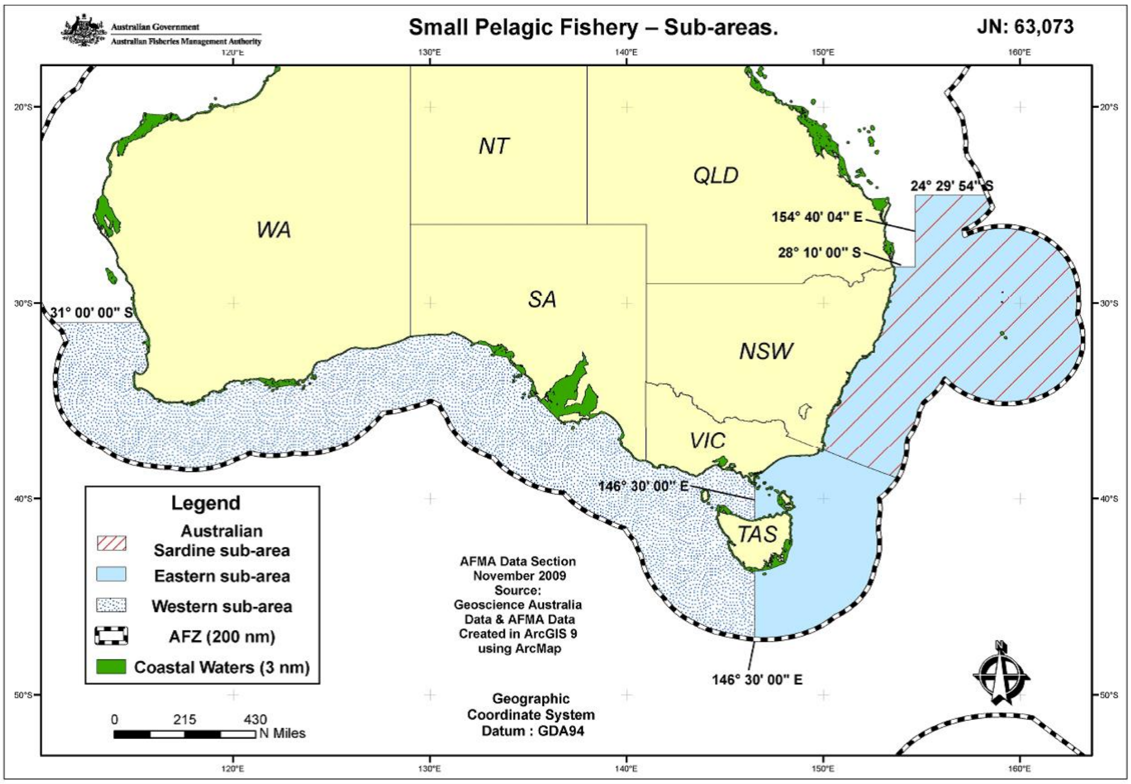


Figure 60 Area of the Small Pelagic Fishery (AFMA, 2018a).

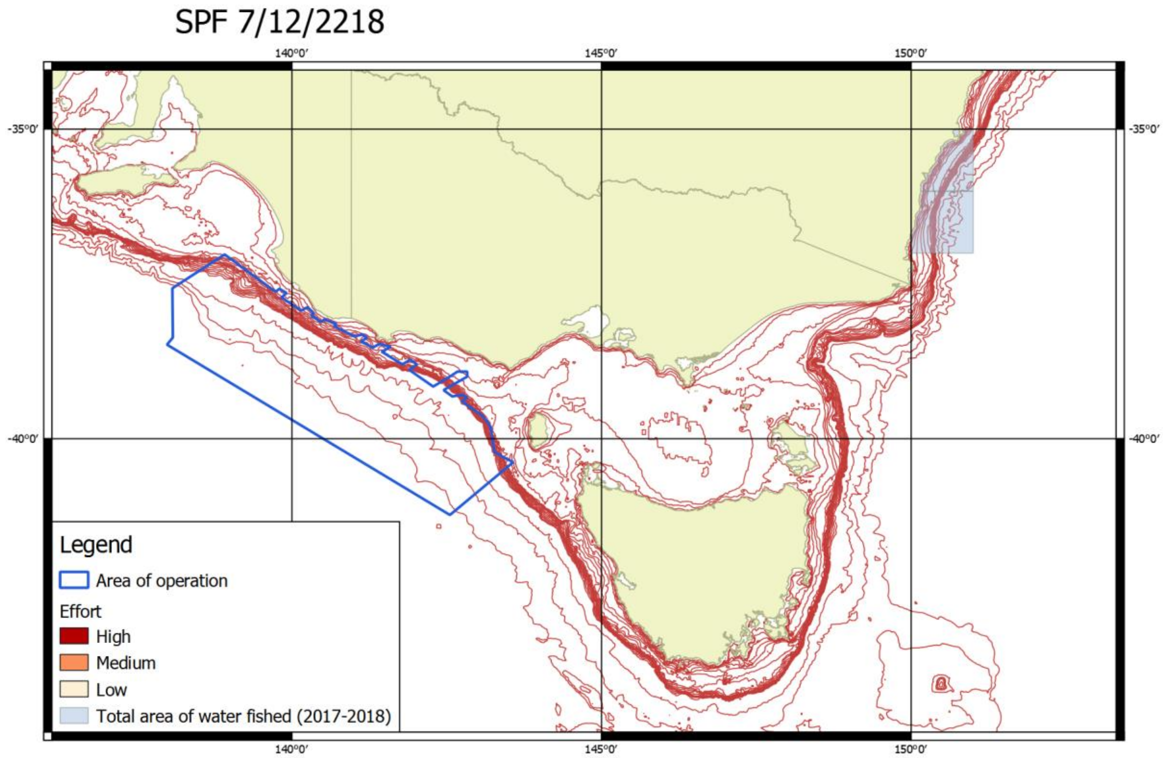


Figure 61. Area fished by the Small Pelagic Fishery in relation to the revised MSS area during 2017–2018. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

6.7. Eastern Tuna and Billfish Fishery

The ETBF operates in the Exclusive Economic Zone across eastern Australia from Cape York to the South Australian–Victorian border (Figure 62), and on the high seas of the Pacific Ocean (Patterson *et al*, 2018). Most catch is taken using pelagic longlines, but minor-line methods are used in the fishery. Main species targeted are Albacore (*Thunnus alalunga*), Yellowfin Tuna (*Thunnus albacares*), Swordfish (*Xiphias gladius*), Bigeye Tuna (*Thunnus obesus*) and Striped Marlin (*Kajikia audax*).

Total catch by the fishery peaked in 2002 at more than 8,000 t, but fell to 4,200 t in 2013 before increasing to more than 6,000 t in 2016 and just under 6,000 t in 2017 (Figure 63) (Patterson *et al*, 2018). The 2017 catch was dominated by Yellowfin Tuna, Swordfish and Albacore. Effort and the number of active vessels have declined since the late 1990s, and the number of longline boat SFRs approximately halved after the structural adjustment package in 1996 (Figure 64). There are 85 longline boat SFRs and 93 minor-line boat SFRs in the fishery, and in 2016, only 39 longline boat and 2 minor-line boat SFRs were active (Patterson *et al*, 2018). From 8.73 million hooks set in 2017, 4,615 t of target species (Striped Marlin, Bigeye Tuna, Yellowfin Tuna, Swordfish and Albacore) was landed with a value of $35.7 million (Patterson *et al*, 2018). Most of the recent effort has been focussed off NSW and southern Queensland (Figure 65).

Overlap between SPF Grounds and Seismic survey footprint

Less than 5 ETBF vessels fished the revised MSS area during 2008–2017, and so catch, effort and value of the fishery in the area cannot be reported, however some effort was reported from the revised MSS area in 2017 (Figure 65).

Likelihood of fishing grounds developing in the future

The ETBF has traditionally focussed on waters further north than the Otway Basin because that is the preferred habitat of the target species. Effort has decreased since the early 2000s, however catch remained relatively high, and has increased in recent years. Biomass of the main species have been assessed as "not overfished" (Patterson *et al*, 2018). It is unlikely that the ETBF effort will increase in the revised MSS area in the near future, however increases in water temperature in the area due to climate change may result in a southward movement of pelagic fish stocks that could see a southward movement of fishing effort in the longer term.

The ETBF is represented by Tuna Australia whose contact is listed in Table 20.

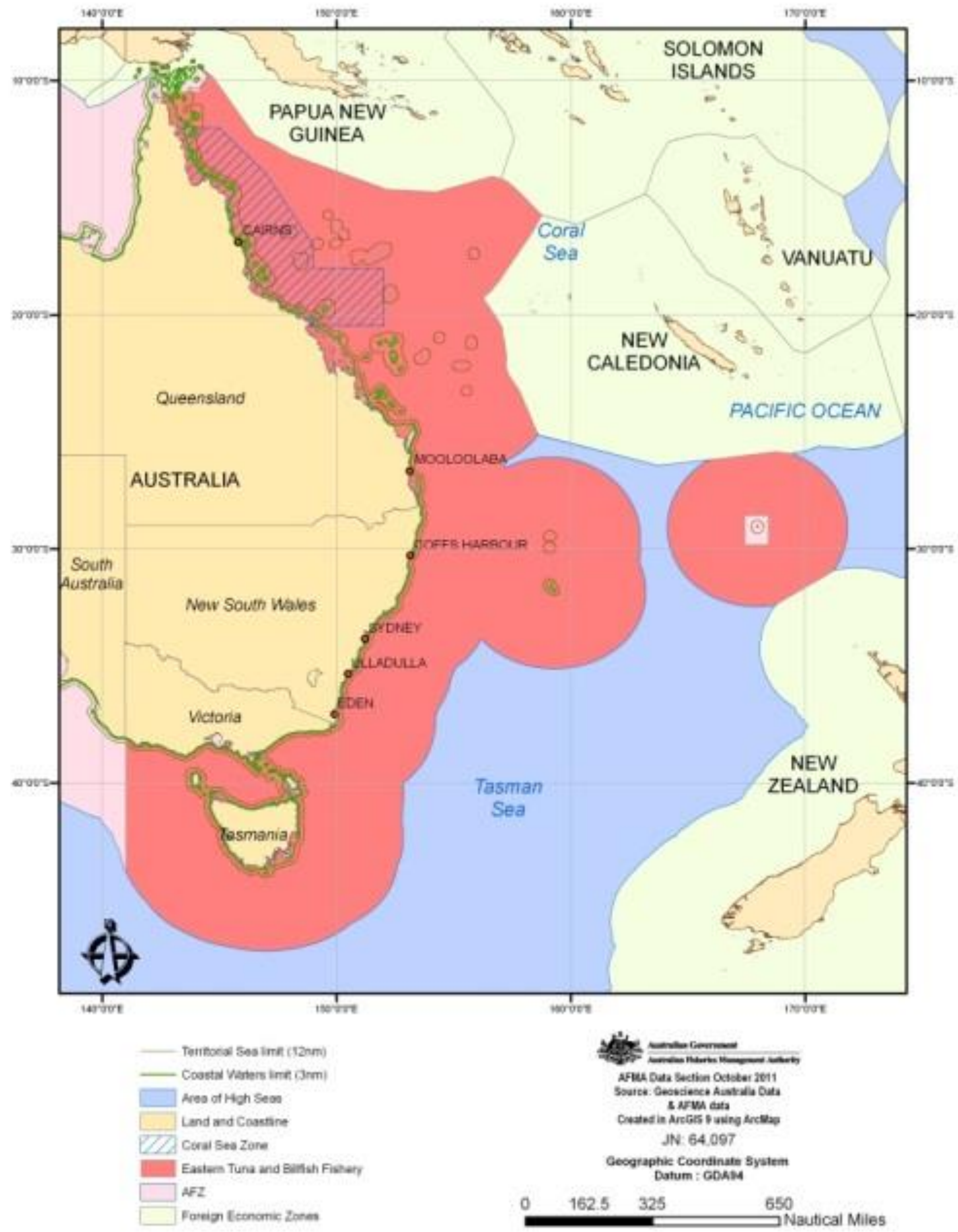


Figure 62. Area of the Eastern Tuna and Billfish Fishery (AFMA, 2018a).

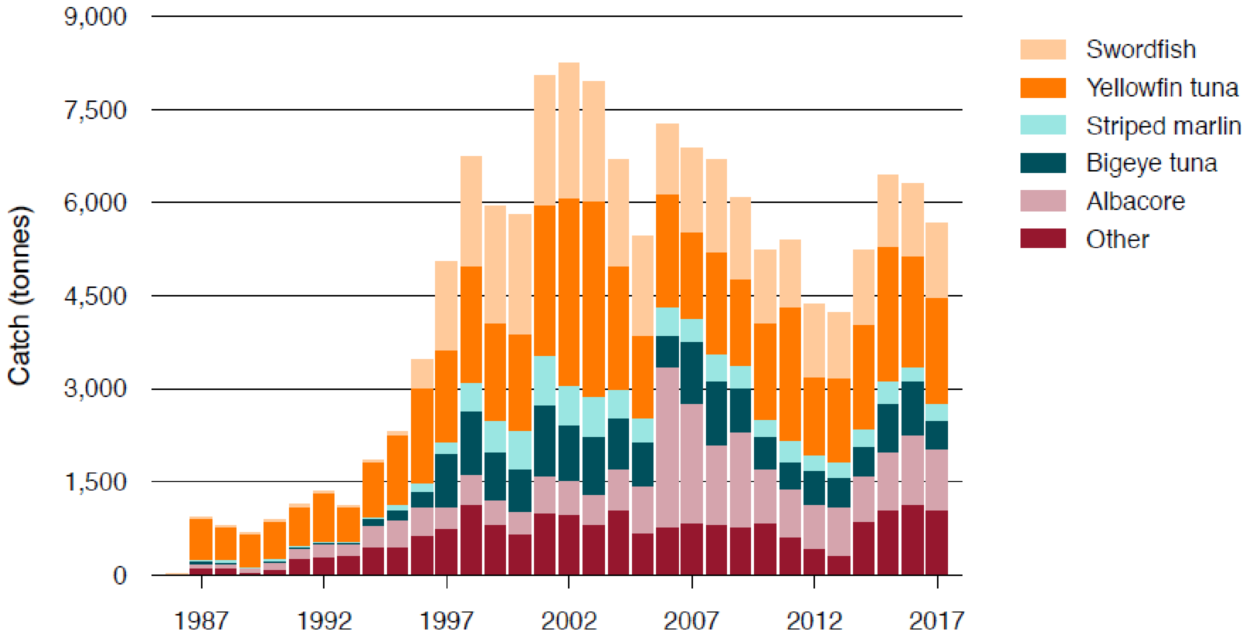


Figure 63. Catch in the ETBF from 1986–17 by species (Patterson *et al*, 2018).

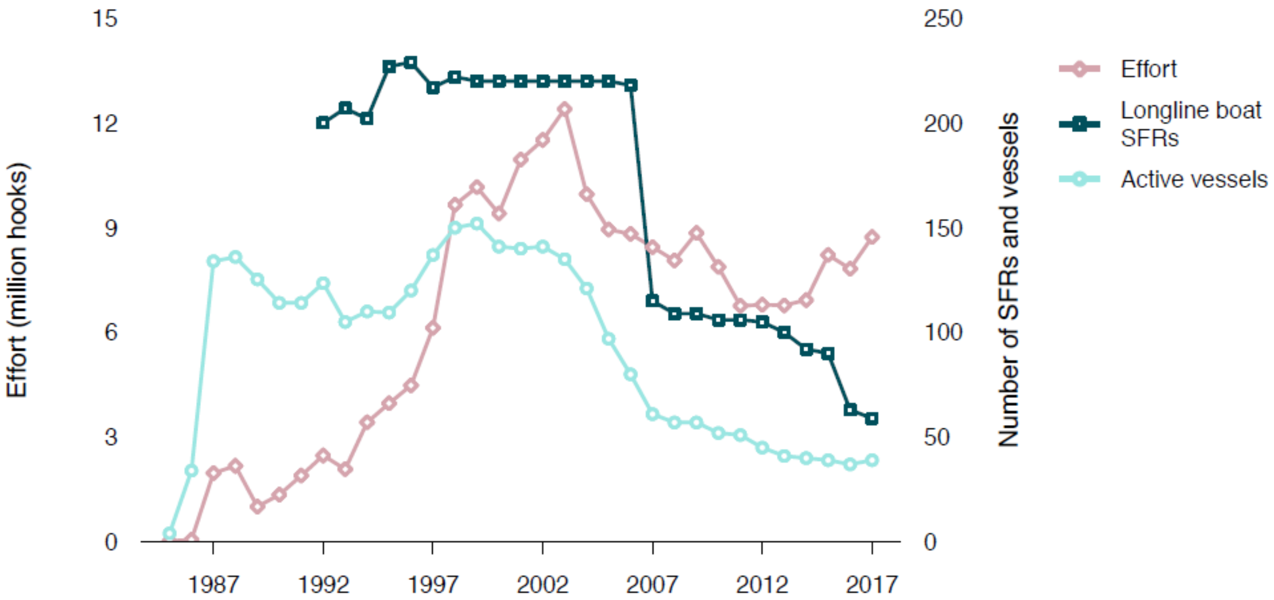


Figure 64. Effort, number of SFRs and active vessels in the ETBF from 1986–17 (Patterson *et al*, 2018).

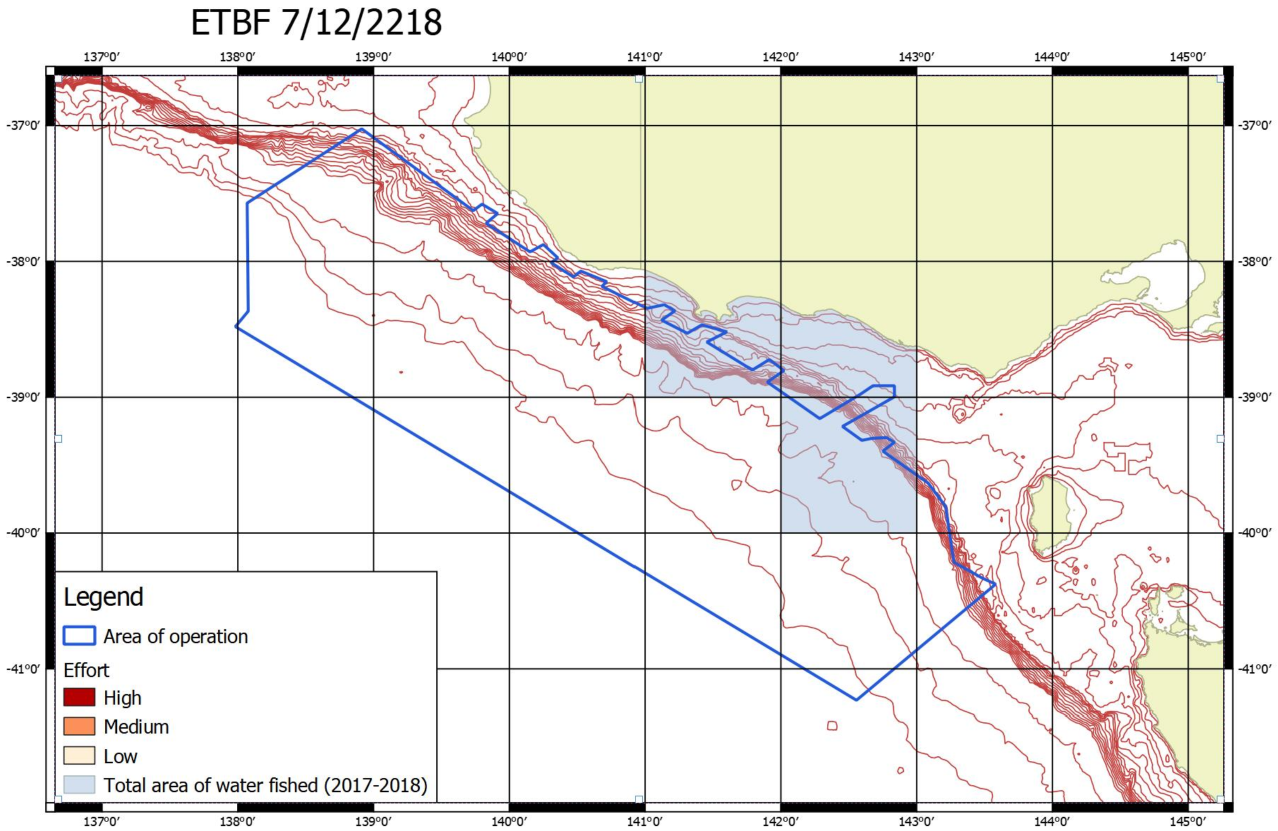


Figure 65. Area fished by the Eastern Tuna and Billfish Fishery in relation to the revised MSS area during 2017. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

6.8. Western Tuna and Billfish Fishery (WTBF)

The WTBF operates in the Exclusive Economic Zone across southern, western and northern Australia from the South Australian–Victorian border around Cocos Island and Christmas Island to Cape York, (Figure 62), and on the high seas of the Indian Ocean (Patterson *et al*, 2018). Most catch is taken using pelagic longlines, but minor-line methods are used in the fishery. Main species targeted are Yellowfin Tuna, Swordfish, Bigeye Tuna and Striped Marlin.

Total catch by the fishery peaked in 2001 at about 3,300 t, but fell to less than 500 t in 2005 and has remained below that level since (Figure 67) (Patterson *et al*, 2018). The 2017 catch was dominated by Swordfish, Yellowfin Tuna and Bigeye Tuna. The number of longline boats SFRs in the fishery approximately halved after the structural adjustment package in 1996 (Figure 68). After a three year increase in effort and active vessels from 2000–2002, both declined quickly, and have remained stable since (Figure 68). There are 95 boat SFRs in the fishery, and in 2017, only 3 longline boat and 1 minor-line vessels were active (Patterson *et al*, 2018). From 417,997 hooks set in 2017, 322 t of the 10,125 t TACC was landed (Patterson *et al*, 2018). Most of the recent effort has been focussed off Western Australia (Figure 69).

Overlap between SPF Grounds and Seismic survey footprint

Less than 5 WTBF vessels fished the revised MSS area during 2008–2017, and so catch, effort and value of the fishery in the area cannot be reported, however some effort was reported by the fishery in the revised MSS area in 2017 (Figure 69).

Likelihood of fishing grounds developing in the future

There is only a very small overlap between the area of the WTBF and the area of operation, and effort in the fishery has traditionally focussed on waters further west. Catch and effort has decreased since the early 2000s, and it is unlikely that the WTBF effort will increase in the revised MSS area in the near future.

The WTBF is represented by Tuna Australia whose contact is listed in Table 20.

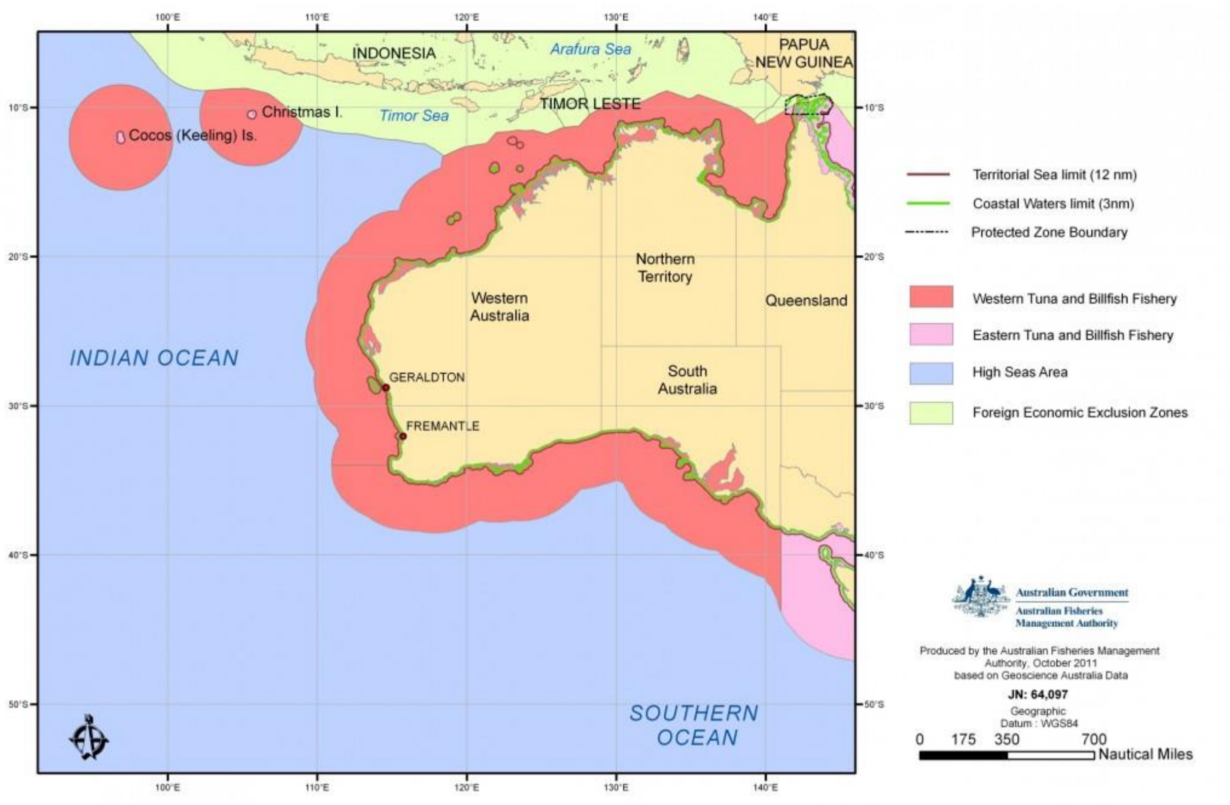


Figure 66. Area of the Western Tuna and Billfish Fishery (AFMA, 2018a).

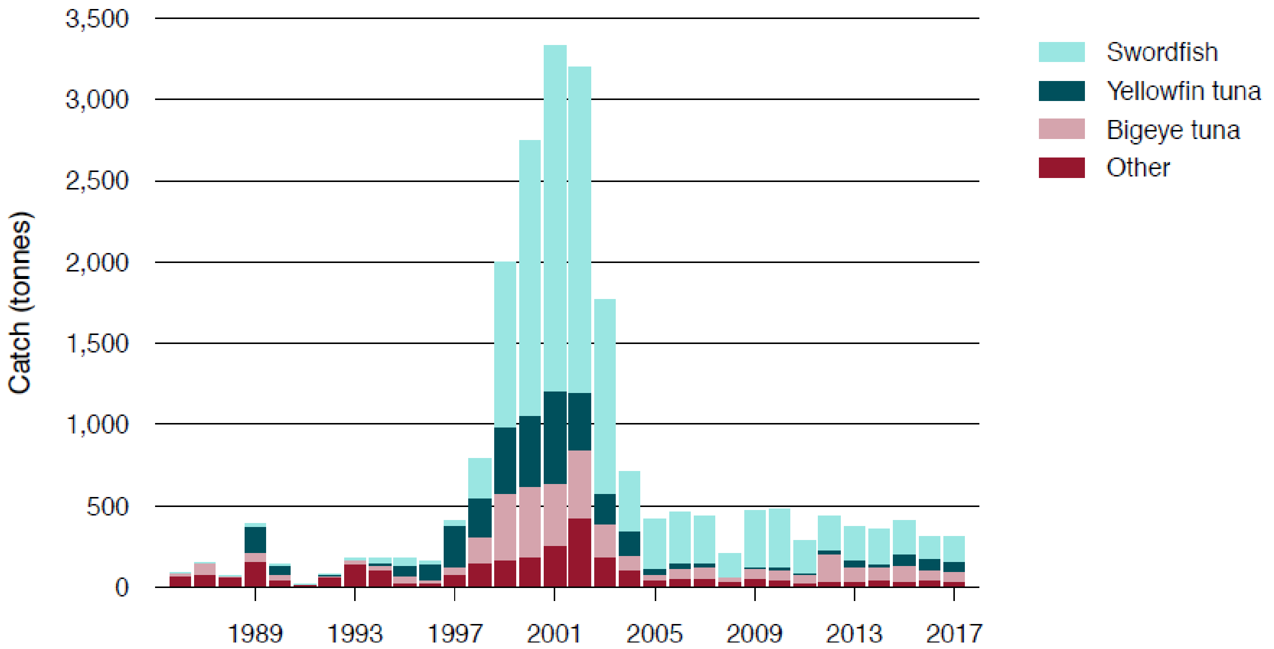


Figure 67. Catch in the WTBF from 1986–17 by species (Patterson *et al*, 2018).

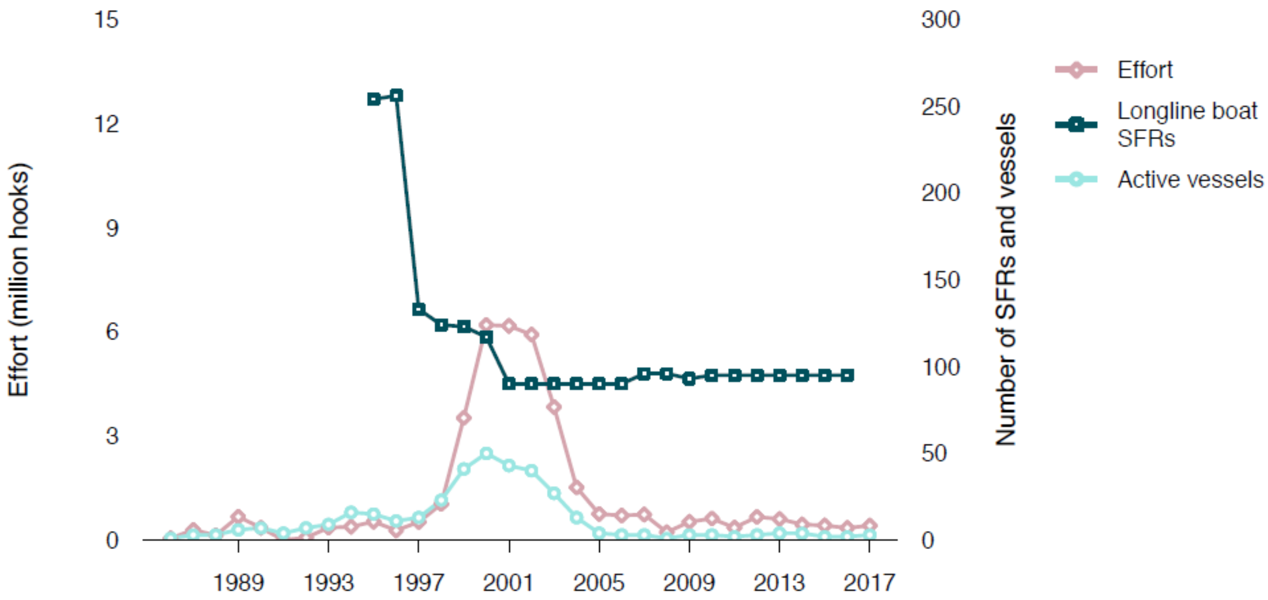


Figure 68. Effort, number of SFRs and active vessels in the WTBF from 1986–2017 (Patterson *et al*, 2018).

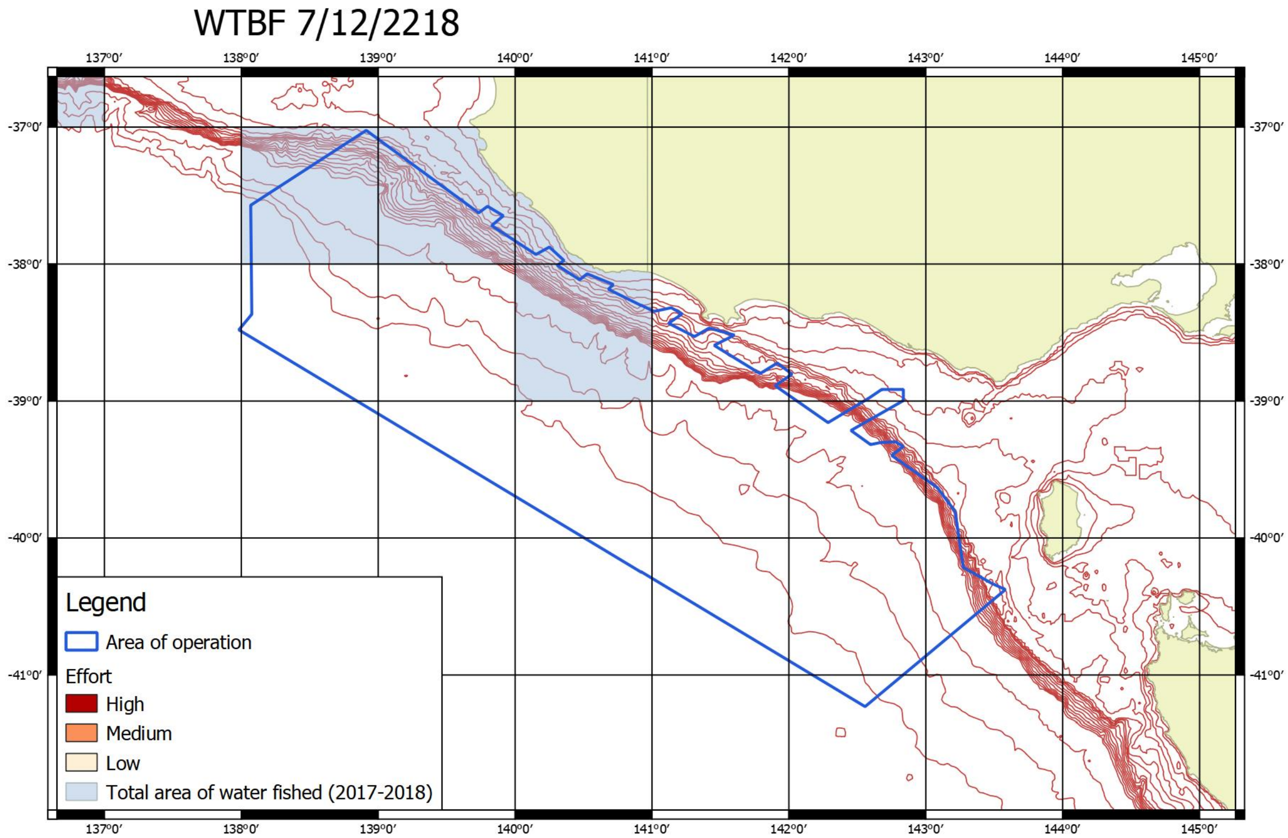


Figure 69. Area fished by the Western Tuna and Billfish Fishery in relation to the revised MSS area during 2017. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

6.9. <u>Southern Bluefin Tuna Fishery (SBTF)</u>

The SBTF operates right across the Australian Fishing Zone (Figure 70). Most catch is taken using purse seine, but some is caught using pelagic longlines. This is a single species fishery targeting Southern Bluefin Tuna.

Since the early 1990s, nearly 100% of the TAC has been caught, however while the TAC stayed at a similar level from 2015–16 to 2016–17, the catch dropped slightly leaving about 360 t of the TAC uncaught (Figure 71). The TAC was steady at about 5,200 t until a decrease in 2009–10 to just over 4,000 t, and less than 4,000 t the following year. The TAC has since increased to 5,703 t in 2015–16 and 5,697 t in 2016–17 (Patterson *et al*, 2018). In that year, the 6 active purse seine vessels and 16 active longline vessels landed 5,334 t of fish valued at $38.57 million (Patterson *et al*, 2018).

Overlap between SPF Grounds and Seismic survey footprint

Less than 5 SBTF vessels fished the revised MSS area during 2008–2017, and so catch, effort and value of the fishery in the area cannot be reported, but there was some effort reported from the revised MSS area during 2017 (Figure 72).

Likelihood of fishing grounds developing in the future

There is only a low level of effort by the SBTF in the revised MSS area during 2008–2017, with effort in the fishery focussed on southern NSW. The TAC has increased in recent years, as has the proportion of the catch taken by pelagic longline. Large numbers of Southern Bluefin Tuna are caught recreationally off western Victoria, and it is possible that an increase in commercial fishing effort could occur in this region.

The SBTF is represented by Tuna Australia whose contact is listed in Table 20.

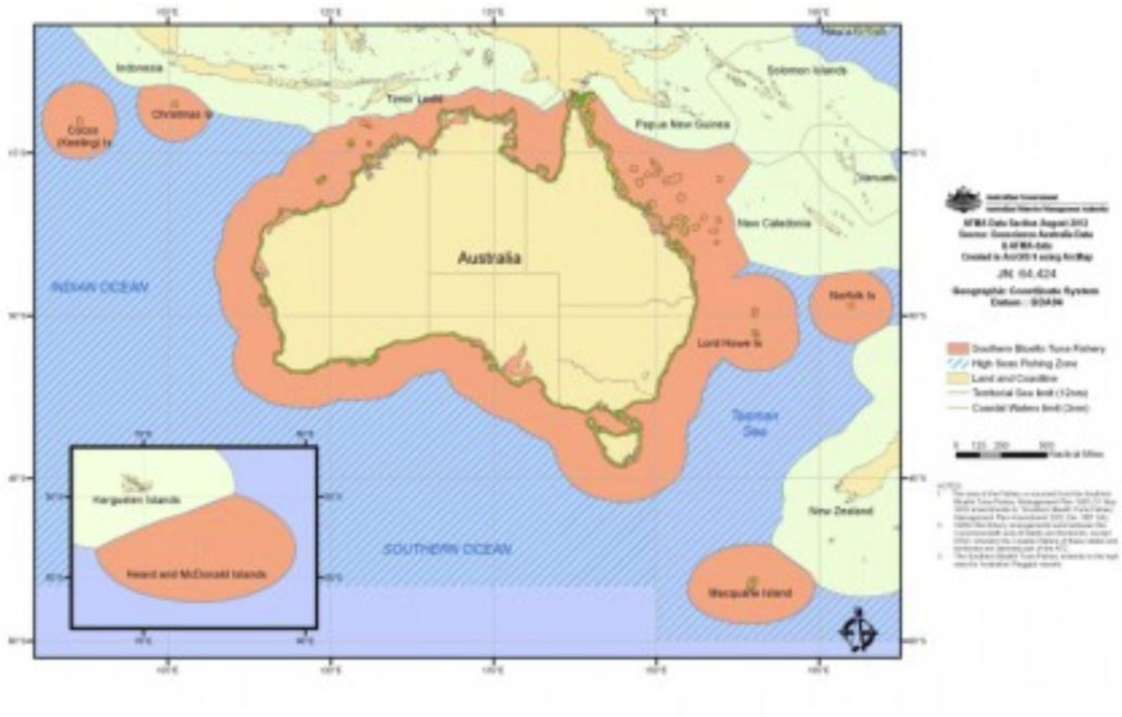


Figure 70 Area of the Southern Bluefin Tuna Fishery (AFMA, 2018a).

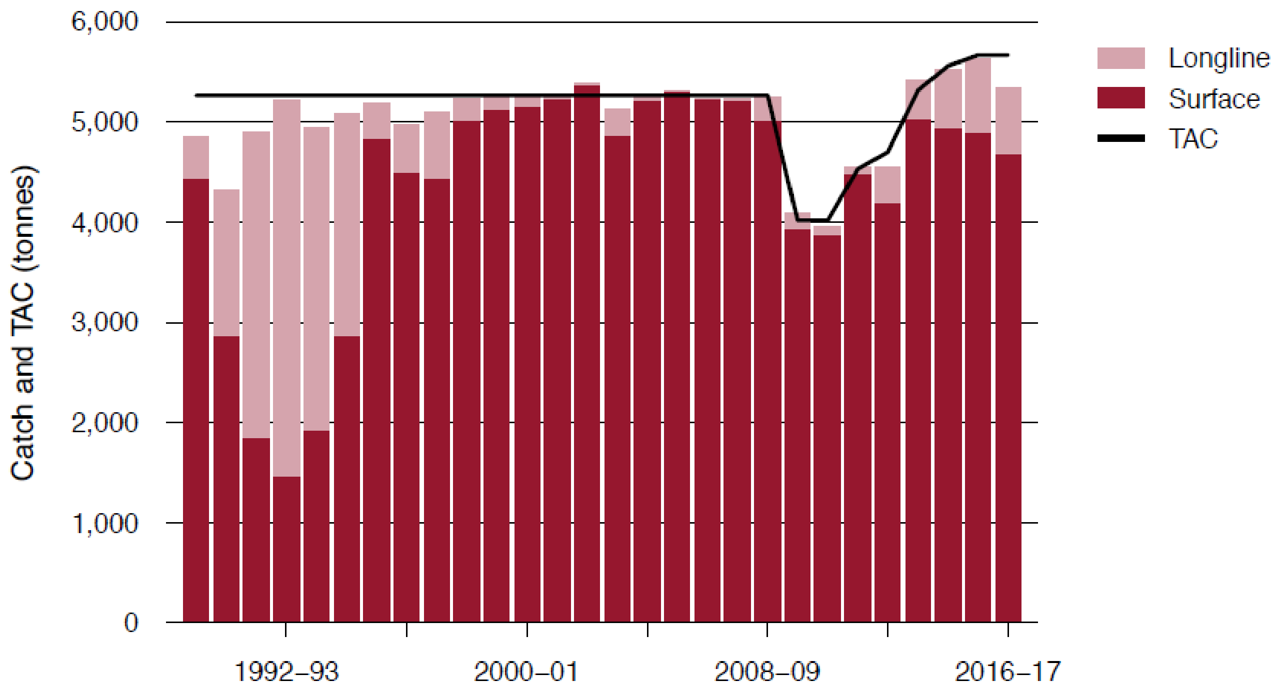


Figure 71. Catch in the SBTF from 1989–1990 to 2016–2017 by species (Patterson *et al*, 2018).

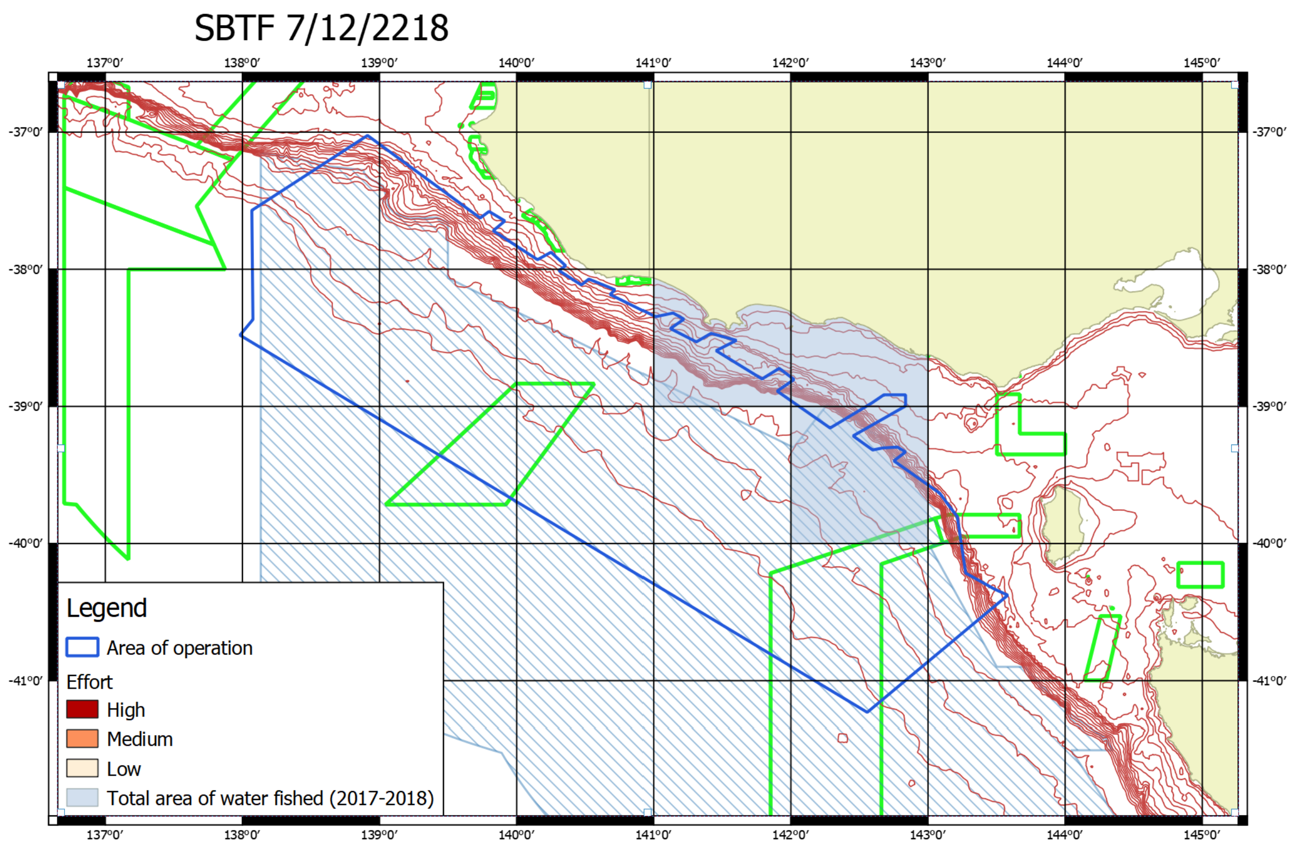


Figure 72. Area fished by the Southern Bluefin Tuna Fishery in relation to the revised MSS area during 2017. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA.

6.10. Victorian Rock Lobster Fisheries

The area of the Victorian Rock Lobster Fishery extends along the Victorian coast, out into Commonwealth waters (>3 nm offshore). The fishery targets Southern Rock Lobster (*Jasus edwardsii*), and is divided into two management zones separated at longitude 143° 40'E, each managed through input and output controls, limited entry, gear restrictions, effort limits and a separate Total Allowable Commercial Catch (TACC). Baited pots are used to target lobster over reef substrate on coastal reefs to depths of 200 m (Department of Environment and Heritage, 2004). The fishing season is open from 16 November to 14 September each year. Most of the catch comes from the Western Zone (Figure 73), with which the area of the original MSS overlaps. The TACC for the Western Zone was 230 t in 2016–17 (Victorian Fisheries Authority, 2017a). Catches in the eastern zone have ranged between 209–554 t since 1982–83 (Victorian Fisheries Authority, 2017a). During 2016–17, a total of 209 t of Southern Rock Lobster was landed from the Western Zone with a value of $16,517,000 (Victorian Fisheries Authority, 2017a). In comparison, 53 t was landed from the Eastern Zone. Effort during 2016–17 in the Western Zone was highest in December and January (51,000 and 52,000 pot-lifts), and apart from the closed season, effort was lowest during May and June (12,000 and 4,000 pot-lifts) (Figure 74). Catch largely followed a similar seasonal cycle to effort during 2016–17, with the highest catches in December and January, however catches during August were disproportionately low compared to effort. As of September 2017, there were 71 Fishery Access Licences in the Western Zone (Victorian Fisheries Authority, 2017a).

Overlap between Victorian Rock Lobster Fishery and area of the proposed seismic survey

Over 2008–2017 a total of 853.3 t of Southern Rock Lobster was taken by the fishery in the original MSS area (Table 8). Annual catch dropped from just under 100 t to about 72 t in 2015, before increasing to about 80 t in 2017 (Figure 76). Catch was lowest in 2017 at just under 16 t. Rock Lobster catch has historically increased from a minimum in September to peak in either December of January, and then slowly decrease through the minimum in September (Figure 78).

The number of fishers that operated in the area over 2008–2017 ranged 21–39 (Table 8). They undertook nearly 17,621 days fishing over that time, but annual effort decreased from about 2,250 fishing days from 2008–2011, to about 1,600 days from 2012–2014 and dropped to 1,126 days in 2017 (Figure 76). Seasonality roughly follows the same pattern as catch (Figure 78, Figure 79), with peaks and troughs in December or January and August or September (apart from in October when the fishery is closed;).

Catch value of Southern Rock Lobster from original MSS area was more than $53 million between 2008 and 2017 (Table 8). Despite falling catches, the value of the catch increased from just over $4 million to more than $6 million from 2014 onwards (Figure 76). Annual value of the catch from the original MSS area ranged $0.4–$1.5 million. Seasonal value followed the same trend as catch and effort Figure 78.

The Victorian Rock Lobster Fishery also landed octopus and at least 17 other species from the original MSS area from 2008–2017. Catch data for most of those species was not provided to maintain confidentiality, however annual catch, effort and value of octopus is shown in Figure 77.

Likelihood of fishing grounds developing in the future

The TACC for the Victorian Rock Lobster Fishery in the Western Zone has decreased from 450 t in 2006–2007 to 230 t in 2016–2017 (Victorian Fisheries Authority, 2017a). The fishery is considered to have recovered after over-exploitation, and it is unlikely that there will be large increases in the TACC in the near future. Therefor it is unlikely that there will be significant expansion of fishing effort in the original MSS area in the near future.

The Victorian Rock Lobster Association and SIV represent Victorian Rock Lobster Fishery. Eastrock represented quota owners and some operators in the eastern zone of the Rock Lobster Fishery. Contact details for these associations are provided in Table 20.

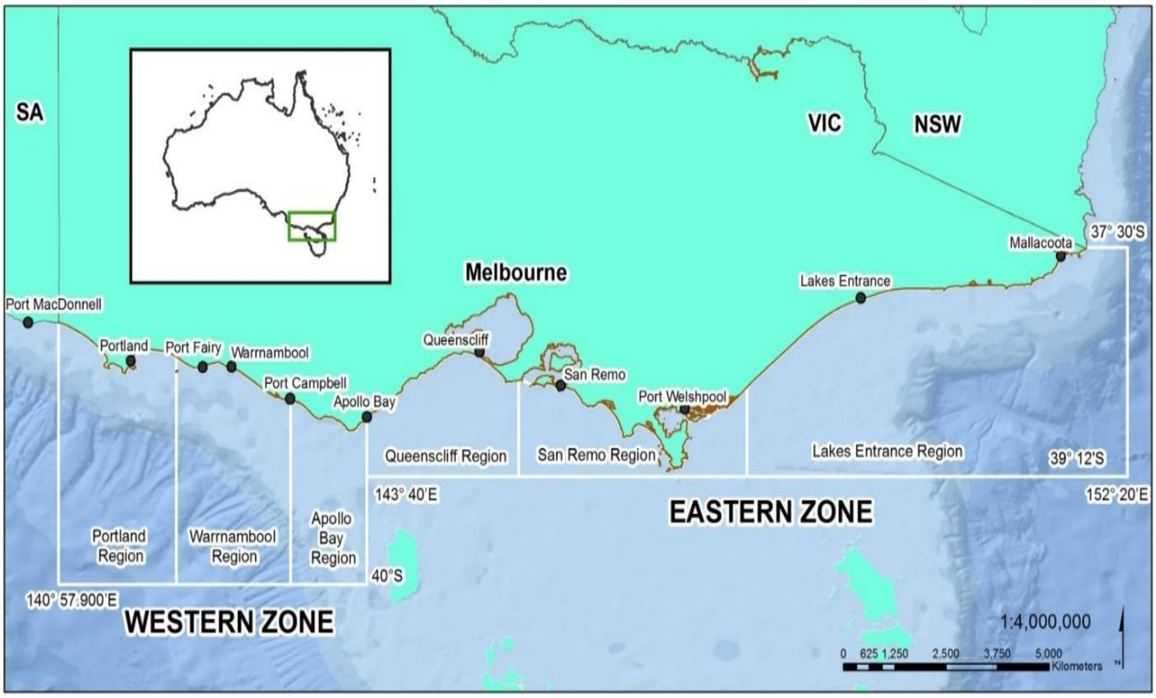


Figure 73. Extent of the Victorian Rock Lobster Fishery showing eastern and western zones. From Victorian Fisheries Authority (2017b).

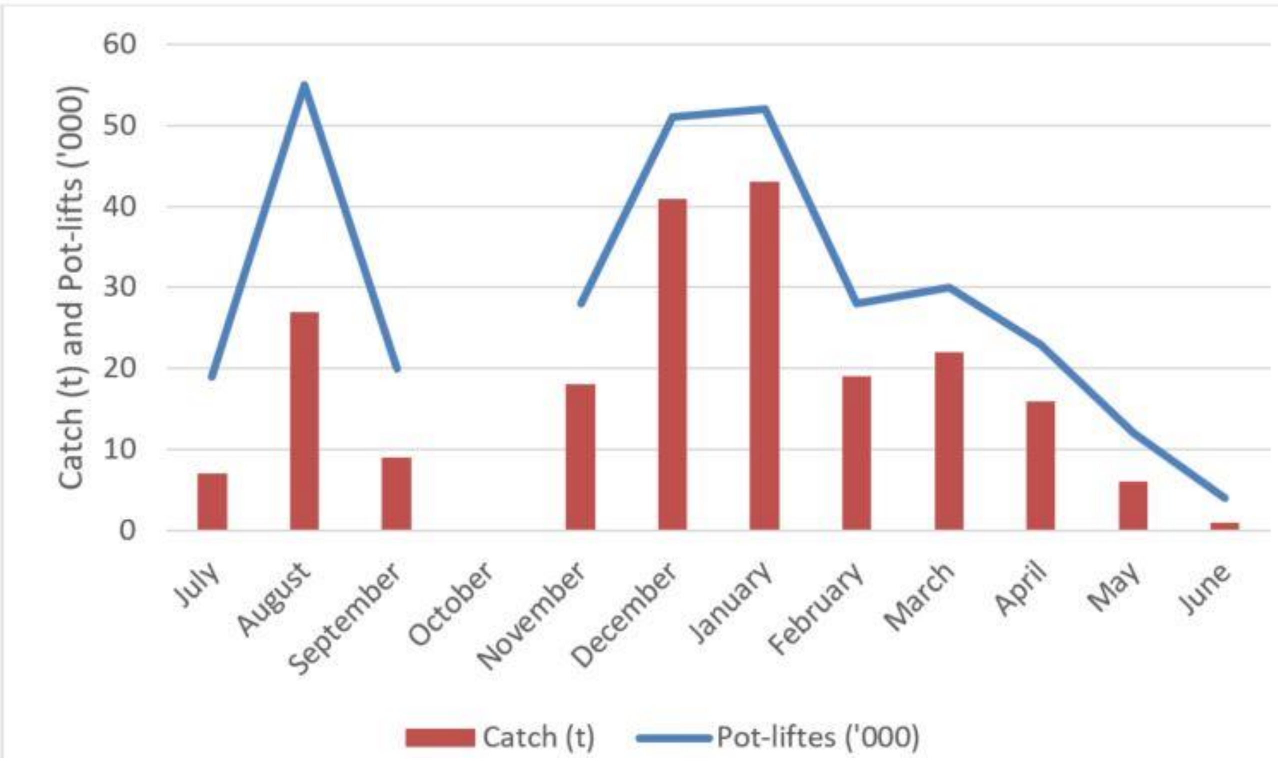


Figure 74. Catch (t) and number of pot-lifts ('000) in the western zones of the Victorian Rock Lobster Fishery for 2016-17. From Victorian Fisheries Authority (2017a).

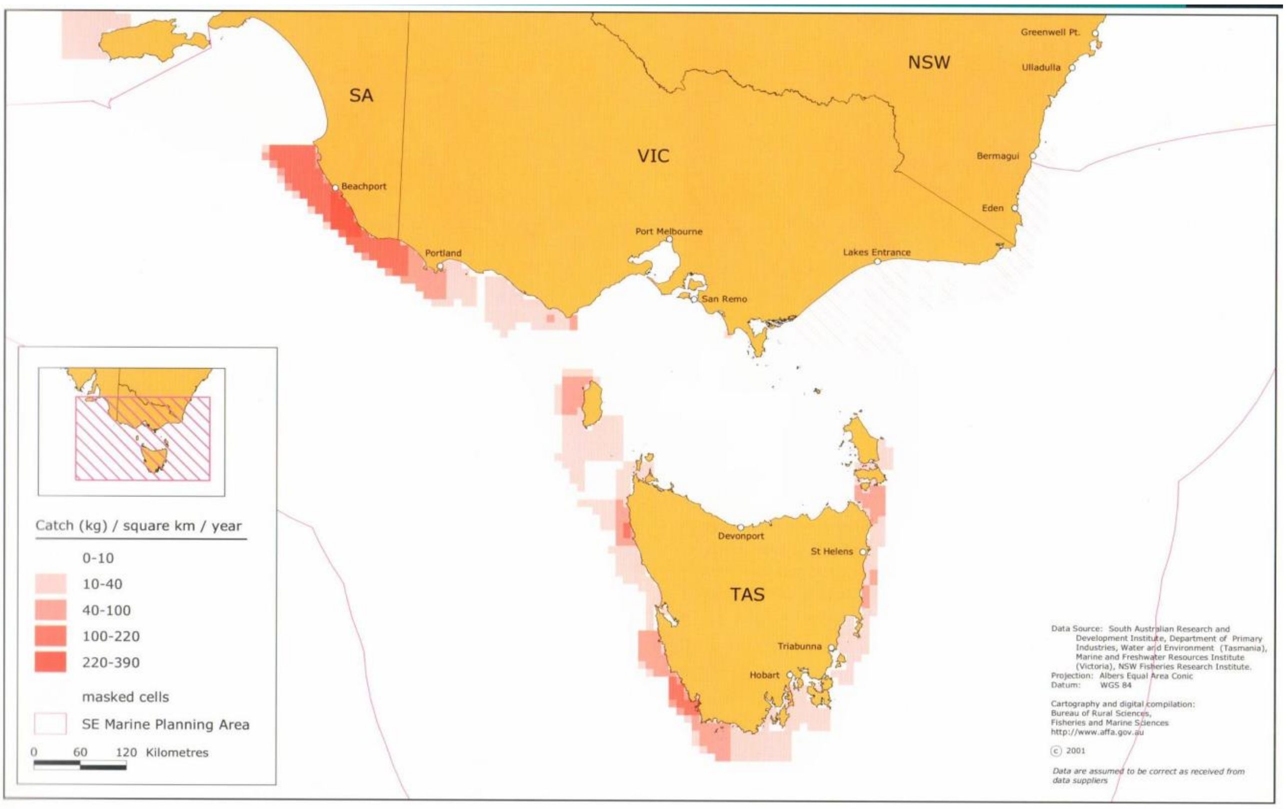


Figure 75. Catch rate (kg/square km/year) in the combined (Victorian and Tasmanian) Rock Lobster fisheries in south east Australia 1995 – 99 (Larcombe *et al*, 2002). Note that we have unsuccessfully attempted to obtain higher quality images of historical catch rate.

Table 8. Victorian Rock Lobster effort, catch, catch value and main species caught in the original MSS area. Original data source: VFA.

Years included	2008–2017
Number of different vessels	21–39 per year
Total days fished	17,621
Total catch (t)	853 t
Total value	$53,281,817
Main species caught	Southern Rock Lobster
Fishing methods used	Pot

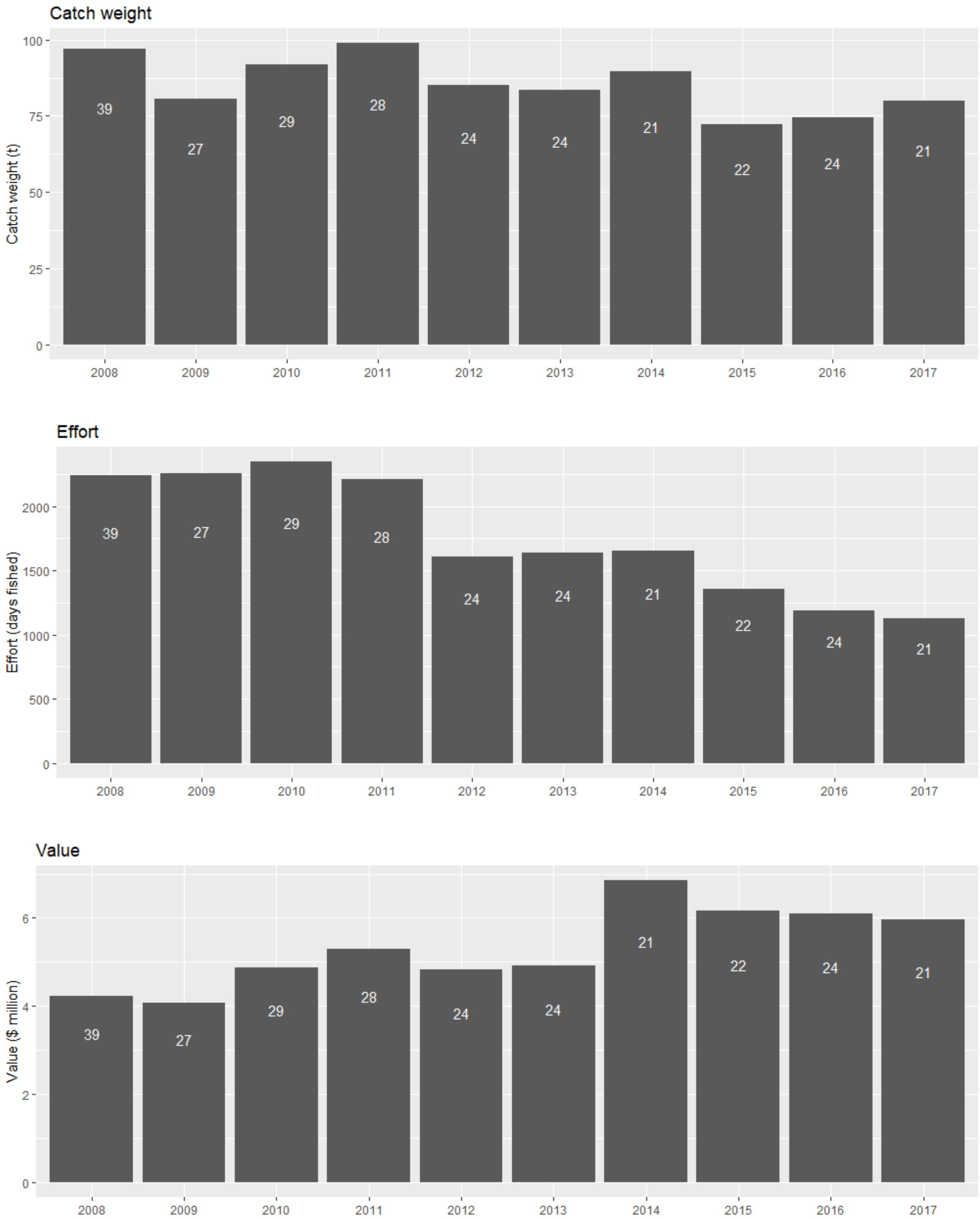


Figure 76. Annual catch (t; top panel), effort (days fished; middle panel) and value ($ million; lower panel) of Southern Rock Lobster by the Victorian Rock Lobster Fishery for 2008–2017 from the original MSS area.

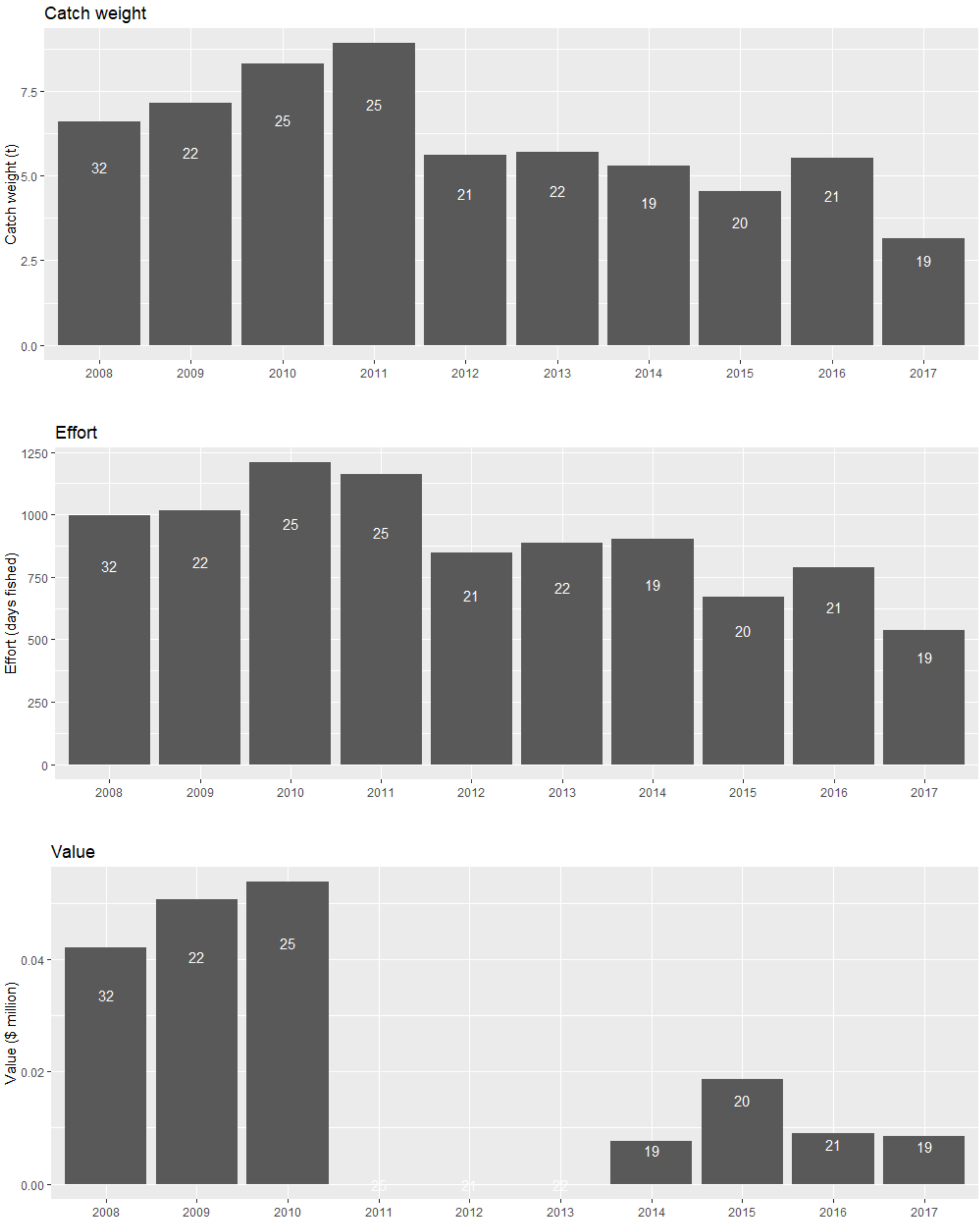


Figure 77. Annual catch (t; top panel), effort (days fished; middle panel) and value ($ million; lower panel) of Octopus by the Victorian Rock Lobster Fishery for 2008–2017 from the original MSS area. Note: 2011–2013 values missing in data.

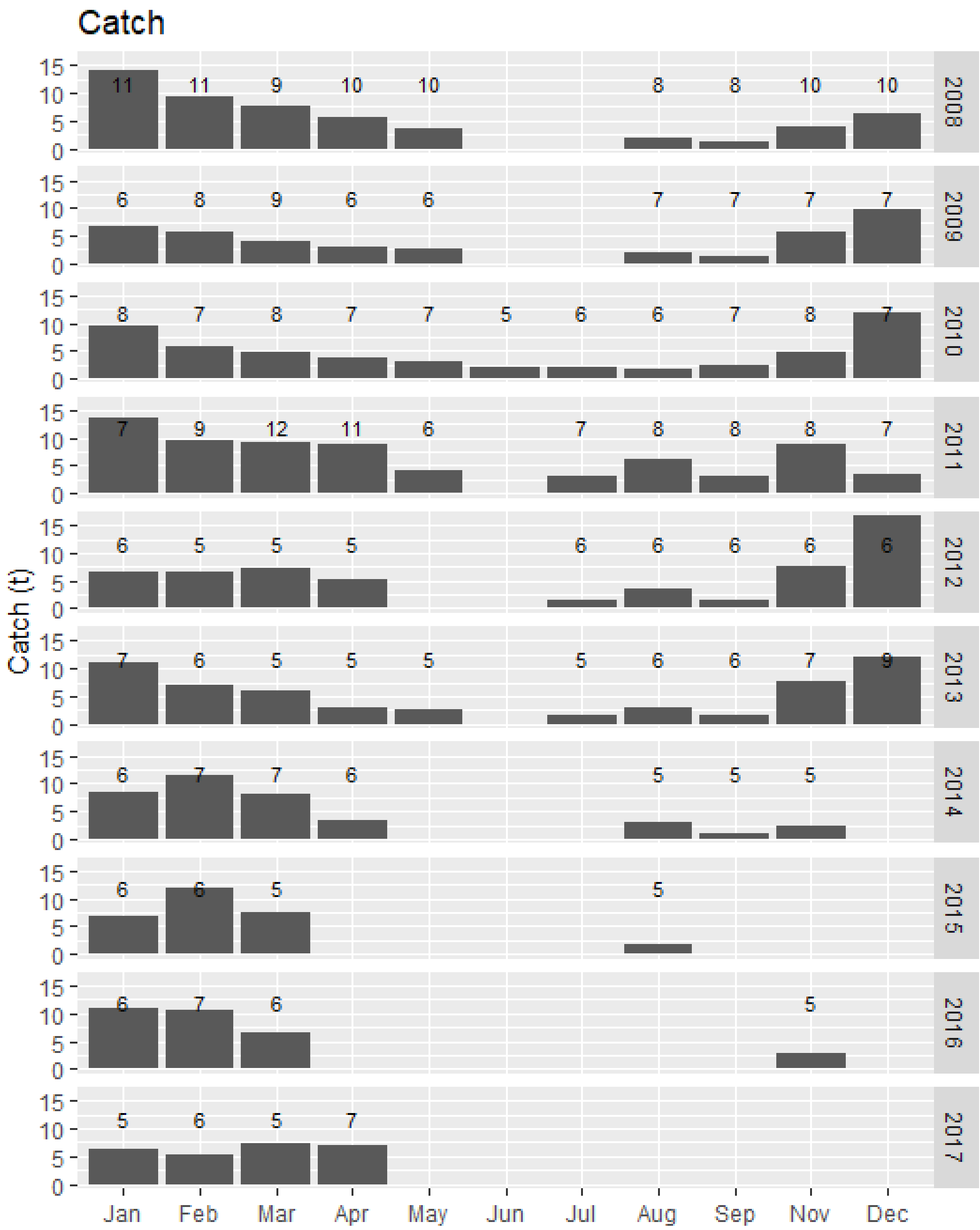


Figure 78. Monthly catch (t) of Southern Rock Lobster by the Victorian Rock Lobster Fishery for 2008–2017 from the original MSS area. Note: missing data due to confidentiality policy.

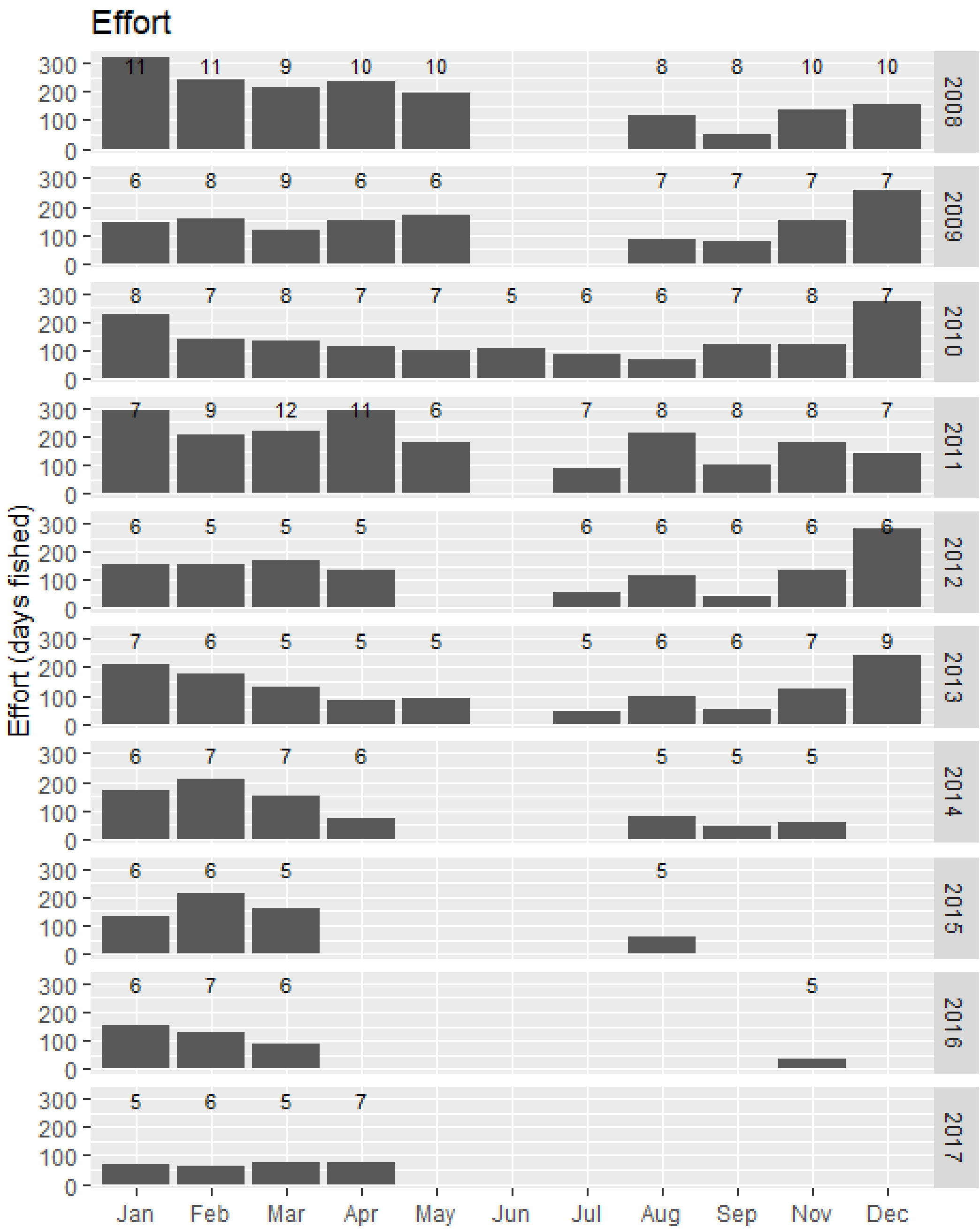


Figure 79. Monthly effort (days fished) of Southern Rock Lobster by the Victorian Rock Lobster Fishery for 2008–2017 from the original MSS area.

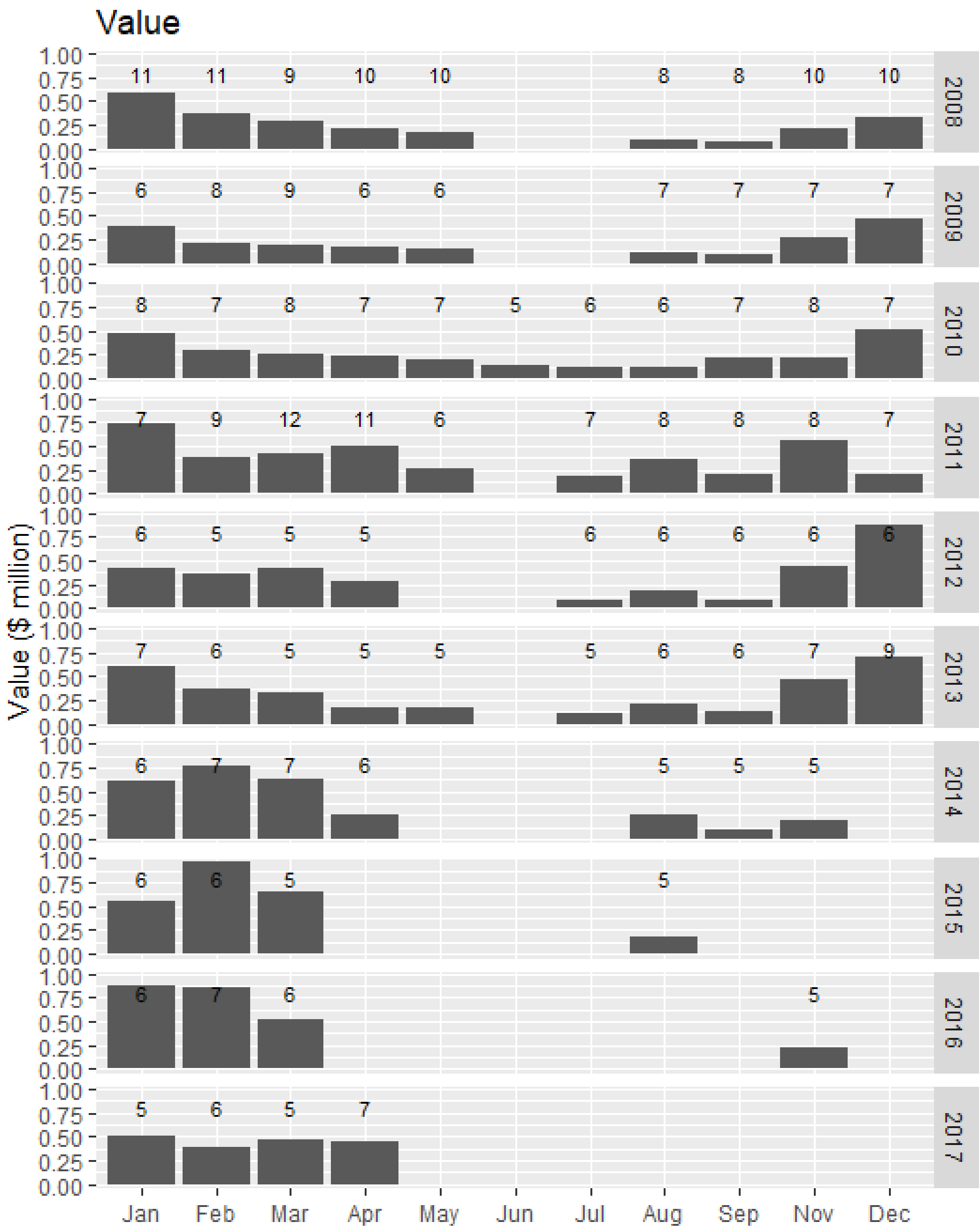


Figure 80. Monthly ($ million) of Southern Rock Lobster by the Victorian Rock Lobster Fishery for 2008–2017 from the original MSS area.

6.11. Victorian Giant Crab Fishery

The area of the Victorian Giant Crab Fishery is the same as for the Victorian Rock Lobster Fishery, including the separation into Western and Eastern zones (Fisheries Victoria, 2010). The fishery targets the Giant Crab (*Pseudocarcinus gigas*) using baited Rock Lobster pots in depths of 150–300 m (Fisheries Victoria, 2010). The Victorian Giant Crab Fishery is managed by both input and output controls including a Total Allowable Commercial Catch (TACC – which was 10.5 t in 2016–17 (Victorian Fisheries Authority, 2017a)), limited entry, gear restrictions, size limits and seasonal closures. The closed season for females and males is from 1 June – 15 November and from 15 September – 15 November respectively, and retention of berried females is prohibited. The catch of Giant Crab in the Western Zone has ranged <1 –171 t since 1982–83 and in 2015–16 (the latest year for which annual catch data is available) was 9 t, with a value of $280,000. As of September 2017, there were 14 Fishery Access Licences state-wide (Victorian Fisheries Authority, 2017a).

Overlap between Victorian Giant Crab Fishery and area of the proposed seismic survey

Over 2008–2017 a total of 116.9t of Giant Crab was taken from the original MSS area (Table 9). Annual catches have decreased from more than 20 t in 2009 to only about 7 t 1.5 t in 2014 (Figure 81). Seasonal catch figures were not provided to maintain confidentiality.

Effort has decreased considerably since 2009 when 9 different fishers undertook nearly 200 days fishing 2013 when three fishers undertook about 40 days fishing (Figure 81). There was only one active fisher in 2017.

Catch value was highest in 2008 and 2009 at nearly $0.6 million and $0.7 million, but was only $0.2 million in 2014 (Figure 81).

The Victorian Giant Crab Fishery does land small amounts of other species including Banded Ling, School Shark, Octopus, Gummy Shark and Striped Trumpeter, however the catch of those species was not provided.

Likelihood of fishing grounds developing in the future

The TACC for the Victorian Giant Crab Fishery in the Western Zone has decreased from 25 t in 2009–10 to 10.5 t in 2016–17 (Victorian Fisheries Authority, 2017a). There has been a continuing trend of decreased catch until 2012 which has now plateaued around 10t, and it is unlikely that there will be a significant expansion of effort by the Victorian Giant Crab Fishery in the near future.

SIV represent the Giant Crab Lobster Fishery. Contact details for this industry association are provided in Table 20.

Table 9. Victorian Giant Crab Fishery effort, catch, catch value and main species caught in the areas of interest. Original data source: VFA. * This does not include catch and effort from 2013, 2015, 2016 or 2017.

Years included	2008–2017
Number of different vessels	1–11 per year
Total days fished	1003*
Total catch (t)	116.9 t
Total value	$2,233,010*
Main species caught	Giant Crab
Fishing methods used	Pot

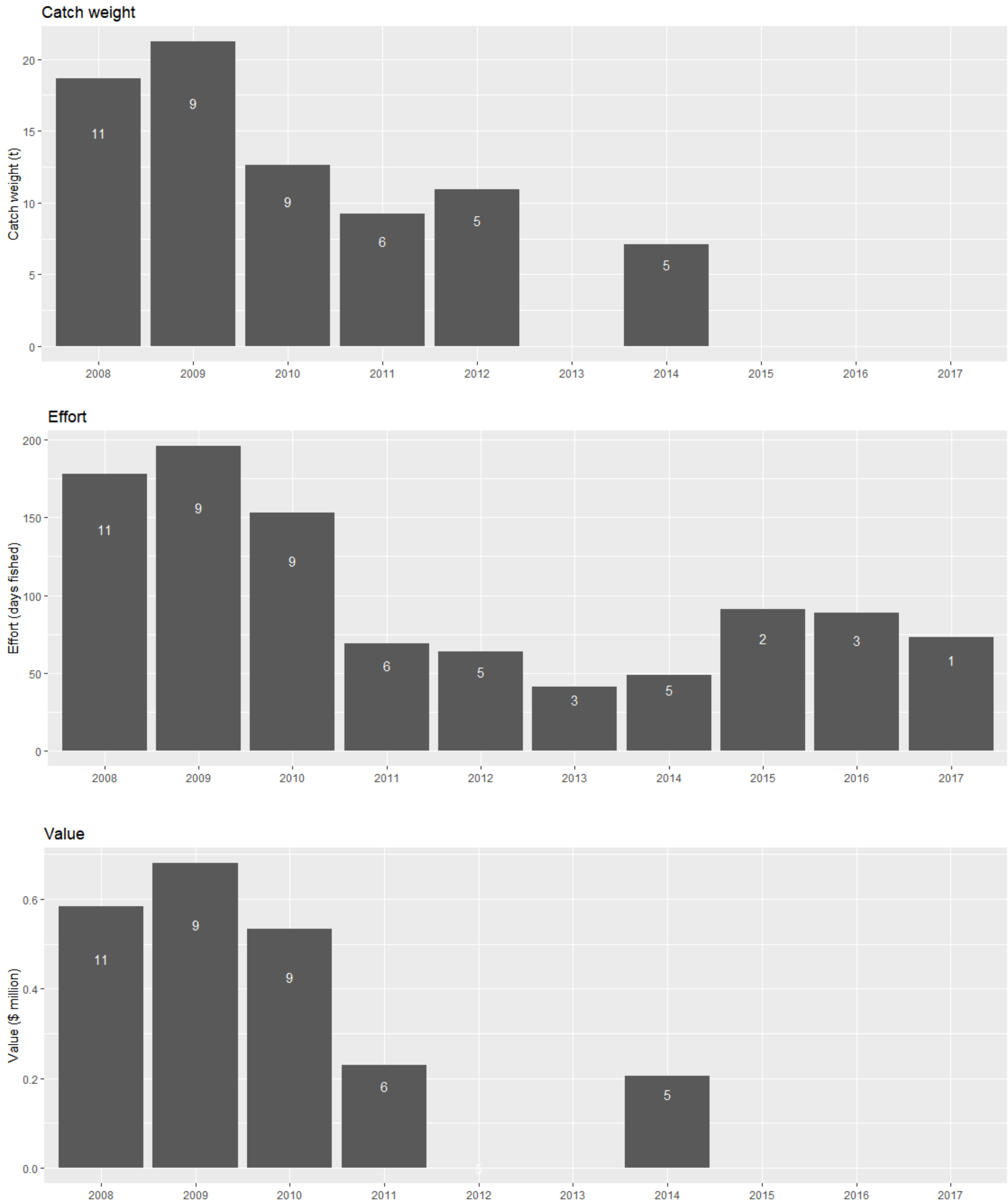


Figure 81. Annual catch (t; top panel), effort (days fished; middle panel) and value ($ million; lower panel) of Giant Crab by the Giant Crab Fishery for 2008–2017 from the original MSS area. Note: 2012, 2013, 2015, 2016 and 2017 values missing in data.

6.12. Victorian Ocean General Fishery

The Victorian Ocean General Access Licence authorises the 171 licence holders (Victorian Fisheries Authority, 2017) to carry out fishing activities using a variety of gear types in marine waters other than Port Phillip Bay, Western Port, Gippsland Lakes and any inlet of the sea. Gear types permitted include line methods (dropline, long line, hand line), dip net, bait traps, octopus traps, landing nets, gaffs, seine nets, mesh nets and bait pumps. This fishery can land fish (mostly Snapper, octopus and Gummy Shark) other than abalone, jellyfish, Southern Rock Lobster, Giant Crab, Commercial Scallop and sea urchins. Main management methods are input controls including limited access and gear restrictions. The fishery usually conducts day trips operating out of small vessels (<10 m), and may fish at anchor or underway. Most of the fishing under these licences off Lakes Entrance occurs during April–July.

Overlap between Victorian Ocean General, and the proposed seismic survey area

Historically, effort by the Ocean General Fishery has been low (0.03–0.9 fishing days / square km / year) in the area of the proposed seismic survey (Figure 82). Total catch by the Ocean General Fishery from 2008 to 2017 in the original MSS area was 44.1 t (Table 10). Annual catch ranged from less than 1 t in 2017 to about 19 t in 2012 (Figure 83). Effort in the area of intertest has decreased since 2008 from more than 175 days by 11 different fishers, to about 30 days by 6 fishers in 2017. Value was only provided for 2008–2010 (Figure 83). More than 45 different species of fish were recorded by the fishery in the original MSS area from 2008–2017 (Table 11).

Likelihood of fishing grounds developing in the future

There is considerable latent effort in the Ocean Fishery General Access, and it is uncertain what might trigger those licenses to become active.

Victoria's Ocean Fishery General is represented by Seafood Industry Victoria (SIV). Contact details for this industry association are provided in Table 20.

Table 10. Victorian Ocean General Fishery effort, catch, catch value and main species caught in the areas of interest. Original data source: VFA. * This does not include catch from 2016. ** This does not include value from 2011–2017.

Years included	2008–2017
Number of different vessels	1–11 per year
Total days fished	750
Total catch (t)	41.4 t*
Total value	$130,276**
Main species caught	Gummy Shark Snapper King George Whiting
Fishing methods used	Longline Handline

Table 11. Fish species reported by the Victorian Ocean General Fishery during 2008–17. Original data source: Victorian Fisheries Authority).

Australian salmon	Leatherjacket	Pipi	Squid, Goulds
Barracouta	Ling, Banded	Queen snapper	Sweep
Calamari, Southern	Mackerel, Blue	Redfish	Trevally
Cod, Southern Rock	Morwong, Silver	Redfish, Bight	Trumpeter, Striped
Cod, Unspecified	Morwong, Unspecified	Ruff	Tuna, Unspecified
Flathead, Sand	Mullet, Sand	Shark, Blue Pointer	Whiting, King George
Flounder, Unspecified	Mullet, Unspecified	Shark, Blue Whaler	Whiting, Sand
Garfish, Southern (Sea)	Mullet, Yelloweye	Shark, Dog	Wrasse, Bluethroat
Gurnard perch, Common	Mulloway	Shark, Gummy	Wrasse, Saddle
Gurnard, Unspecified	Octopus	Shark, School	Wrasse, Unspecified
Kingfish, Yellowtail	Perch, Ocean	Snapper	
Knife jaw	Pike, Unspecified		

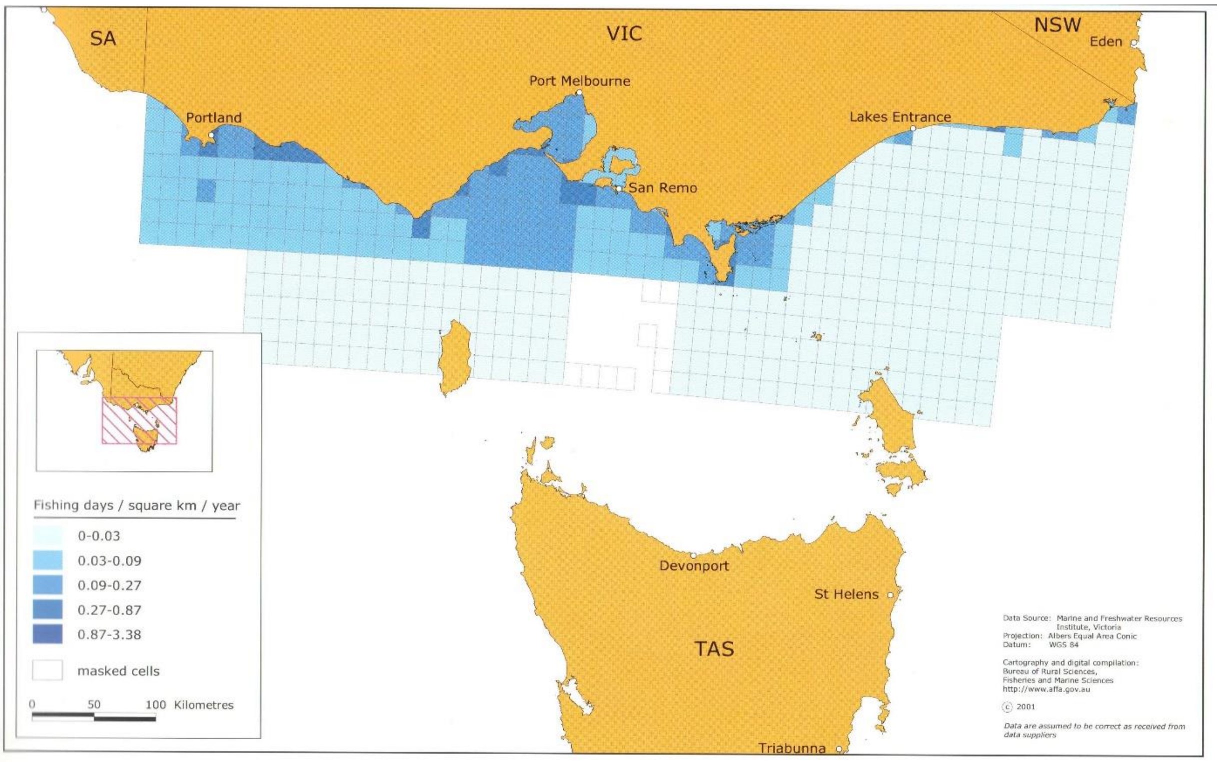


Figure 82. Effort (fishing days/square km/year) in the Victorian Ocean General Fishery in south east Australia 1995 – 99 (Larcombe *et al*, 2002).

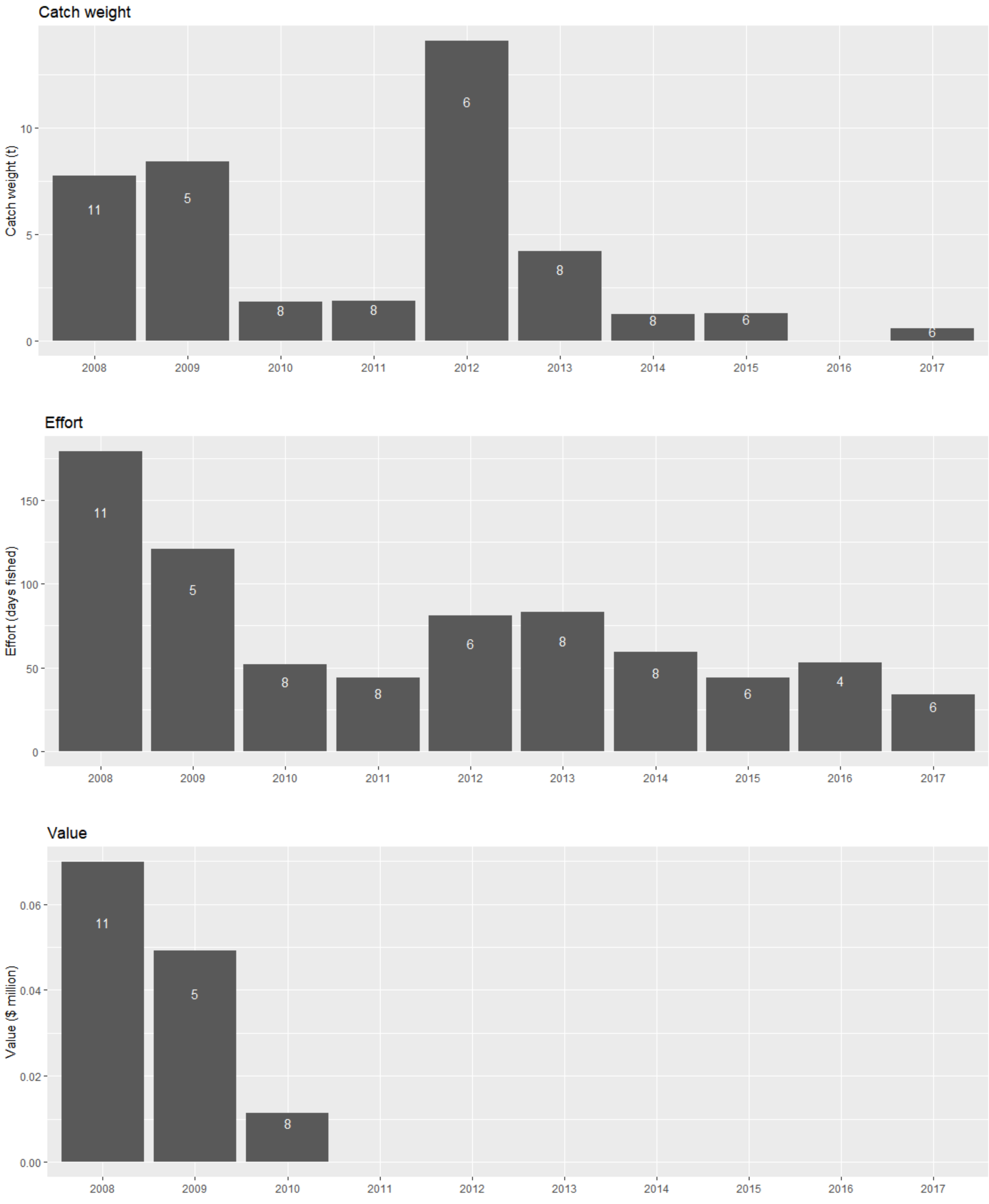


Figure 83. Annual catch (t; top panel), effort (days fished; middle panel) and value ($ million; lower panel) of all species by the Victorian Ocean General Fishery for 2008–2017 from the original MSS area. Note: missing data due to confidentiality policy.

6.13. Victorian Ocean Wrasse Fishery

There are 22 Victorian Ocean Wrasse Fishery licence holders (Victorian Fisheries Authority, 2017) They use hand lines to target Bluethroat Wrasse and Purple Wrasse from reef habitats. Main management methods are input controls including limited access and gear restrictions. Fishers usually conduct day trips operating out of small vessels (<10 m), and may fish at anchor or underway.

Overlap between Victorian Ocean Wrasse Fishery, and the proposed seismic survey area

The small amount of effort in this fishery in the original MSS area greatly limited the amount of data provided. In 2014, three fishers recorded a total of 14 days of effort from the original MSS area catching Bluethroat Wrasse. In 2015, three fishers recorded 27 days of effort when Bluethroat Wrasse was caught, and 14 days of effort when Purple Wrasse was caught. In 2015, three fishers recorded 25 days of effort when Bluethroat Wrasse was caught, and 22 days of effort when Purple Wrasse was caught.

Likelihood of fishing grounds developing in the future

Given the very low effort in the fishery in the area of operation, and that wrasse are generally caught in relatively shallow water, it is unlikely that fishing effort will expand in the near future.

Victoria's Ocean Wrasse Fishery is represented by Seafood Industry Victoria (SIV). Contact details for this industry association are provided in Table 20.

6.14. <u>Tasmanian Rock Lobster Fishery</u>

The Tasmanian Rock Lobster Fishery targets Southern Rock Lobster (*Jasus edwardsii*), and is managed through both input and output controls, with limited entry, gear restrictions, effort limits and a Total Allowable Commercial Catch (TACC). Baited pots are used to target lobster over reef substrate. There are two management areas subject to catch cap closures, however neither are in the region of the original MSS area. In 2018, the North East Area was re-opened to fishing on 1 March 2019[8]. The East Coast Catch Cap Area is also currently open to fishing. At the time of writing season end dates had not been set. The TACC for the 2018–19 season is 1050.7 t. There were 235 active fishers during 2011–12 (Hartmann *et al.*, 2013).

Annual catch of Southern Rock Lobster has decreased from nearly 1,500 t in 2007–08 and 2008–09, to a total of 1026.71 t during the 2017–18 quota year (Figure 84). Percent of TACC caught dropped to 91% in 2010–11, but has since been about 98%. Most of the catch comes from 0–40 m depth, however some catch is taken from as deep as 200 m (Environment Australia, 2001).

Overlap between Tasmanian Rock Lobster Fishery and area of the proposed seismic survey

Annual catches for the whole of the Tasmanian Rock Lobster Fishery fell from about 1,300 t in 2008–2009 to just over 1,000 t in 2017–2018 when 98% of the TAC was caught (Figure 84). About 29 t of Southern Rock Lobster was caught during 2008/09–2016/17 in reporting grids that overlap with the original MSS area (Table 12). This catch was taken in 20,000 pot-lifts with a value of $1.5 million. Data on seasonality could net be provided to protect confidentiality.

Annual (by fishing season) catch in fishing grids that overlap with the revised area of interest ranged 0.7 t–4.2 t over 2008/09–2016/17, and was 1.5 t in 2016/17 (Figure 85). Effort followed a similar patter, and peaked in 2010/11 at about 5,678 potlifts, and was very low in 2015/16 at only 754 pot-lifts. Revenue was highest in 2010/11 at about $0.5 million, and at its lowest was $0.04 million in 2013/14.

Total monthly catches for the whole of the Tasmanian Rock Lobster Fishery increased from winter through to a peak of about 60 t per month in March, and dropped significantly in May and June to less than 10 t per month (Figure 86). While no information on seasonality of the catch in the **revised MSS area** could be provided, since 2008 in the **original MSS area**, catches in November–April have historically been relatively high, however the number of years that comprise the total catch and effort from those months was low (most years were omitted to maintain confidentiality) (Figure 87). This is also reflected in the effort (Figure 88).

[8] http://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/rock-lobster-fishery/rock-lobster-fishing-seasons

The Tasmanian Rock Lobster Fishery catches Giant Crabs as bycatch, however there was no reported catch of Giant Crab in the revised MSS area during 2008/09–2016/17 by this, or the Giant Crab Fishery.

Likelihood of fishing grounds developing in the future

TACCs have been lowered in recent years to allow recovery of the stock, coinciding with a decease in catch from the original MSS area. The latest (2014–2015) combined stock assessment for South Australia, Victoria and Tasmania estimated that the combined egg production was above the limit reference points. If the stock recovers sufficiently it is possible that TACCs will also increase, potentially resulting in an increase in fishing in the revised MSS area.

The Tasmanian Rock Lobster Fisherman's Association represent Tasmanian Rock Lobster Fishery. Contact details for this industry association are provided in Table 20. The Tasmanian Seafood Industry Council is the peak state body representing all seafood producers.

Table 12. Tasmanian Southern Rock Lobster Fishery catch, catch value and main species caught in the areas of interest. Original data source: IMAS. Note, data have been filtered so that it comprises data from no less than 6 vessels.

Fishing seasons included	2008/09–2016/17
Number of different vessels (maximum 6 month period season)	13
Effort (pot-lifts)	20,010
Total catch (t)	29 t
Total value	$1.5 m
Main species caught	Southern Rock Lobster
Fishing methods used	Pots

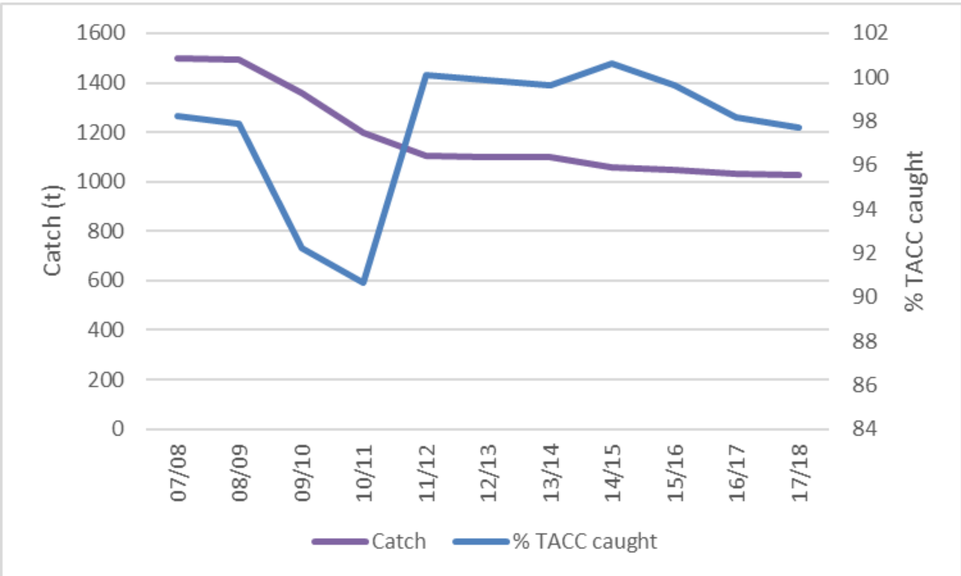
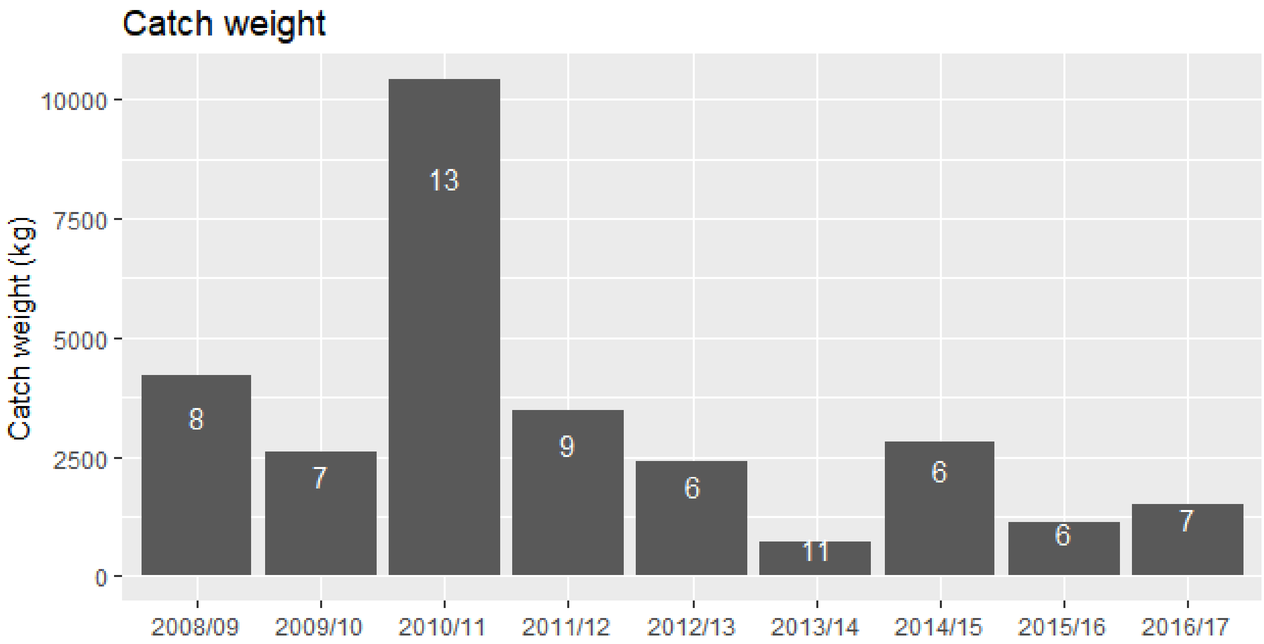
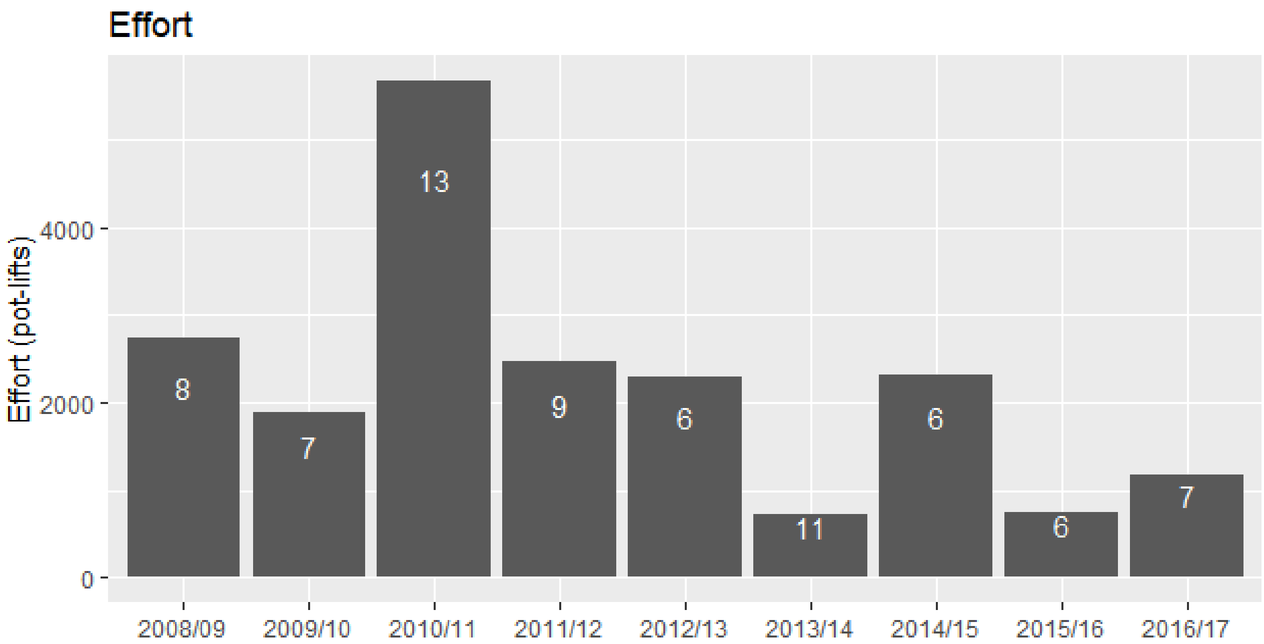


Figure 84. Annul catch of Southern Rock Lobster by the Tasmanian Lobster Fishery since 2007/08. Based on data reported by DPIPWE (2018[9]).

[9] http://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/rock-lobster-fishery/rock-lobster-catch


Catch weight
Catch weight (kg)
10000
7500
5000
2500
0
13
8
7
9
6
11
6
6
7
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17


Effort
Effort (pot-lifts)
4000
2000
0
13
8
7
9
6
11
6
6
7
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17

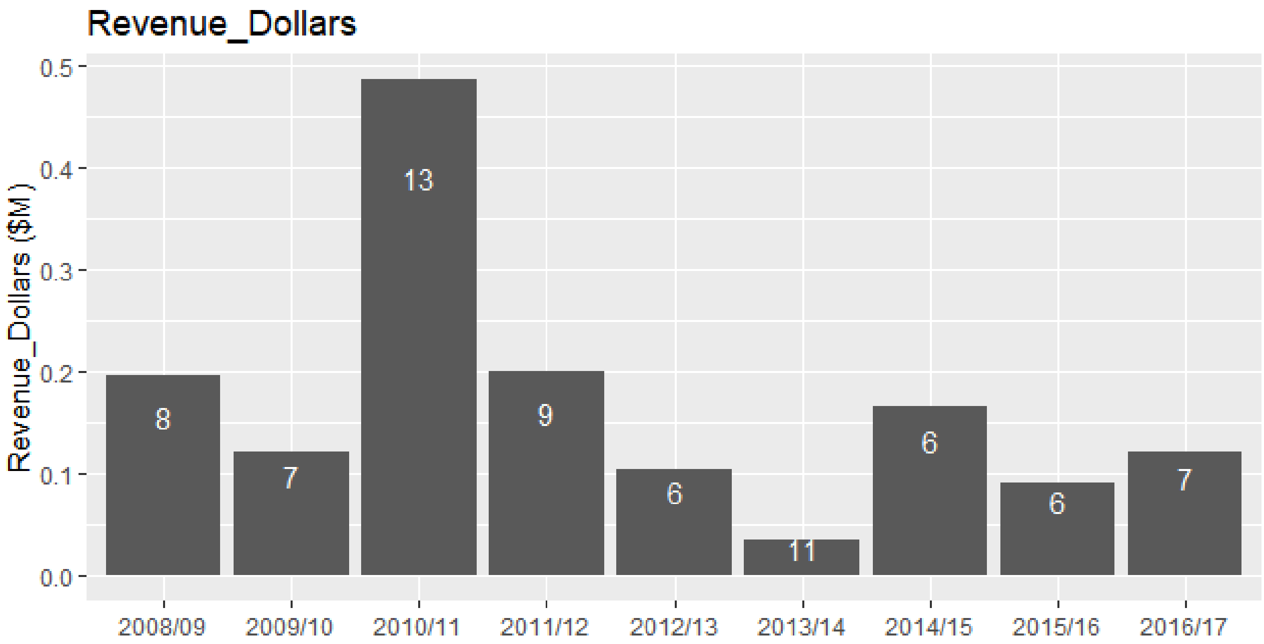


Figure 85. Top panel: Annual catch of Southern Rock Lobster by the Tasmanian Rock Lobster Fishery for 2008/09–2016/17 seasons from the revised MSS area. Middle panel: Annual effort (number of pot-lifts) by the Tasmanian Rock Lobster Fishery for 2008/09–2016/17 seasons from the revised MSS area. Lower panel: Annual revenue ($ million) by the Tasmanian Rock Lobster Fishery for 2008/09–2016/17 seasons from the revised MSS area. Minimum number of vessels contributing to data annotated — note the data on the number of vessels was for "seasonal blocks", and so the actual number of vessels contributing to these data in each year could be higher.

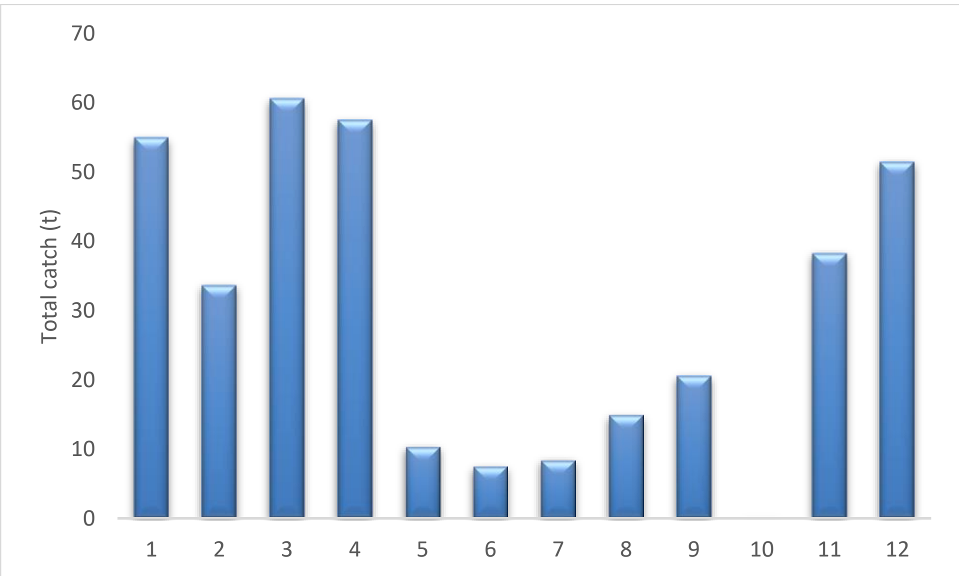


Figure 86. Total monthly catch of Southern Rock Lobster by the Tasmanian Lobster Fishery since 2007–2008.

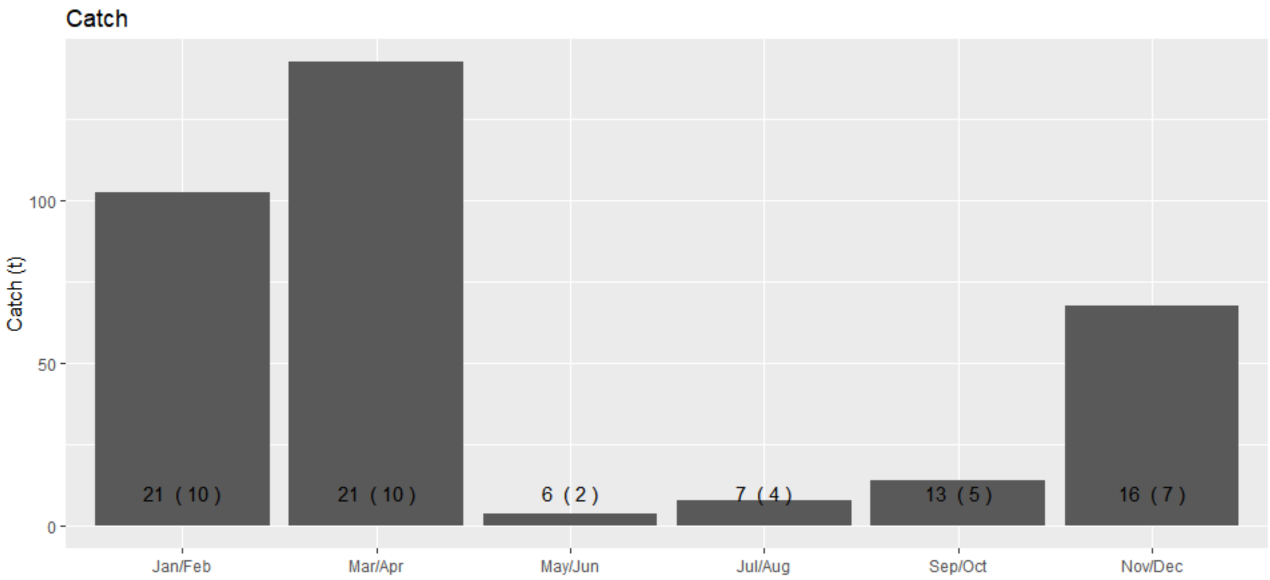


Figure 87. Bimonthly catches (t) of Southern Rock Lobster by the Tasmanian Rock Lobster Fishery for 2008–2017 from the original MSS area summed across years. The maximum number of vessels contributing to the data in any one year is annotated, and the number of years contributing to the data (not filtered to maintain confidentiality) is annotated in parenthesis.

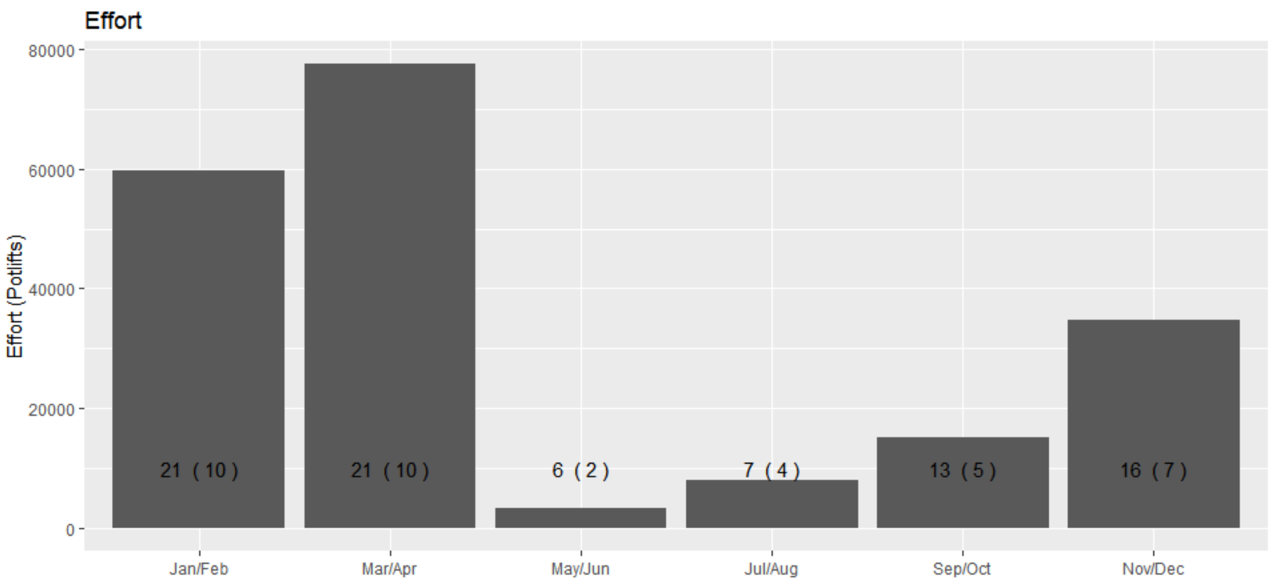


Figure 88. Bimonthly effort (pot-lifts) of Southern Rock Lobster by the Tasmanian Rock Lobster Fishery for 2008–2017 from the original MSS area summed across years. The maximum number of vessels contributing to the data in any one year is annotated, and the number of years contributing to the data (not filtered to maintain confidentiality) is annotated in parenthesis.

6.1. Tasmanian Scalefish Fishery

The Tasmanian Scalefish Fishery is multi-gear, multi-species fishery that operates in waters around Tasmania (Emery *et al*., 2017). The fishery is largely controlled via input controls such as limited entry, closed seasons and gear restrictions. Output controls include minimum and maximum size limits and quota management for Banded Morwong on the east coast. Licencing arrangements in the fishery comprises gear-based and species-based licence types and endorsements for different areas and gear types. The relevant reporting blocks are shown in Figure 6.

Gears used in the fishery include beach 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 licences in the fishery, 195 of which were active (Emery *et al*., 2017).

More than 90 different species are reported in catch logbook, and assessments conducted vary depending on them being classified as either Key Species or Minor Species, and the level of data available. Determination of stock status is based on a number of performance indicators and references points outlined in (Emery *et al*., 2017). Catch of scalefish has been declining since the late 1990s from about 1,400 t to 343 t in 2015–16. Catch of small pelagic species has generally been low, but spiked at more than 1,000 t in 2008–09 and 2009–10. Annual catches of cephalopods have generally been just below 200 t, but reached 600 t in 1999–00, 625 t in 2011–12 and 1,261 t in 2012–13.

Overlap between Tasmanian Scalefish Fishery and area of the revised proposed seismic survey area

The revised MSS area overlaps very slightly with reporting grid 4C2, however because fine scale information on fishing position is not recorded, catch and effort data that occurred inside the revised MSS area cannot be distinguished from catch and effort data that occurred outside the revised MSS area. The shallowest the revised MSS area comes into that reporting grid is about 110 m.

From 2007/08–2017/18 as many as 5 different vessels (a total of 16 different vessels in that year) fished in the revised MSS area in any one year, undertaking a total of 103 fishing days, catching about 4 t of fish valued at about $25,720 (Table 13). Because of the low number of vessels reporting in any one year, annual catch of effort cannot be reported

Main species caught over 2007/08–2017/18 in the revised MSS area (in order of total catch) are Gummy Shark (0.9 t) and Striped Trumpeter. Striped Trumpeter are targeted using hand lines and drop lines. Figure 89 shows the distribution of catch of Striped Trumpeter and dropline effort (the main gear used to target Striped Trumpeter) in the revised MSS area from 2011–20012 to 2015–2016, and from 2016–2017 alone. Both maps show catch and effort in the grid that overlaps with the revised MSS area.

At least six different gear types were recorded over 2007/08–2017/18 in the revised MSS area (Table 15). Of those, only handline was used by more than 5 operators, catching 1.9 t of fish. Six different vessels fished in water deeper than 110 m, catching 2.2 t from 42 fishing days, with a value of $13,266. Most catch is taken during summer, when 2.2 t of fish was caught by 11 different vessels over 53 fishing days during 2007/08–2017/18 in the revised MSS area (Table 16). Data from other seasons is confidential.

Likelihood of fishing grounds developing in the future

Given the declining catches in the fishery overall, and especially from the original MSS area, and the very low 2008–2017 catch and effort from revised MSS area, it is unlikely that there will be an expansion of the fishery in the near future. However, both small pelagic species and Gould’s Squid can undergo large annual fluctuations in biomass, and it is possible that those species might “boom” in the original MSS area, which could attract significant amounts of fishing effort in the area. But this is impossible to predict.

Table 13. Tasmanian Marine Scalefish Fishery catch, catch value and main species caught in the areas of interest. Original data source: IMAS. Note, data have been filtered so that it comprises data from no less than 6 vessels. Value calculated using industry provided market values for species where catch was provided, and an assumed $2.50 per kg for all other species combined.

Years included	2008–2017
Maximum number of vessels used in any one year	5
Maximum number of vessels used over 10 years	16
Total days fished	103
Total catch (t)	4.1 t
Total value	$25,720
Main species caught	Gummy Shark Striped Trumpeter
Main fishing methods used	Bottom longline Drop line Gillnet Handline Shark longline

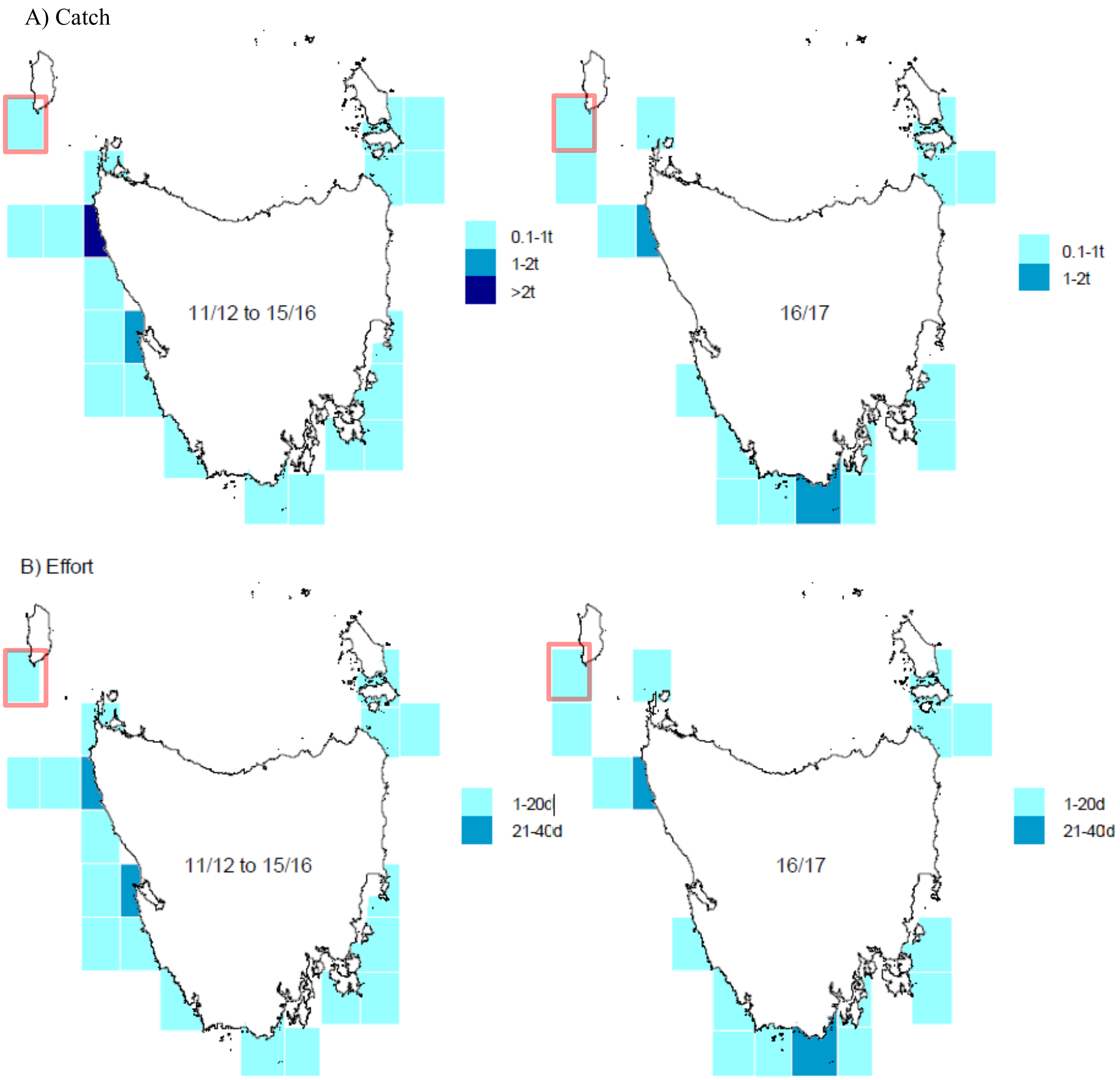


Figure 89. Average catch (t) of Striped Trumpeter and effort (days) for dropline, hand-line and gillnet by fishing block from 2011/12 to 2015/16 (left) and 2016/17 (right). Note that this data includes that from the Commonwealth managed SSJF. From Moore *et al*. (2018). Grids that overlap with the original MSS area shown in red.

Table 14. Species caught by Tasmania's Marine Scalefish Fishery in the original MSS area over 2007/08 – 2017/18. Where data comprised at least 6 operators, catches (t) and number of operators are shown in parenthesis.

Species
Sand Flathead
Jackass Morwong
Morwong other
Yellowtail Kingfish
Ling
Gummy Shark (935 kg; 10)
School Shark
Snapper
Sweep
Bastard Trumpeter
Striped Trumpeter (2185 kg; 6)
Blue Warehou
Blue Throated Wrasse
Purple Wrasse

Table 15. Fishing gear and number of operators used by Tasmania's Marine Scalefish Fishery in the original MSS area over 2007/08 – 2017/18. Where data comprised at least 6 operators, the total catch (t) is also shown.

Species	Catch weight (t)	Number of vessels
Bottom longline	CONFIDENTIAL	<6
Drop line	CONFIDENTIAL	<6
Dip net	CONFIDENTIAL	<6
Gillnet	CONFIDENTIAL	<6
Handline	1.9 t	10
Shark longline	CONFIDENTIAL	<6

Table 16. Total catch (t) by two month blocks from 2007/08–2017/18 by Tasmania's Marine Scalefish Fishery in the original MSS area.

Season	Catch weight (t)	Number of vessels	Effort (vessel days)
Summer	2.2	11	53
Autumn	Confidential	<6	Confidential
Winter	Confidential	<6	Confidential
Spring	Confidential	<6	Confidential

6.2. South Australian Southern Zone Rock Lobster Fishery

The South Australian Southern Zone Rock Lobster Fishery targets Southern Rock Lobster (*Jasus edwardsii*), and is managed through both input and output controls, with limited entry, gear restrictions, effort limits and a Total Allowable Commercial Catch (TACC) (Linnane *et al*., 2017). Baited pots are used to target lobster over reef substrate. There fishery operates in all marine waters between the mouth of the Murray River and the Victorian border (Figure 90).

Annual catch and effort fluctuated in cycles until the TACC was introduced in 1993 (Figure 91). In 1998 despite still catching the TACC, effort declined sharply before increasing just before the TACC was dropped in 2008, 2009 and 2010. Effort has since steadied, along with the TACC and catch. From 1,295,715 potlifts in 2016–17, the fishery landed 1,237.7 t of its 1,245.7 t TACC (Linnane *et al*., 2017). In the 2016 season, catch and effort in the fishery increased from October and peaked in January at about 300 t of catch and 260,000 potlifts (Figure 92). Both catch and effort declined as the season continued to May. The fishery is closed from June to September, and in 2010 was also closed in October.

Overlap between South Australian Southern Zone Rock Lobster Fishery and area of the proposed seismic survey

Most of the Southern Zone Rock Lobster Fishery catch is taken in MFAs 55, 56 and 58 (Figure 95). Annual catch in MFAs 54, 55, 56 and 58 decreased 1,850 t in 2007–2008 to about 1,240 t since 2009–2010 in line with the TACC (Figure 94). Despite this drop, the value increased from around $70 million per year to $113 million in 2015–2016 (Figure 94). Catch and effort are consistently high from October–January, and through to March in some years, dropping during April and May (Figure 95).

The depth distribution of the SZRL catch is shown in Figure 96. About 40% of the total catch is taken in depths shallower than 30 m, and 80% taken shallower than 80 m depth.

The depth distribution of the SZRL catch is shown in Figure 96. About 40% of the total catch is taken in depths shallower than 30 m, and 80% taken shallower than 80 m depth. Because the MSS overlaps with the three reporting grids from which nearly all of the catch is taken, and that most of the overlapping areas are outside of the depth where Southern Rock Lobster are caught, we combined the depth distribution of the catch (Figure 98) reported in Linnane *et al*. (2017) with the proportion of the area of each grid in each depth category to estimate the total catch directly affected by the MSS. Catches in MFAs 55, 56 and 58 are 4.7 t, 20.0 t and 65.3 t respectively, totalling 90.1 t. Note that very little catch is taken in MFA 54, and only a very small fraction of that grid is in water shallower than 100 m. Based on the 2015–2016 beach prices provided by SARDI ($90.7 per kg), the total value of the affected catch is $8.2 million.

Likelihood of fishing grounds developing in the future

Catch, effort and fishery indicators have been stable in this fishery since 2010. Historically both catch and effort have widely fluctuated and it is possible that even with a stable TACC, that effort might increase if catch per unit effort decreases to catch the available TACC.

The South Australian Rock Lobster Advisory Council represent the South Australian Southern Zone Rock Lobster Fishery. Contact details for this industry associations are provided in Table 20.

Table 17. South Australia Rock Lobster Fishery effort, catch, catch value and main species caught in the MFAs 54, 55, 56 and 58. Original data source: SARDI. The catch and values reported is from the estimated proportion directly affected, and total reported catch and value of entire reporting grids are shown in parenthesis. Effort reported is for entire reporting grids.

Years included	2007/08–2016/17
Number of different vessels	More than 5
Days fished	200,615
Total catch (t)	901 t (13,193 t)
Total value	$81.707,000 ($852,854,000)
Main species caught	Southern Rock Lobster
Fishing methods used	Pot

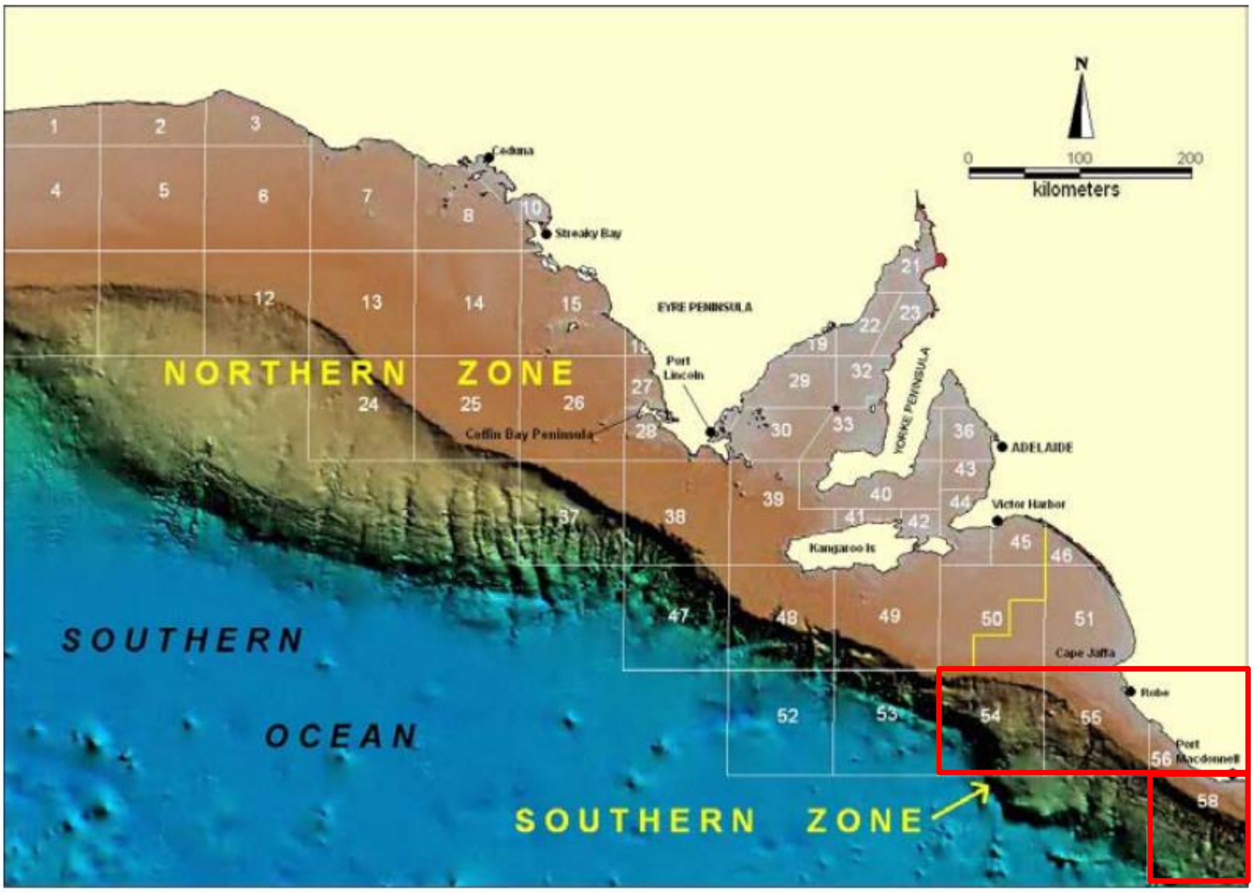


Figure 90. Area of the Northern and Southern Zone Southern Rock Lobster Fisheries showing Marine Fishing Areas.

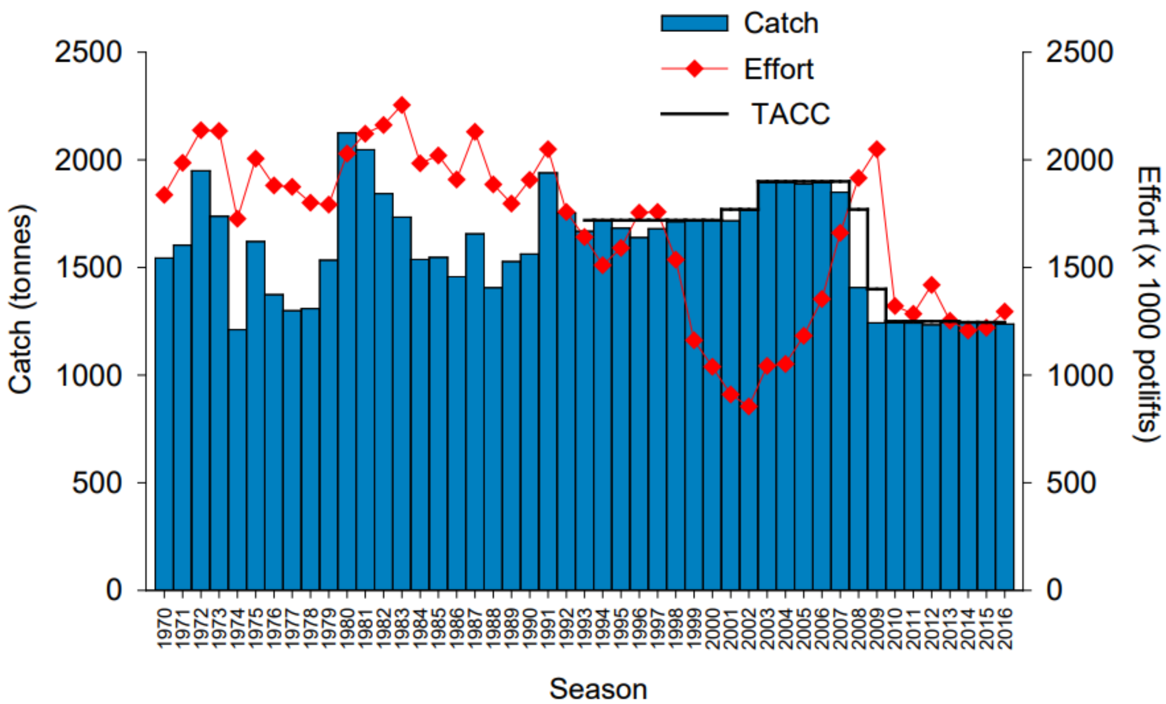


Figure 91. Annual catch (t) and effort (1000 potlifts) by the Southern Zone Southern Rock Lobster Fishery from 1970 to 2016 (Linnane *et al.*, 2017).

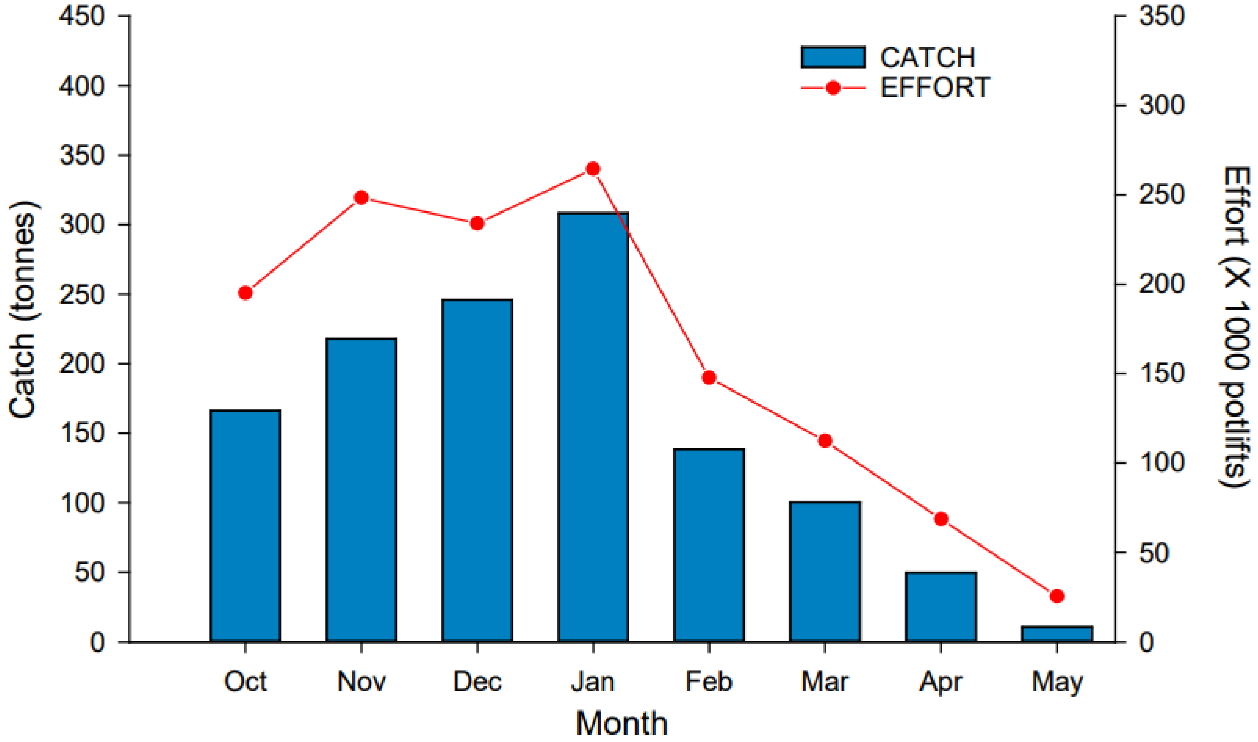


Figure 92. Monthly catch (t) and effort (1000 potlifts) by the Southern Zone Southern Rock Lobster Fishery in 2016 (Linnane *et al.*, 2017).

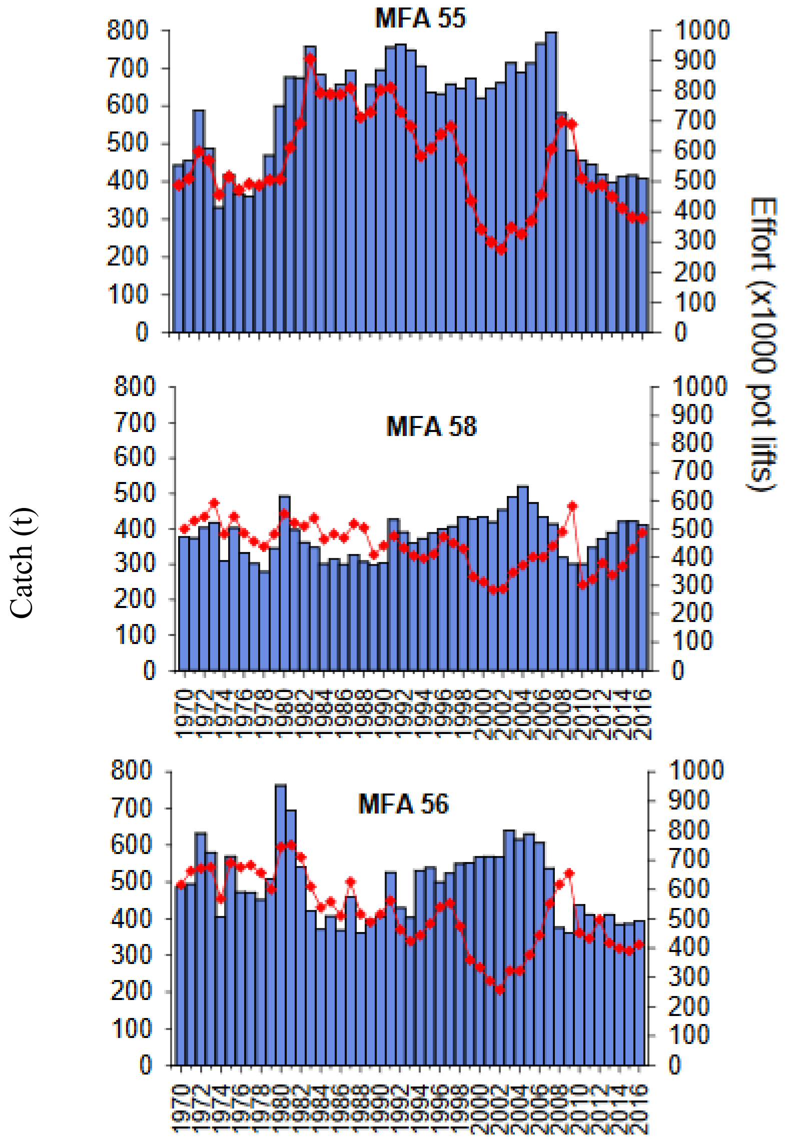


Figure 93. Annual catch (t) and effort (1000 potlifts) in MFAs 55, 56 and 58 by the Southern Zone Southern Rock Lobster Fishery from 1970 to 2016 (Linnane *et al*., 2017).

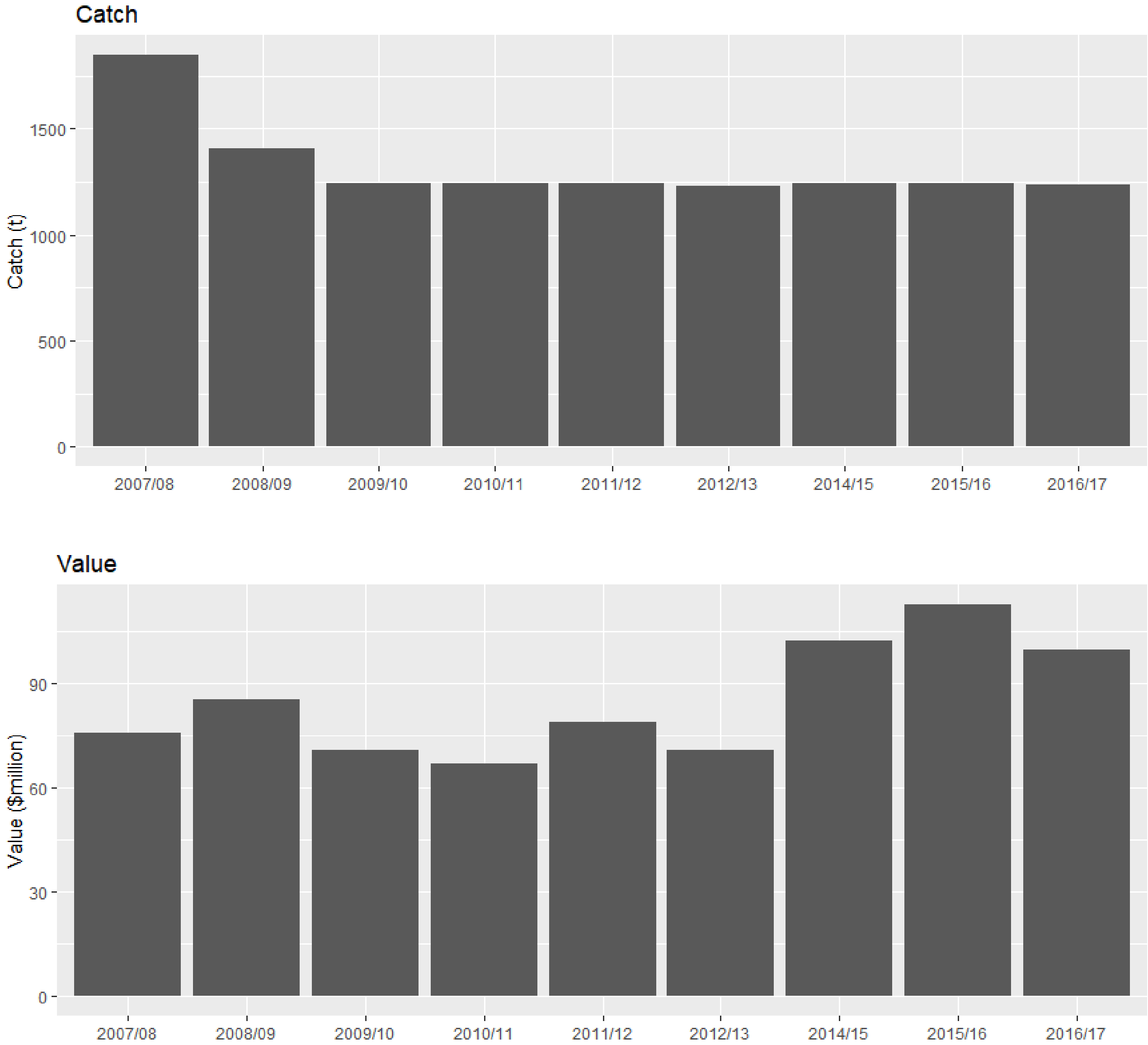


Figure 94. Catch (t; top panel) and value ($ million; lower panel) by the South Australia's Southern Zone Rock Lobster Fishery from Marine Fishing Areas 54, 55, 56 and 58 (see Figure 8).

Figure 95. Catch (t; left panel), effort ('000 potlifts; right panel) and value ($ million; lower panel) by the South Australia's Southern Zone Rock Lobster Fishery from Marine Fishing Areas 54, 55, 56 and 58.

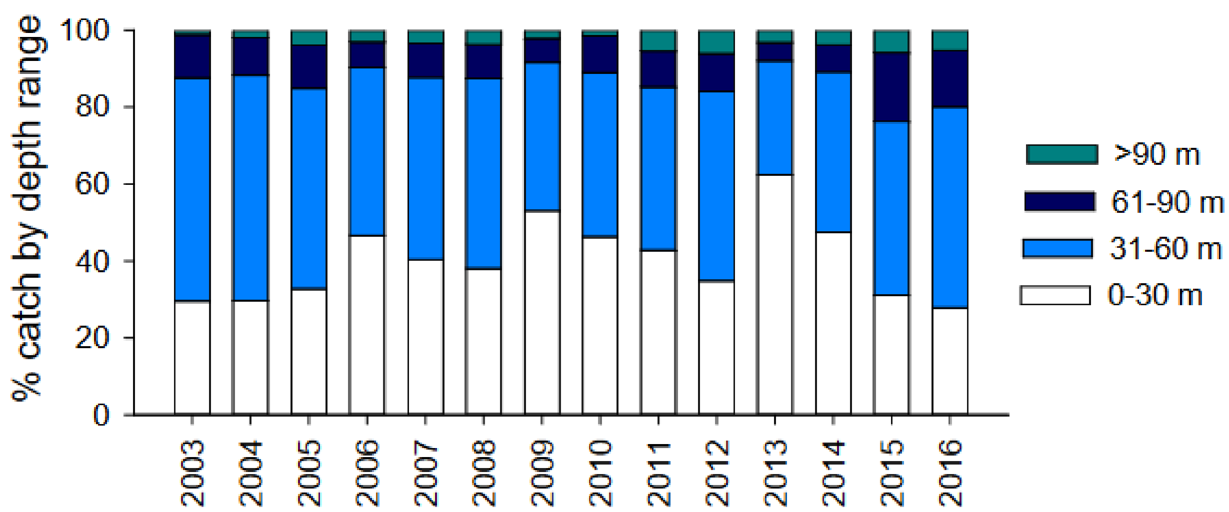


Figure 96. Percentage of catch by depth from 2003 to 2016 in the Southern Zone for the SZRLF (from Linnane et al., 2017).

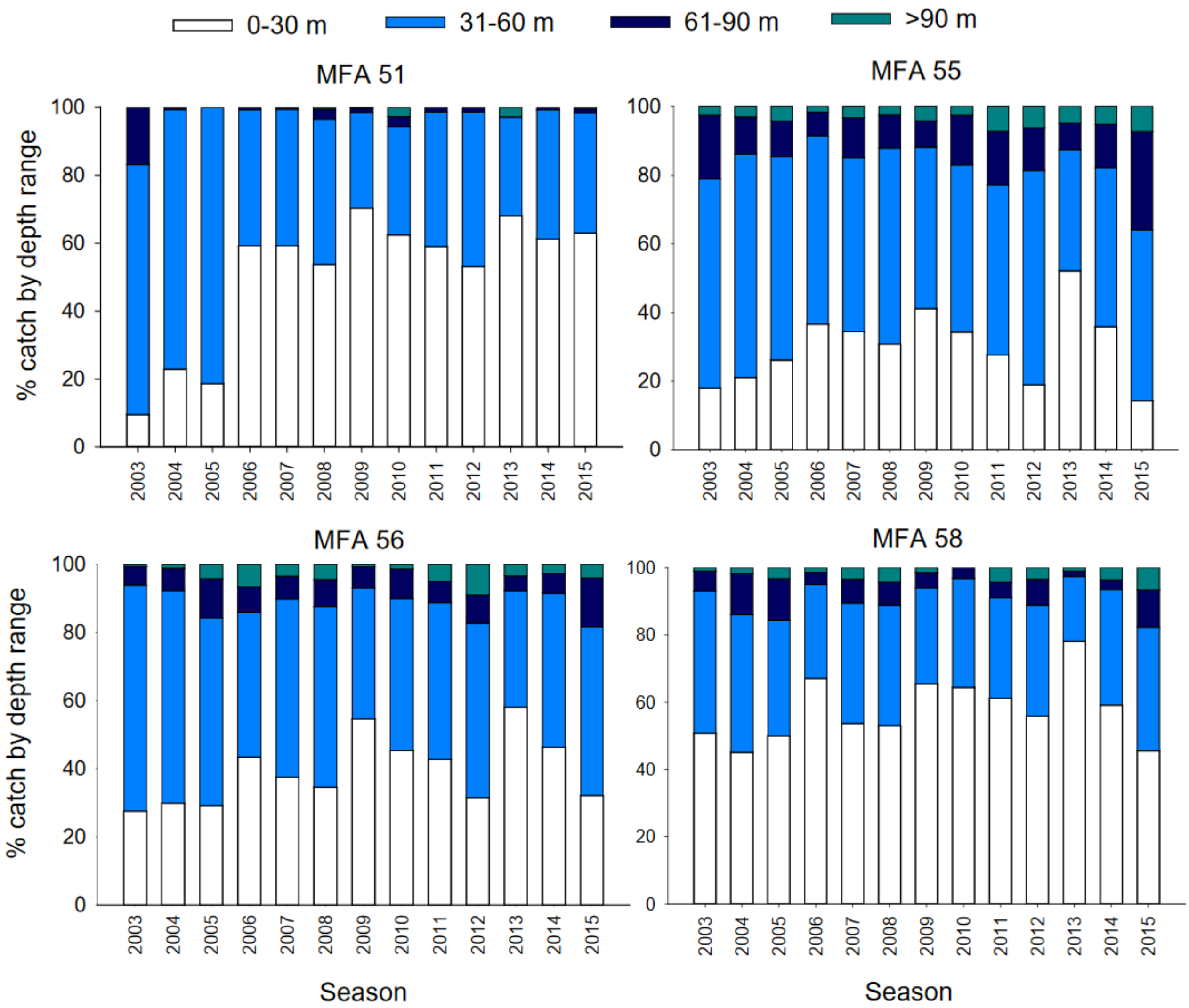


Figure 97. Percentage of catch by depth from 2003 to 2015 by MFA in the Southern Zone for the SZRLF (from Linnane et al., 2017).

6.3. South Australian Marine Scalefish Fishery (MSF)

The Marine Scalefish Fishery is a multi-species, multi-gear fishery that operates in all coastal waters of South Australia between the Western Australian and Victorian border, and for some species this extends out 200 nm to the extent of the EEZ (PIRSA, 2018). Main species caught are King George Whiting, Southern Garfish, Snapper and Southern Calamari. The 316 MSF licences caught about 2000 t of fish in 2016 from 55,837 fisher days (Steer *et al*., 2018).

Overlap between South Australian Marine Scalefish Fishery and area of the proposed seismic survey

Four catch reporting grids (Marine Fishing Areas 54, 55, 56 and 58, see Figure 8) overlap with the original MSS area. Significant effort has occurred in those areas in the past, particularly up until 1998 (about 1000 fisher days in two of the areas), but has since dropped to less than 150 days per year (Figure 98). From September 2007 to May 2017 (apart from three seasons were data was not provided to protect confidentiality), a total of 300 t of fish was taken from 2571 days fishing, with a value of $1.7 million (Table 18). Seasonality of the catch has been inconsistent over time, but effort has been lowest during June – August since 2007 and relatively stable throughout the other seasons (Figure 99). Seasonality in catch value has also been inconsistent between years, reaching as high as $225,000 in June–August 2010 (Figure 100).

Likelihood of fishing grounds developing in the future

In 1994 a licence amalgamation scheme was introduced to reduce the number of licences in the fishery which has removed about 15 licences per year (Steer *et al*., 2018). Combined with a lack of recent effort in MFA 54, 55, 56 and 58, it is unlikely that there will be an increase in fishing effort in that MFA in the foreseeable future.

The MSF is represented by the Marine Fishers Association. Their contact details are provided in Table 20.

Table 18. South Australia's MFA effort, catch, catch value and main species caught in the MFA 54, 55, 56 and 58 from September 2007 to May 2017. Original data source: SARDI. Note that this does not include data from three seasons for which there was not enough vessels to comply with confidentiality policies.

Years included	2007–2017
Number of different vessels	More than 5
Total days fished	2571
Total catch (t)	300 t
Total value	$1,666,663
Main species caught	Gummy shark Yellow-eye mullet Australian salmon,
Fishing methods used	Longline Minor line Haul seine Mesh nets

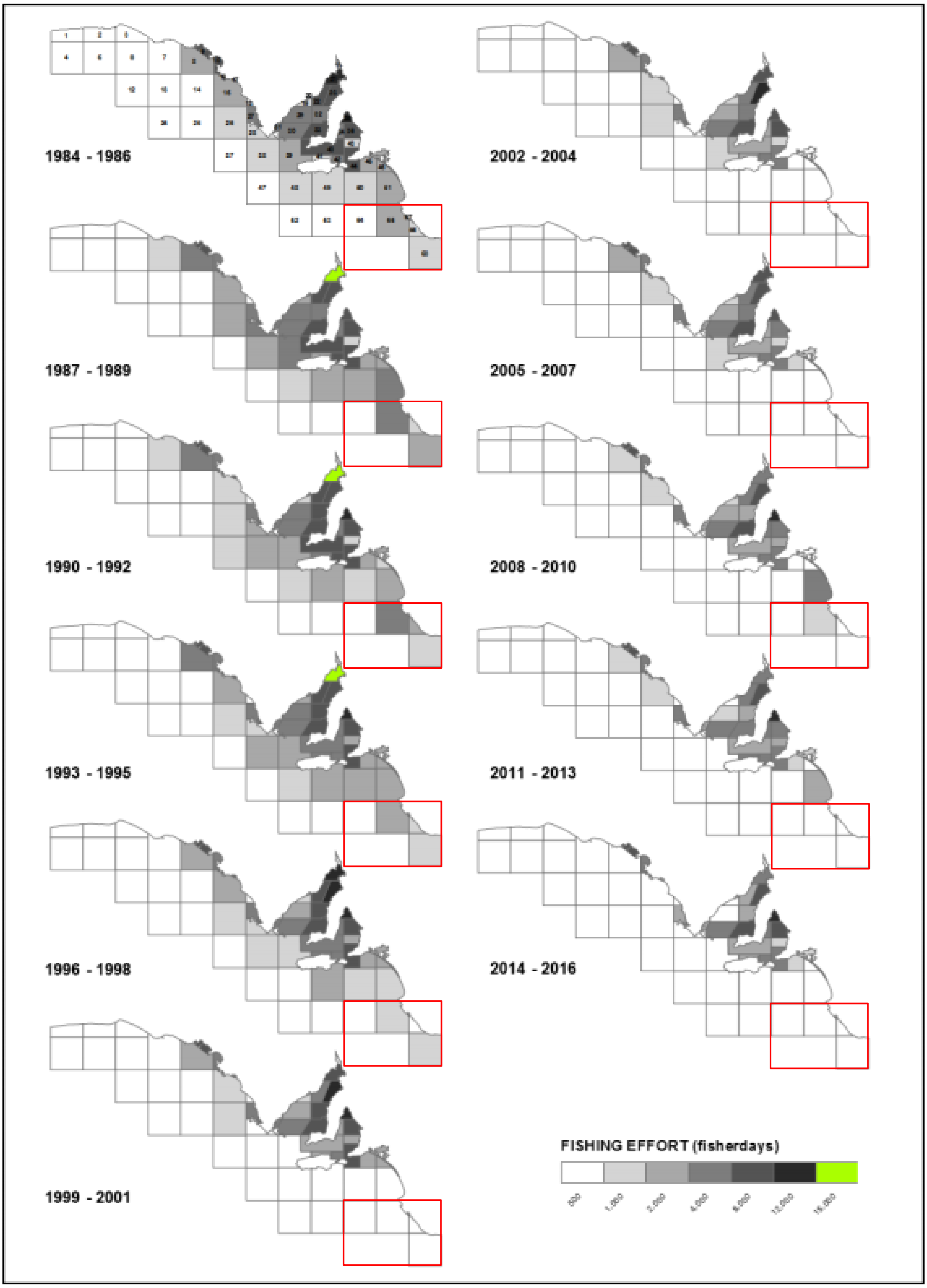


Figure 98. Distribution of fishing effort (fisher days) by the MSF averaged over triennia from 1984–2016 (from Steer *et al*., 2018). MFAs that overlap with the area of operation are within the red rectangle.

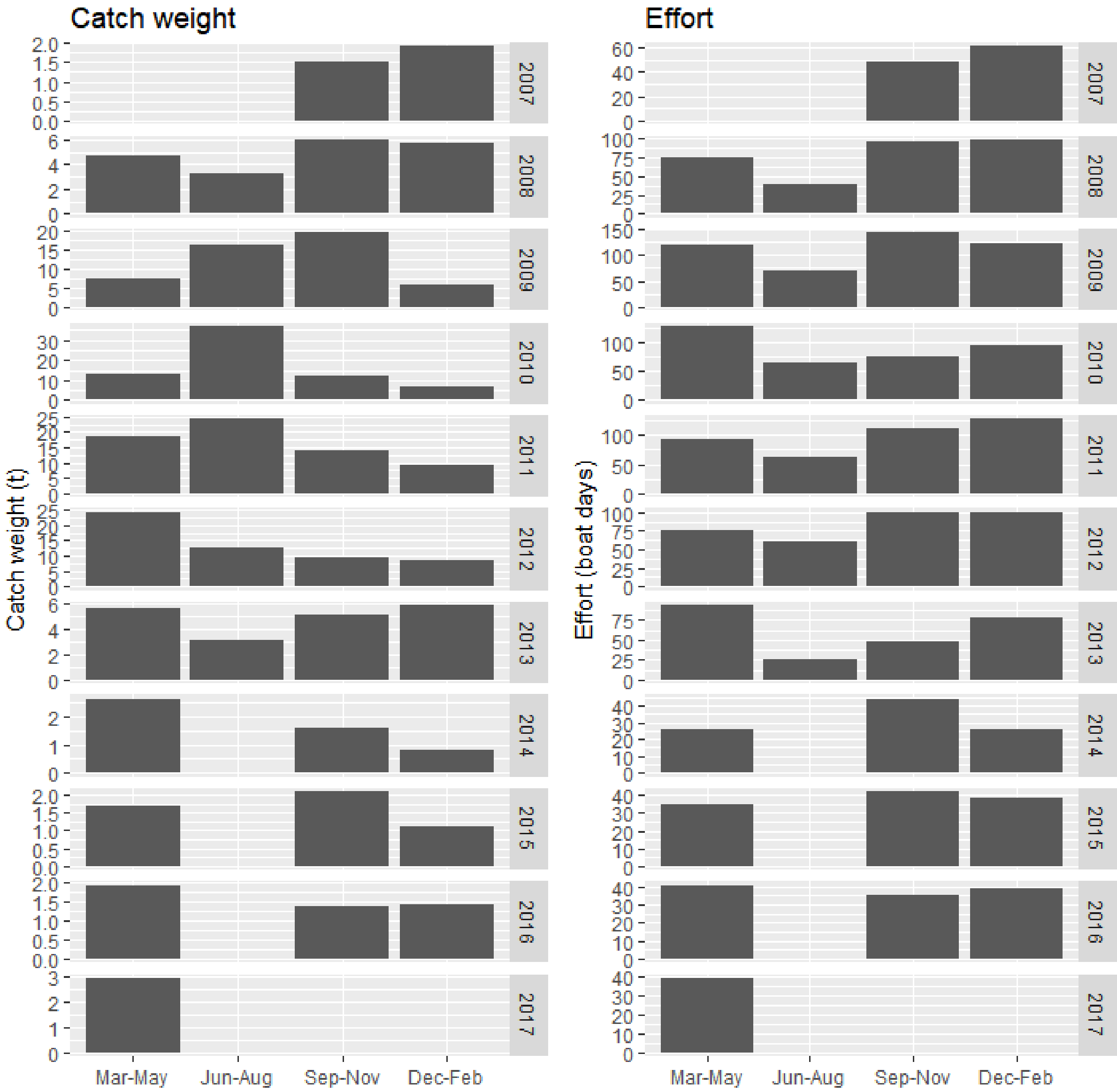


Figure 99. Catch (t; left panel) and effort (days fished; right panel) by South Australia's Marine Scalefish Fisheries from Marine Fishing Area that overlap the original MSS area by season. Not that where season spans two years, the year displayed is the earlier of the two.

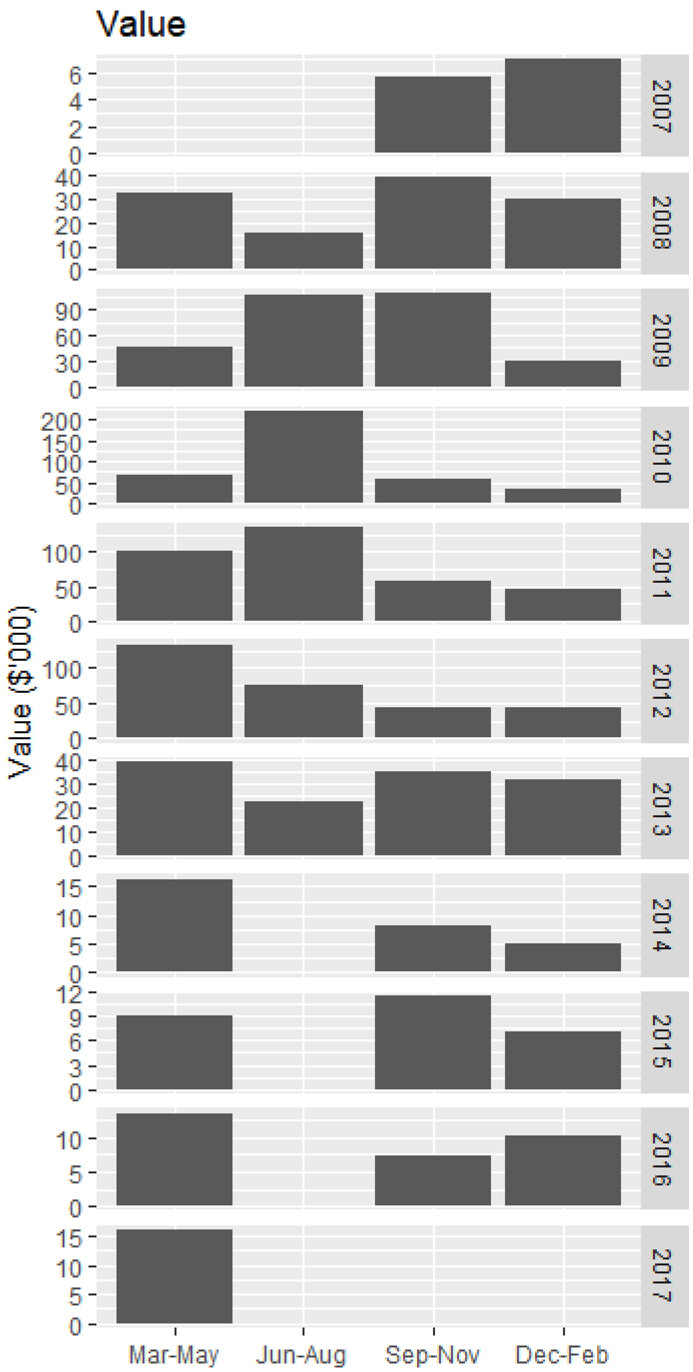


Figure 100. Value ($'000) of fish caught by South Australia's Marine Scalefish Fisheries from Marine Fishing Area that overlap the original MSS area by season. Not that where season spans two years, the year displayed is the earlier of the two.

6.4. South Australian Southern Zone Abalone Fishery (SZAF)

The South Australian Southern Zone Abalone Fishery (SZAF) targets Blacklip (*Haliotis rubra*) and Greenlip (*Haliotis laevigata*) abalone using hand harvesting while diving. The SZAF is managed using both input and output controls including: limited entry, gear restrictions, spatial closures, Total Allowable Commercial Catches (TACCs) and size limits. Catches of Blacklip Abalone increased through the 1970s and peaked at just over 180 t in 1992 (Figure 101). Catches remained stable at around 150 t before falling slightly to about 130 t from 2013 onwards. About 19 t of Greenlip Abalone was landed in 1968, but this fell the following year and has ranged <1 t to 7 t per year since (Figure 101). Over the past ten years, the total annual value of the SZAF ranged from just under $3.5 million to more than $5 million (Figure 102).

Overlap between South Australian Abalone Fishery and area of the proposed seismic survey

The area of operation overlaps several reef codes of the SZAF (Figure 9), however abalone diving is generally restricted to depths of 30 m, and it is unlikely that the MSS area overlaps with the actual reefs fished. Bi-monthly catch from the overlapping reef code is shown in (Figure 103). Seasonality varies between years, but the highest catches are generally taken from November – December when the most effort is usually recorded (Figure 104). Catch and effort are also relatively high during March to June.

Over the 2007–2008 to 2016–2017 seasons, a total of 1,132 days fishing was reported in the reef codes that overlapped with the original MSS area, landing 655 t of abalone valued at $189 million (Table 19). However, given that the MSS area is unlikely to overlap with the actual reefs fished, we have categorised the catch and catch value as negligible.

Likelihood of fishing grounds developing in the future

The TACC was dropped to 126 t of Blacklip Abalone in 2015 from 151.5 t the year before (Ferguson et al., 2017). The TACC of Greenlip Abalone was also dropped from 7.2 t in 2014 to 3.6 t in 2016. With the stocks of Blacklip Abalone classified as transitional depleting in the last published stock assessment (Ferguson et al., 2017), it is unlikely that fishing effort in this region will be increased in the near future.

The SZAF are represented by the Abalone Industry Association of South Australia Inc. Contact details for this industry associations are provided in Table 20.

Table 19. South Australia's Southern Zone Abalone Fishery effort, catch, catch value and main species caught in the mapcodes 39A, 39B, 39C, 39D, 39F, 39G, 40A and 40B from September 2007 to April 2017. Original data source: SARDI. The catch, value and effort reported are deemed negligible, and total reported catch and value of entire reef areas are shown in parenthesis. Note that this does not include data from months for which there was not enough vessels to comply with confidentiality policies. * Value was calculated from the proportion of the total catch in each year taken from mapcodes 39A, 39B, 39C, 39D, 39F, 39G, 40A and 40B multiplied by the total value for the fishery in each year.

Years included	2007–2017
Number of different vessels	More than 5
Total days fished	Negligible (1,132)
Total catch (t)	Negligible (655 t)
Total value	Negligible $189,08,000*
Main species caught	Blacklip Abalone Greenlip Abalone
Fishing methods used	Hand Harvest

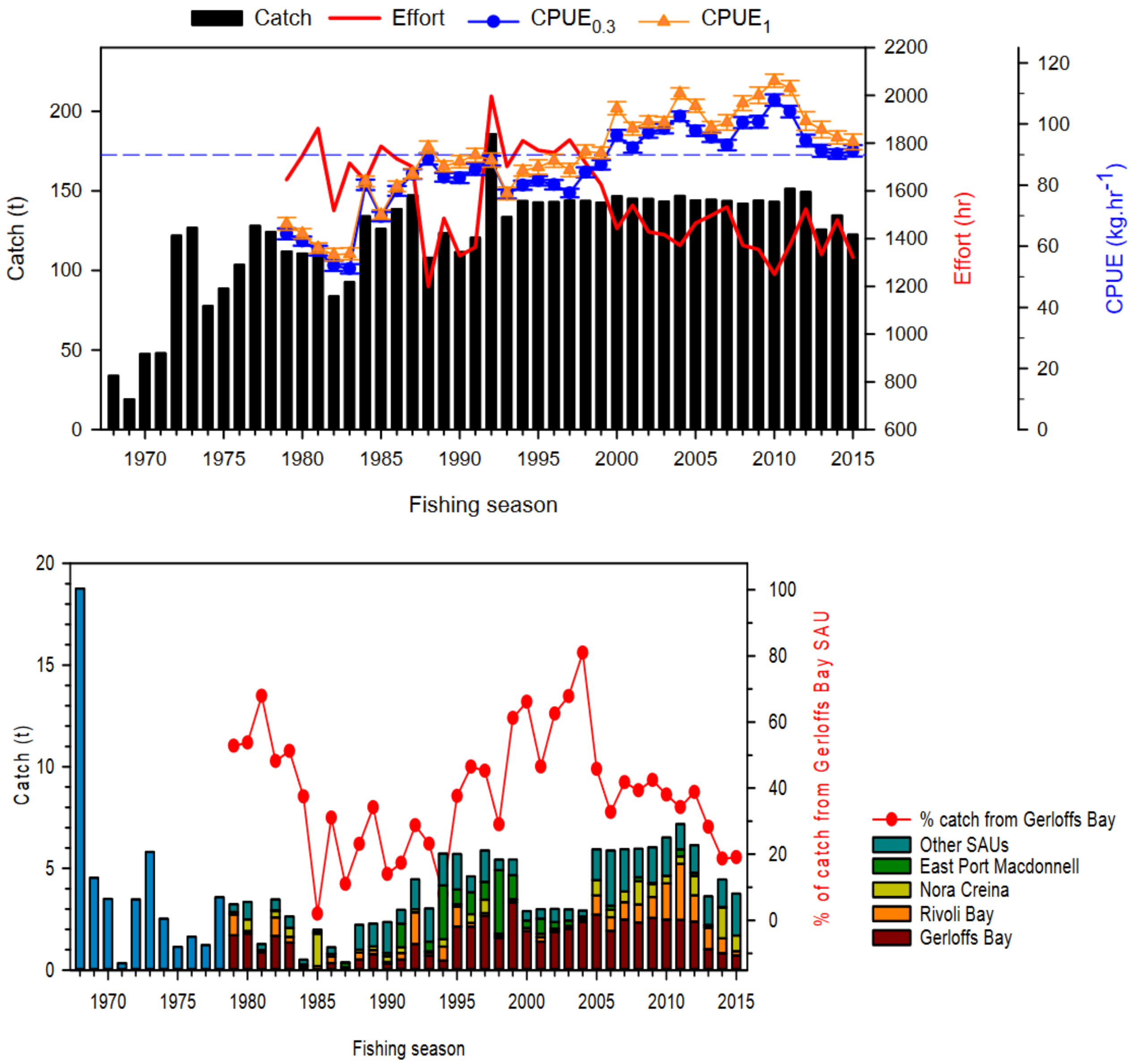


Figure 101. Annual catch of Blacklip (top panel) and Greenlip (lower panel) abalone from 1968–2015 (Ferguson et al., 2017).

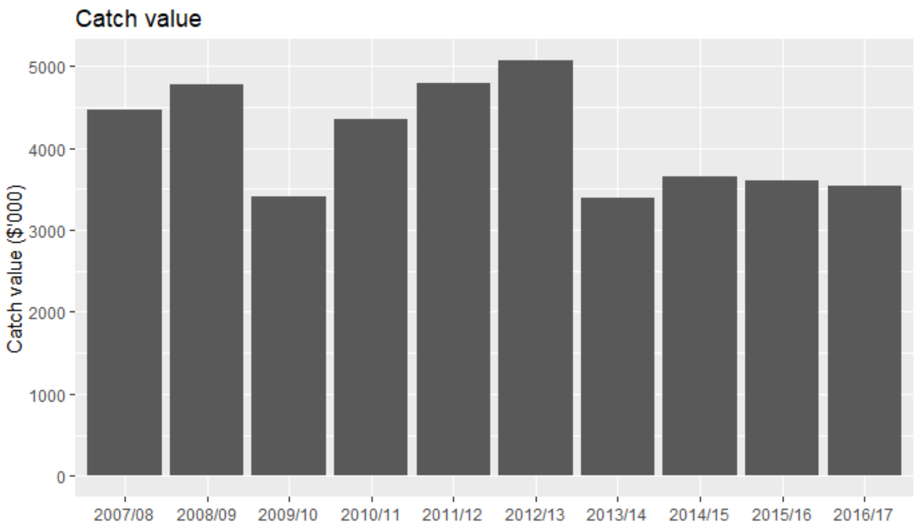


Figure 102. Annual catch value ($'000) of abalone from the whole SZAF from 2007–2008 to 2016–2017 (Data provided by SARDI).

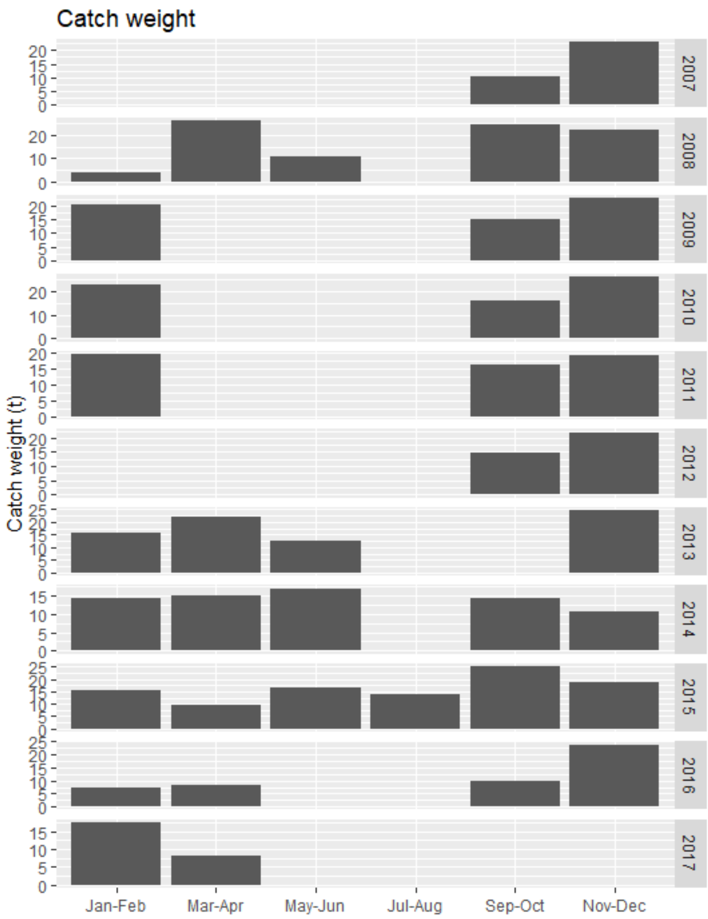


Figure 103. Bimonthly catch (t) of abalone from the SZAF in Reef Codes that overlap with the area of operation from September–October 2007 to March–April 2017 (Data provided by SARDI). Note, data from some month are missing due to the confidentiality policy.

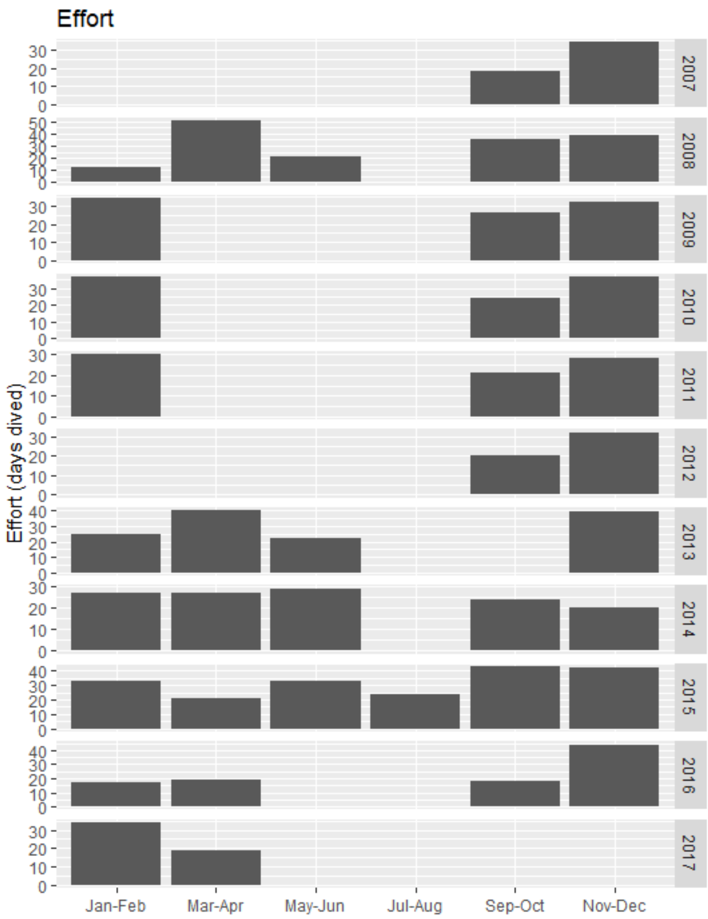


Figure 104. Bimonthly effort (days dived) of abalone from the SZAF in Reef Codes that overlap with the area of operation from September–October 2007 to March–April 2017 (Data provided by SARDI).

6.5. South Australian Charter Boat Fishery (CBF)

The South Australian Charter Boat Fishery is managed through a licensing and registration system, and is subject to bag, boat, size and trip limits. It operates in South Australian marine waters, and is considered a commercial platform for recreational fishing (Tsolos and Boyle, 2015). While the catch is taken by recreational fishers, Charter Boat operators must report catch and effort in logbooks.

Overlap between South Australian Marine Scalefish Fishery and area of the proposed seismic survey

Detailed catch and effort data was not provided because of confidentiality issues, however from 2007–2008 to 2016–2017, the Charter Boat Fishery undertook 868 trips in MFA 58 alone, retaining 5,992 fish. The fishery is seasonal, peaking in January and February each year, and is lowest in July and August. Main species caught in the Victor Harbour / South East region (Figure 105) were Southern Bluefin Tuna, Snapper and King George Whiting (Rogers et al., 2017). Fishing in this sector in the Victor Harbour / South East region is diverse comprising inshore, offshore and game fishing (Steer and Tsolos, 2016).

Likelihood of fishing grounds developing in the future

The number of licences, active licenses and effort have all decreased since 2012 (Tsolos and Boyle, 2015), and there is no information to suggest that there will be an increase in CBF effort in these MFAs in the near future.

The CBF was represented by the Charter Boat Owners Association, but their contact details are no longer publicly available.

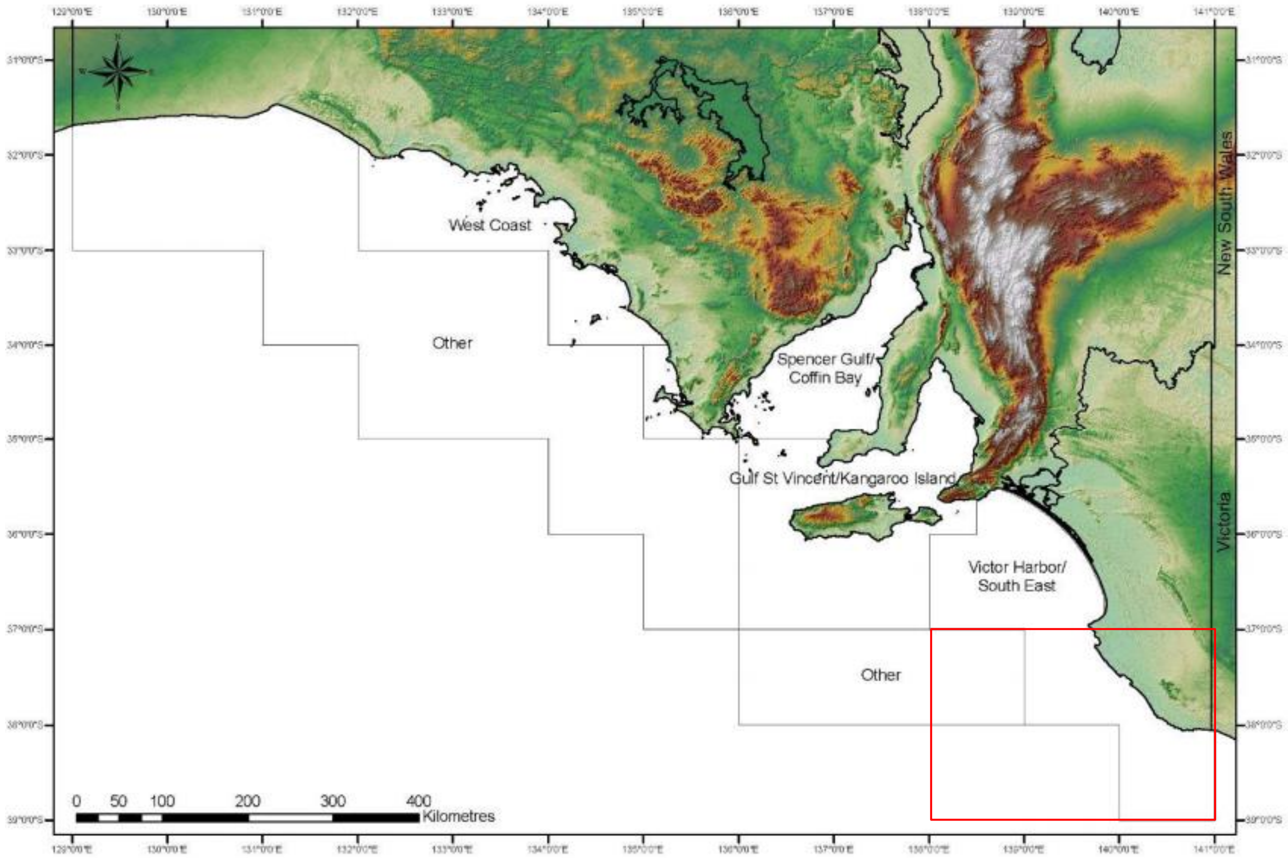


Figure 105. Amalgamated reporting areas used by Tsolos and Boyle (2015) to describe catch and effort. MFAs 54, 55, 56 and 58 are highlighted by the red polygon. These MFAs are reported as Victor Harbour / South East and Other management units.

6.6. South Australian Giant Crab Fishery (GCF)

The South Australian Giant Crab Fishery targets the Giant Crab (*Pseudocarcinus gigas*) using baited traps by the South Australian Miscellaneous Fishery and South Australian Rock Lobster Fishery. The highest annual catch by the fishery was 34.7 t in 1997, and a TACC of 26 t was implemented in 1999 (Figure 106). In 2016 the 7,157 targeted potlifts caught 16.8 t of the 22.1 t Giant Crab TACC (Figure 106) (McLeay, 2018).

Overlap between South Australian Giant Crab Fishery and area of the proposed seismic survey

Because of the small number of operators in the fishery, no detailed data was provided for this fishery, and no information on seasonality or spatial distribution of the catch and effort was found.

Likelihood of fishing grounds developing in the future

The TACC has remained at 22.1 t since 2000, and there is no information to suggest that this will be increased in the near future.

We believe that the Giant Crab Fishery is represented by the South Australian Rock Lobster Advisory Council. Contact details for this industry associations are provided in Table 20.

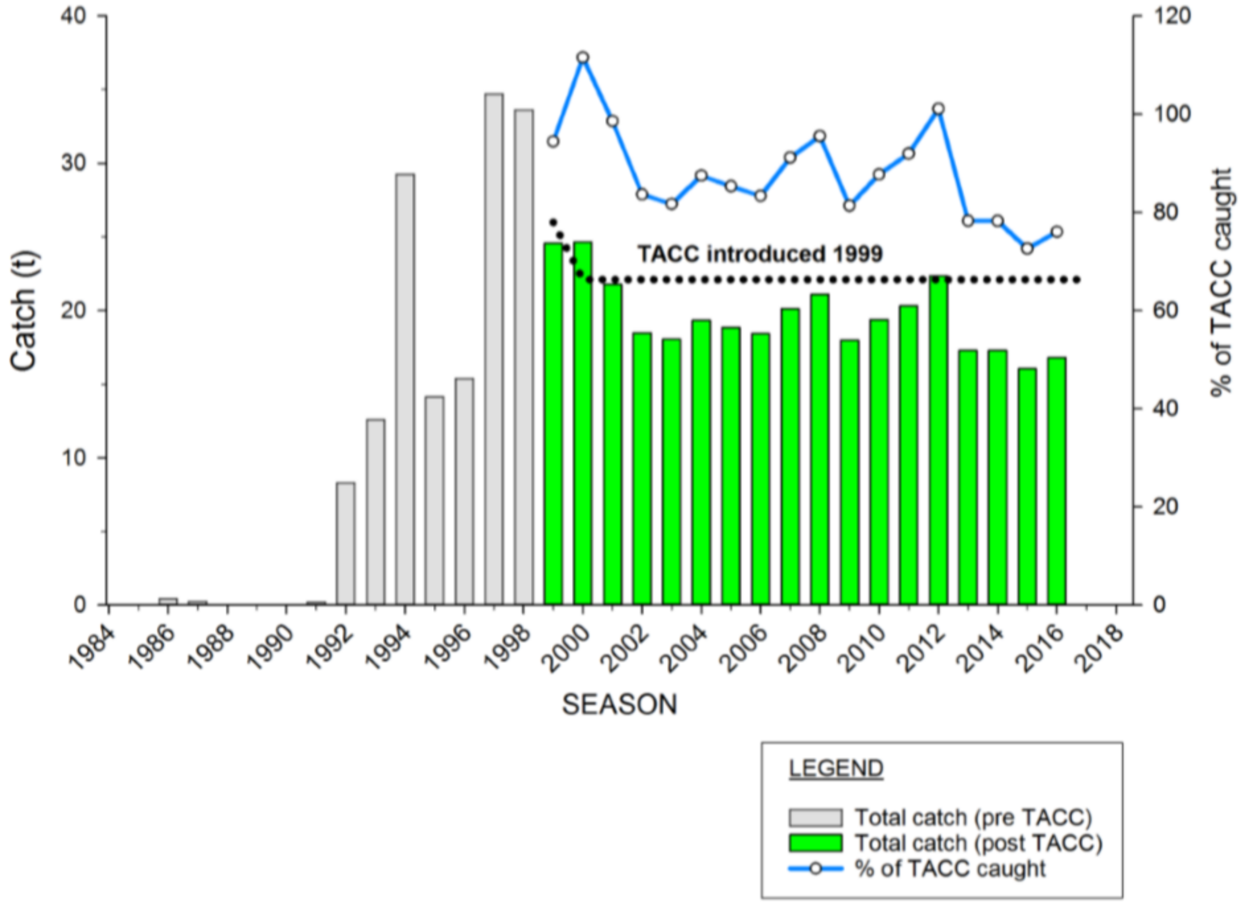


Figure 106. Total catch (t) of Giant Crab, TACC (t) and percent of TACC caught from 1984 to 2016 (McLeay, 2018).

7. SUGGESTED CONTACTS FOR FISHING SECTORS

Some sectors have their own representative body (or two), but both Commonwealth and State managed fisheries and are also represented by overarching representative bodies. Key contacts for each are listed in Table 20.

Table 20. Key contacts for representative bodies for each affected sector.

Fisheries	Representative organisations	Key contact name	Key contact phone number	Key contact email address
Commonwealth Trawl Sector (CTS)	[redacted]	[redacted]	[redacted]	[redacted]
Shark Gillnet and Shark Hook Sector	Southern Shark Industry Alliance (SSIA)	[redacted]	[redacted]	[redacted]
Shark Gillnet and Shark Hook Sector	Sustainable Shark Fishing Inc.	[redacted]	[redacted]	[redacted]
Eastern Tuna and Billfish Fishery	Tuna Australia	[redacted]	[redacted]	[redacted]
Western Tuna and Billfish Fishery	Tuna Australia	[redacted]	[redacted]	[redacted]
Southern Bluefin Tuna Fishery	Australian Southern Bluefin Tuna Industry Association	[redacted]	[redacted]	[redacted]
Southern Bluefin Tuna Fishery	Tuna Australia	[redacted]	[redacted]	[redacted]
Victorian Rock Lobster Fishery	Victorian Rock Lobster Association (VRLA)	[redacted]	[redacted]	[redacted]
Victorian Giant Crab Fishery	Seafood Industry Victoria	[redacted]	[redacted]	[redacted]
Victorian Rock Lobster Fishery	Seafood Industry Victoria	[redacted]	[redacted]	[redacted]
Victorian Rock Lobster Fishery	Apollo Bay Cooperative	[redacted]	[redacted]	[redacted]
Tasmanian Rock Lobster Fishery	Tasmanian Rock Lobster Fisherman's Association	[redacted]	[redacted]	[redacted]
Tasmanian Giant Crab Fishery	Tasmanian Seafood Industry Council	[redacted]	[redacted]	[redacted]
Tasmanian Scalefish Fishery	Tasmanian Seafood Industry Council	[redacted]	[redacted]	[redacted]
South Australian Southern Rock Lobster Fishery	South Australian Rock Lobster Advisory Council Inc	[redacted]	[redacted]	[redacted]
South Australian Marine Scalefish Fishery	Marine Fishers Association	[redacted]	[redacted]	[redacted]
South Australian Southern Zone Abalone Fishery	Abalone Industry Association of South Australia Inc.	[redacted]	[redacted]	

Table 21 Contact details for some affected fishers

Sector	Name	Phone	Vessel	Email	Port of domicile
Tasmanian giant crab	[redacted]	[redacted]			
Tasmanian Rock Lobster	[redacted]	[redacted]			
Tasmanian Rock Lobster	[redacted]	[redacted]			
Victorian Rock Lobster	[redacted]	[redacted]			Portland, Vic
Victorian Rock Lobster	[redacted]	[redacted]			Portland, Vic
Rock Lobster?	[redacted]	[redacted]			
Victorian Rock Lobster	[redacted]	[redacted]			
Victorian Rock Lobster	[redacted]	[redacted]			Port Fairy, Vic
Victorian Rock Lobster	[redacted]	[redacted]			Warrnambool, Vic
Victorian Rock Lobster	[redacted]	[redacted]			Warrnambool, Vic
Victorian Rock Lobster	[redacted]				Apollo Bay, Vic
Victorian Rock Lobster	[redacted]	[redacted]			Warrnambool, Vic
Victorian Rock Lobster	[redacted]	[redacted]			Port Fairy, Vic
Victorian Giant Crab	[redacted]	[redacted]		[redacted]	
Victorian Giant Crab	[redacted]	[redacted]			Williamstown, Vic
CTS	[redacted]	[redacted]	[redacted]	[redacted]	Portland, Vic
CTS	[redacted]	[redacted]	[redacted]		Lakes Entrance, Vic
CTS	[redacted]	[redacted]	[redacted]	[redacted]	Lakes Entrance, Vic
CTS	[redacted]	[redacted]	[redacted]		Lakes Entrance, Vic
CTS	[redacted]	[redacted]	[redacted]		Lakes Entrance, Vic
CTS	[redacted]	[redacted]	[redacted]		Lakes Entrance, Vic
CTS	[redacted]	[redacted]	[redacted]		Lakes Entrance, Vic
CTS	[redacted]	[redacted]	[redacted]		Lakes Entrance, Vic
CTS	[redacted]	[redacted]	[redacted]		Portland, Vic
CTS	[redacted]	[redacted]	[redacted]	[redacted]	Portland, Vic
CTS	[redacted]	[redacted]		[redacted]	Portland, Vic
CTS	[redacted]	[redacted]	[redacted]	[redacted]	Portland, Vic
CTS	[redacted]	[redacted]	[redacted]		Portland, Vic

Sector	Name	Phone	Vessel	Email	Port of domicile
CTS	[redacted]	[redacted]	[redacted]	[redacted]	Geogetown, Tas
CTS	[redacted]	[redacted]	[redacted]	[redacted]	Sydney, NSW
CTS	[redacted]	[redacted]		[redacted]	Georgetown, Tas
GHAT gillnet shark	[redacted]	[redacted]			Devonport, Tas
GHaT shark gillnet	[redacted]	[redacted]	[redacted]	[redacted]	San Remo, Vic
GHaT shark gillnet	[redacted]	[redacted]	[redacted]	[redacted]	Hobart, Tas
GHaT shark gillnet		[redacted]	[redacted]	[redacted]	San Remo, Vic
GHaT shark gillnet		[redacted]	[redacted]	[redacted]	Esperence, Tas
GHaT shark gillnet		[redacted]	[redacted]	[redacted]	San Remo, Vic
GHaT shark gillnet	[redacted]	[redacted]	[redacted]	[redacted]u	San Remo, Vic
GHaT shark gillnet		[redacted]	[redacted]	[redacted]	Robe, SA
GHaT shark gillnet		[redacted]	[redacted]		San Remo, Vic
GHaT shark gillnet	[redacted]	[redacted]	[redacted]		Tasmania
GHaT shark gillnet	[redacted]	[redacted]			Port Fairy, Vic
GHaT scalefish hook	[redacted]	[redacted]	[redacted]	[redacted]	Devonport, Tas
GHaT scalefish hook	[redacted]	[redacted]	[redacted]	[redacted]	Hobart, Tas
GHaT scalefish hook	[redacted]	[redacted]	[redacted]		Gilston Bay, Tas
C'wealth SFR holder	[redacted]	[redacted]		[redacted]	Port Sorrell, Tas
C'wealth SFR holder	[redacted]	[redacted]		[redacted]	Stanley, Tas
C'wealth SFR holder	[redacted] [redacted] [redacted] [redacted]	[redacted]		[redacted]	Devonport, Tas
C'wealth SFR holder	[redacted]	[redacted]		[redacted]	Devonport, Tas
C'wealth SFR holder	[redacted]	[redacted]		[redacted]	Stanley, Tas
C'wealth SFR holder	[redacted] [redacted] [redacted]	[redacted]		[redacted]	Strahan, Tas
C'wealth SFR holder	[redacted]	[redacted]		[redacted]	Smithton, Tas

8. REFERENCES

AFMA. (2018a). http://www.afma.gov.au (Accessed 28/7/2018)

AFMA. (2018b). Southern and Eastern Scalefish and Shark Fishery Management Arrangements Booklet 2018. Australian Fisheries Management Authority. Canberra ACT

Commonwealth of Australia. (2015). South-east marine region profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region, Commonwealth of Australia

DAFF. (2007). Commonwealth Fisheries Harvest Strategy: policy and guidelines, DAFF, Canberra.

Department of Environment and Heritage. (2004). Assessment of the Victorian Rock Lobster Fishery. Department of Environment and Heritage, Commonwealth of Australia.

Earth Resources. (2018) http://earthresources.vic.gov.au/earth-resources/victorias-earth-resources/petroleum/victorias-sedimentary-basins (Accessed 8/7/2018)

Emery, T., Lyle, J. and Hartmann, K. (2017). Tasmanian Scalefish Fishery Assessment 2015/16. Institute for Marine and Antarctic Studies, University of Tasmania.

Environment Australia. (2001). Assessment of the Tasmanian Rock Lobster Fishery against the Guidelines for the ecologically sustainable management of fisheries for the purposes of Part 13 and Part 13A of the Environment Protection and Biodiversity Conservation Act 1999. Environment Australia, Commonwealth of Australia.

Ferguson, G., Mayfield, S., Hogg, A. and Carroll, J. (2017). Assessment of the Southern Zone Abalone (Haliotis rubra and H. laevigata) Fishery in 2015/16. Fishery Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000552-6. SARDI Research Report Series No. 956. 62pp.

Fisheries Victoria. (2010). Victorian Giant Crab Fishery Management Plan. Fisheries Victoria Management Report Series No. 79 November 2010. https://vfa.vic.gov.au/operational-policy/fisheries-management-plans/victorian-giant-crab-fishery/giant-crab-management-plan

Hartmann, K., Gardner, C. and Hobday, D. (2013). Tasmanian Rock Lobster Fishery 2011/12. Institute for Marine and Antarctic Studies, Hobart, TAS.

Linnane, A., McGarvey, R., Feentra, J. and Hawthorne, P. (2017). Southern Zone Rock Lobster (*Jasus edwardsii*) Fishery Status Report 2016/17. Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000715-11. SARDI Research Report Series No 969. 17pp.

Koopman, M.T., McCoy, P., Troynikov, V.S., Braccini, J.N. and Knuckey, I.A. (2010). Selectivity and bycatch reduction of Tiger Flathead and Eastern School Whiting nets in the Danish seine fishery. Final report to Fisheries Research and Development Corporation Project No. 2007/040. Department of Primary Industries, Queenscliff.

Larcombe, J., Brooks, K., Charalambou, C., Fenton, M., Fisher, M., Kinloch, M. and Summerson, R. (2002). Marine Matters - Atlas of marine activities and coastal communities in Australia's South-East Marine Region. Bureau of Rural Sciences, Canberra, A.C.T.

McLeay, L. (2018). Stock Status Report for the South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery in 2016/17. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000332-7. SARDI Research Report Series No. 976. 19pp.

Mehin K and Kamel, M. (2002). Gas Resources of the Otway Basin in Victoria. Department of Natural Resources and Environment, State of Victoria.

Moore, B., Lyle, J. and Hartmann, K. (2018). Tasmanian Scalefish Fishery Assessment 2016/17. Institute for Marine and Antarctic Studies, University of Tasmania.

National Parks. (2013). South-east Commonwealth Marine Reserves Network management plan 2013-23, Director of National Parks, Canberra.

Noble, A. (2006). Riggers Handbook. A. Noble and Sons LTD, Melbourne.

Patterson, H, Larcombe, J, Nicol, S, and Curtotti, R. (2018). Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

PIRSA, 2018. http://www.pir.sa.gov.au/fishing/commercial_fishing/fisheries/marine_scalefish_fishery (Accessed 31/7/2018)

Rogers, P. J., Tsolos, A., Boyle, M.K. and Steer, M. (2017). South Australian Charter Boat Fishery Data Summary. Final Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000437-2. SARDI Research Report Series No. 966. 17pp.

Steer, M.A., Fowler, A.J., McGarvey, R., Feenstra, J., Westlake, E.L., Matthews, D., Drew, M., Rogers, P.J. and Earl, J. (2018). Assessment of the South Australian Marine Scalefish Fishery in 2016. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute, Adelaide. SARDI Publication No. F2017/000427-1. SARDI Research Report Series No. 974. 250pp.

Steer, M.A. and Tsolos, A. (2016). South Australian Charter Boat Fishery 2014/15. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000847-4. SARDI Research Report Series No. 932. 40pp.

Stobart. B. and Mayfield, S. (2016). Assessment of the Western Zone Greenlip Abalone (*Haliotis laevigata*) Fishery in 2015. Fishery Stock Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2014/000373-2. SARDI Research Report Series No. 920. 67pp.

Stobart, B., Mayfield, S. and Dent, J. (2015). Assessment of the Western Zone Blacklip Abalone (*Haliotis rubra*) Fishery in 2014. Fishery Stock Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication F2015/000407-1. SARDI Research Report Series No. 864. 68pp.

Tomkin, J. (1998). *Commercial Fishing Methods in Victoria* http://pandora.nla.gov.au/pan/59217/20060524-0000/FN0105.pdf (Accessed June 2017)

Tsolos, A. and Boyle, M. (2015). Non-Confidential 2014/15 Data Summary of the South Australian Charter Boat Fishery. SARDI Aquatic Sciences. Data Summary to PIRSA Fisheries and Aquaculture, November 2015. 14pp.

Victorian Fisheries Authority. (2017a). Victorian Fisheries Authority Commercial Fish Production Information Bulletin 2017, Victorian Fisheries Authority, Queenscliff, Victoria, Australia.

Victorian Fisheries Authority. (2017b). Victorian Rock Lobster Fishery Management Plan 2017, Victorian Fisheries Authority, Melbourne, Victoria, Australia.

9. Appendix 1. Fisheries that operate in the area of the proposed survey (SESSF – Southern Scalefish and Shark Fishery; GHaT – Gillnet Hook and Trap Fishery).

Jurisdiction	Fishery — Subsector	Comments
Cth	SESSF — CTS Otterboard Trawl	Considerable effort in the area of operation.
Cth	SESSF — CTS Danish Seine	Unlikely to be much if any effort in the area of operation.
Cth	SESSF — GHaT Scalefish Hook	Considerable effort in the area of operation.
Cth	SESSF — GHaT Shark Gillnet	Low to medium levels of effort in the area of operation.
Cth	SESSF — GHaT Shark Hook	Low to medium levels of effort in the area of operation.
Cth	Southern Squid Jig Fishery	Some effort in the area of operation.
Cth	Small Pelagic Fishery	Negligible.
Cth	Eastern Tuna and Billfish Fishery	Some effort in the area of operation.
Cth	Western Tuna and Billfish Fishery	Some effort in the area of operation.
Cth	Southern Bluefin Tuna Fishery	Some effort in the area of operation.
Cth	Bass Strait Central Zone Scallop Fishery	Negligible if any
Cth	Eastern Skipjack Fishery	No recent effort in Fishery.
Cth	Western Skipjack Fishery	No recent effort in Fishery.
SA	Marine Scalefish Fishery	Considerable effort in the area of operation.
SA	Giant Crab Fishery	Data is confidential. There is potentially effort in the area, but we won't find out.
SA	Charter Boat Fishery	Some effort in the area of operation.
SA	Southern Zone Rock Lobster Fishery	Considerable effort in the area of operation.
SA	Sardine Fishery	No recent effort this far south.
SA	Southern Zone Abalone Fishery	Considerable effort in the area of operation.
Tas	Giant crab	No effort in the area of operation.
Tas	Rock Lobster Fishery	Some effort in the area of operation.
Tas	Scalefish Fishery	Some effort in the area of operation.
Tas	Scallop Fishery	No effort in the area of operation.
Tas	Abalone Fishery	No effort in the area of operation.
Vic	Rock lobster (W)	Considerable effort in the area of operation.
Vic	Giant Crab Fishery	Considerable effort in the area of operation.
Vic	Ocean General Fishery	Some effort in the area of operation.
Vic	Victorian Ocean Wrasse Fishery	Some effort in the area of operation.
Vic	Scallop (Ocean) Fishery	None.
Vic	Western Zone Abalone Fishery	None.

10.Appendix 2. Areas of operation for Commonwealth managed fisheries.

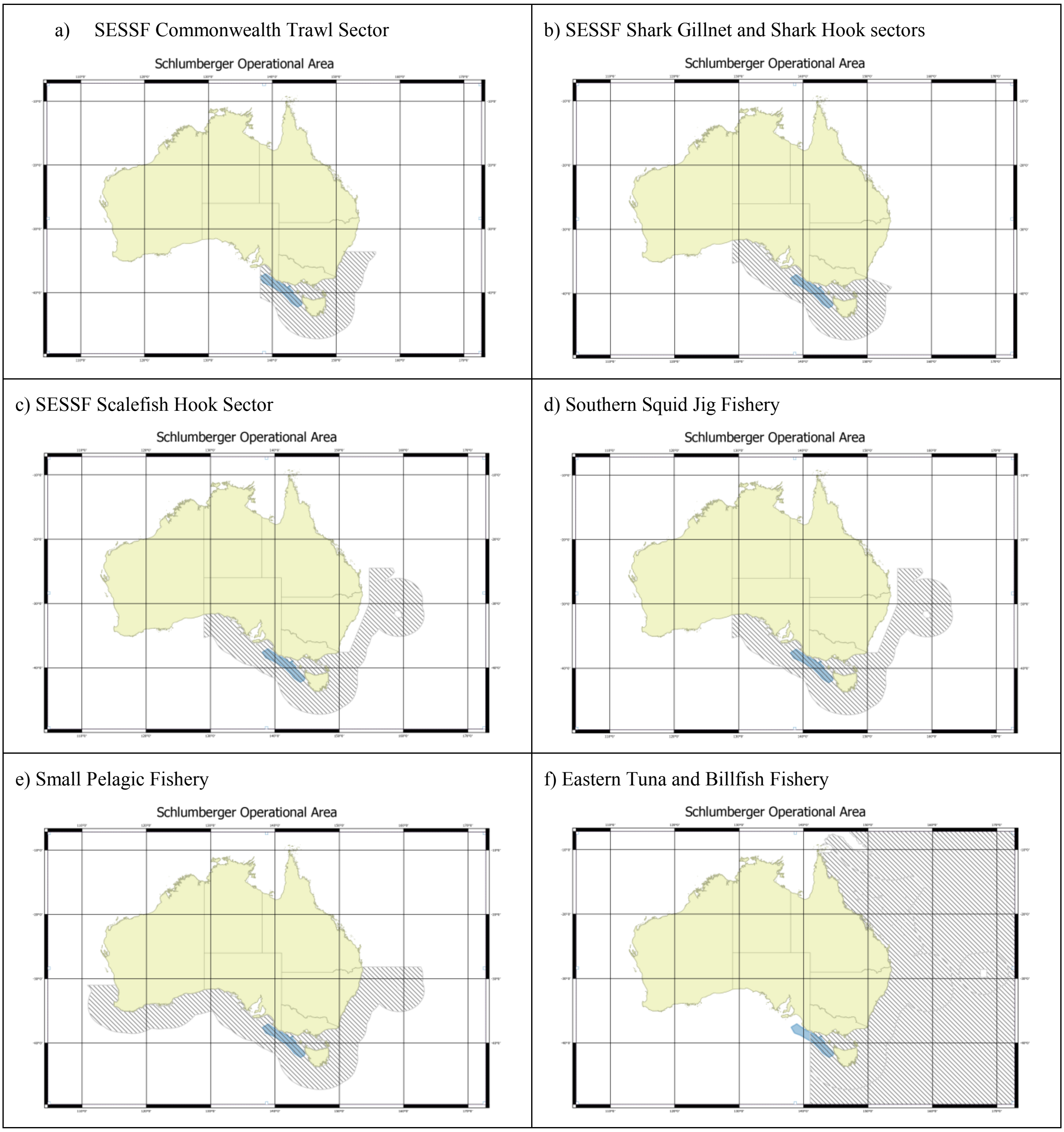


Figure 107. Area of operation of Commonwealth managed fisheries that can operate in the area of the proposed seismic survey. Note: Fisheries closures are not shown.

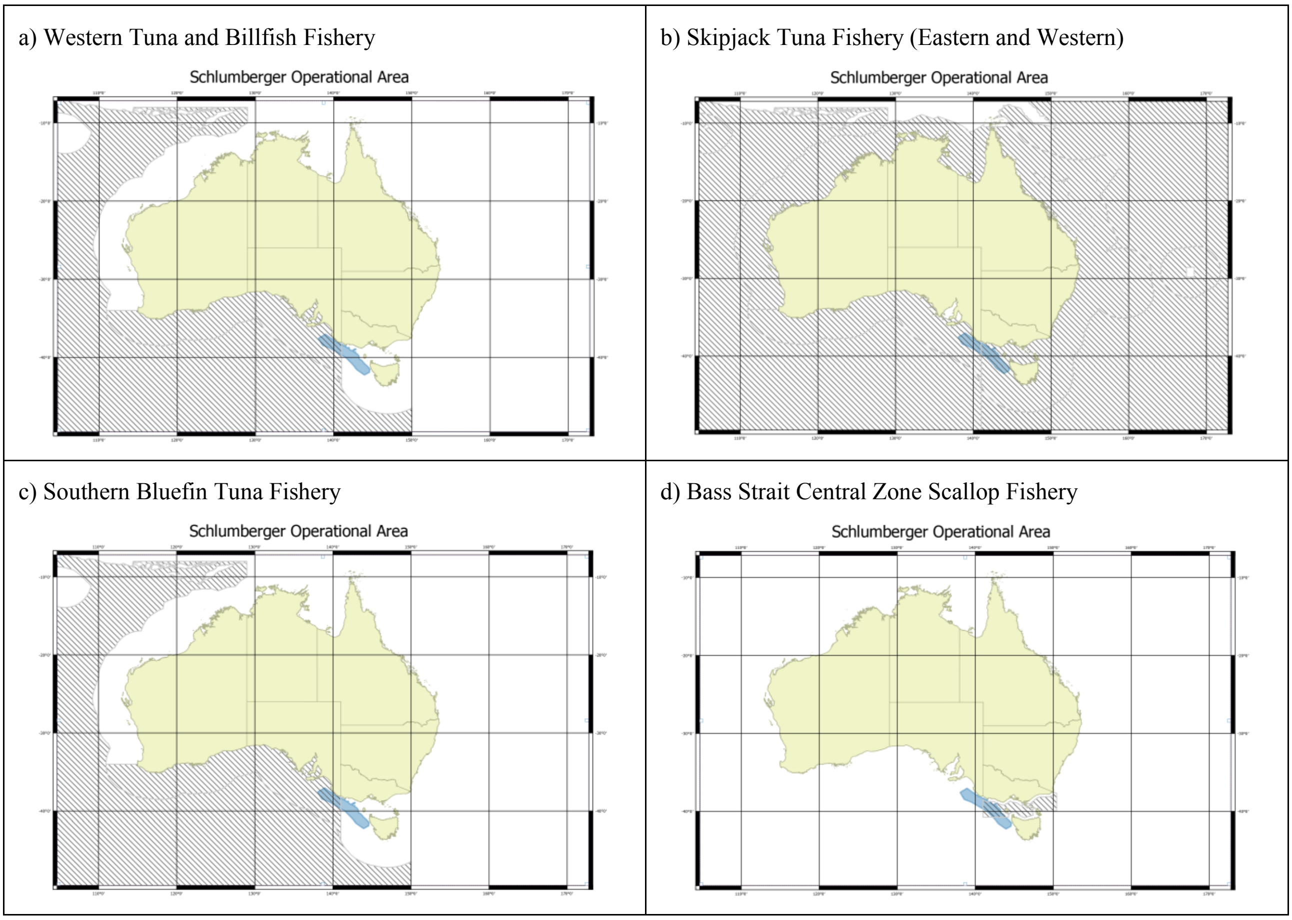


Figure 108. Area of operation of Commonwealth managed fisheries that can operate in the area of the proposed seismic survey. Note: Fisheries closures are not shown.

APPENDIX H

SIV Consultation Feedback Report

Seafood Industry Victoria

Industry Communication & Engagement

Towards Proposed Schlumberger Otway Basin 2D Seismic Survey

Office 14, 133 Kensington Road, West Melbourne, VICTORIA 3003
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Schlumberger Consultation report prepared by Seafood Industry Victoria

As per agreement between Schlumberger and Seafood Industry Victoria (SIV), we have undertaken a consultation process with the Victorian fishing industry. The engagement of SIV was essential to engage with all Victorian fishing licence holders as SIV is the representative peak body for the Victorian seafood industry, from commercial fishing to the wholesale and processing sectors.

SIV represents all commercial fishing licences across Victoria, through collection of representative levies by the State Government. SIV also has a further 17-member associations ensuring it represents the seafood industry across Victoria.

Upon receipt of the information from Schlumberger, including the operation map, SIV consulted with 612 licence holders, quota owners and operators across 8 Victorian fisheries, of which those fisheries have the potential to be impacted by the Otway Basin 2D seismic survey being proposed.

We consulted with:
78 Abalone stakeholders (Central and Western fisheries)
23 Giant Crab stakeholders (licence holders, quota owners and operators)
62 Eastern Zone Rock Lobster stakeholders (licence holders, quota owners and operators)
154 Western Zone Rock Lobster stakeholders (licence holders, quota owners and operators)
148 Ocean Access fishery licence holders
90 Ocean Scallop licence holders
56 In-shore Trawl licence holders
1 Purse Seine (Ocean) licence holder, and
18 Member Association

SIV has been able to implement a robust and extensive engagement and consultation process, which has also seen response received from State/Commonwealth licence holders.

This report provides the outcomes of this industry engagement and consultation process, inclusive of SIV's position.

Communication & Engagement Strategy

SIV's communication strategy to produce this report was based on engaging with as many Victorian fishers and seafood stakeholders as possible, including if their licence was able to operate within the affect area. We could have consulted all Victorian fishers, however noting the industry consultation fatigue, there was no need to consult fishers who could not operate in/around the proposed survey area.

Given the ongoing working relationship between SIV and Schlumberger, we successfully had the ability for SIV to engage with all stakeholders identified above via comprehensive mail out. This has then resulted in phone and email correspondence from a number of these potentially affected persons.

The package of information sent to members/other stakeholders included the following documents provided by Schlumberger:

- A SIV cover letter, which included a series of specific questions related to fishing activity and perceived impacts on their fishing operations and stocks. The letter requested email or phone response, by 7 December 2018.
- Schlumberger Stakeholders Fact Sheet Otway Basin 20 Nov 2018 document, and
- The SLB_Otway_Basin_EP_with_Grid map.

In summary response was received to the following questions:

1. **Have you ever fished within the area of the proposed activity?**
    a. **If so, for what species?**
    b. **Using the map with the Victorian fishing grids overlaid, could you please indicate the areas of interest for your fishing activities.**

We received response from a range of fishers who have fished within the area of proposed activity site. There were fishers who had fished, seek to continue to fish for squid, there were concerns raised by rock lobster fishermen who had fished in and around the survey area pending the time of year and availability of Southern Rock Lobsters. We also had fishers respond who have fished and caught squid, giant crabs, blue eye trevalla, shark and other finfish in the survey area.

Some fishers provided grid references for their fishing practices, including fishing for Rock Lobster in F3 & F4 out to 130m during January – March timeframes. Other fishers identified grids F1, J11 and K10 as areas they have previously fished and will do so over this coming summer also. However, with the new map being provided after this consultation period we would seek an opportunity to re-consult the broader industry to again seek feedback on their specific areas. The entire Western Squid fishery is consumed within the survey area.

2. **Do you intend on fishing within the survey area during the time this survey is proposed to occur (between January-May 2019)?**

All fishers who responded indicated that their catch history is stronger in the months January to May when the fish within the 'survey area'.

'Yes we annually fish in the area proposed for squid with the area of interest being the shelf break but of course seismic activity will impact squid behaviour well outside the shelf break.'

'Yes, we will be fishing between January and May 2019'

There were fishers who intend to fish, and have the right to fish, within the survey area and the outer 'operational area' for squid, Southern Rock lobsters, Orange Roughy, Dory and miscellaneous deepwater species and Giant Crab. All of which need be considered in the further development of the survey proposal.

3. **Do you consider yourself a potentially impacted person, through the operation of this survey?**
    a. **If so, would you like SIV to arrange a personal meeting with Schlumberger?**

Through the consultation and varied responses, there are a number of fishers who we would determine as potentially impacted by the operation of the Schlumberger seismic survey being proposed.

Some respondents had been in discussions with Schlumberger already, however a number had not and had not even been made aware of this survey being proposed. Some positive commentary was received about Schlumberger's engagement of SIV to undertake the consultation.

'the fishermen are very pleased / grateful, for the role SIV has taken up and it recognises the importance of proper consultation'

'it seems that the individual 'fisher's' would be better served if by yourselves acting as the conduit between them and Schlumberger'

It was noted that all Western Zone Rock Lobster fishers' rights are displaced by this survey, reducing their economic opportunities. And there was significant concern as to how this will impact the Rock Lobster fishery with the extent of the activity.

'why is there a need for this survey and why does it need to be so big?'

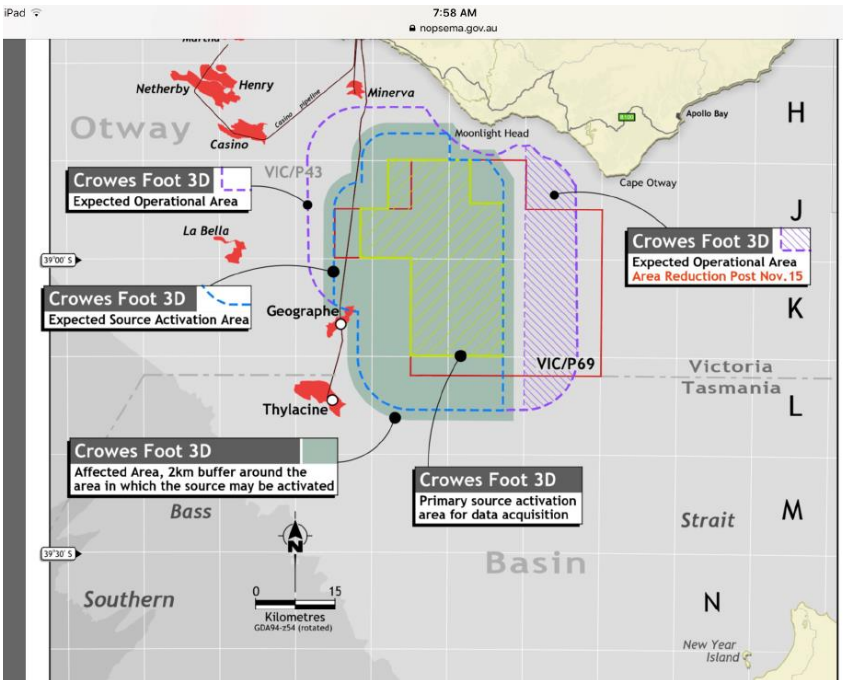
Does Schlumberger realise that summer is right after the Rock Lobster spawning period (our closed season) and this has the potential to significantly impact our fishery recruitment of larvae? Table 1 provides an insight into the spawning and other key time periods for some key species, it is not complete for all potentially impacted species.

One element raised was that any action which has the potential to reduce viability in one sector of the commercial fishing industry always has a knock-on effect in another. Therefore, by simply making a fisher move from a ground they are fishing (due to exclusion areas from a seismic survey, etc), does not mean fishing effort will be reduced. Fishing effort remains constant, but moves from area to area, fishery to fishery, therefore if one fisherman is no longer viable in their fisher they move to another fishery/area, adding pressure to that fishery/area. This must be kept in mind as this has the potential to increase the number of potentially impacted people in the fishing industry.

4. Is there any further information you would like SIV to report to Schlumberger on the impact this survey will/might have on your fishery or you as a fisher?

What is the modelled outermost area of seismic sound exposure? Noting that there has been no sound modelling prepared and presented for consideration at this time.

- We seek the provision of maps similar to those below:



Serious concerns raised about the impact of seismic testing on squid migratory patterns.

- The area under consideration includes the Bonney Upwelling which as you would be aware is a major food source for many animals along the western Victorian coast.

  - Therefore, the impact on this area of significance to the vast majority of Victorian fisheries as their larval stages tend to be suspended in the water column for considerable periods of time.
- Concerns have been raised on the impacts on the spawning success of squid, given that 10% of survey lines in less than 700 metres covers the entire western Victorian squid fishery.
- Concerns were raised about the impacts of seismic on squid reproductive organs and squid eggs.
  - How will Schlumberger address the short term (ie seasonal) decline in catches and the possible catastrophic impact on larvae and squid eggs.
- Significant weight needs to be given to concerns about the proven impact of seismic on plankton, which is a major food source for squid.
- It was also noted that Squid and scallops have similar sensory organs and we know what happened to scallops.

There must also be serious considerations of the impacts to other finfish and their reproductive, spawning and aggregation phases.

'December to April is when the gummies come up the shelf into the local waters, a survey at this time of year could be potentially devastating for us.'

Rock Lobster fishers raised serious concerns following the research published by McCauley *et al.* 2016 and the potential impact on Rock Lobsters, but also Giant Crabs. Southern Rock Lobster will be impacted sub-lethally based on McCauley *et al.* (2016). These findings found mortality did not occur post exposure when kept in an ideal controlled environment, but questioned survival in the wild - catch ability, reproduction etc. Lack of scientific certainty should not be used to avoid adopting mitigation control measures.

Research on damage to RL concludes that this damage is likely to be applicable to all crustaceans which includes Giant Crab.

There is currently no known safe range for fish resources from seismic operations, i.e. we don't know how far beyond 500 m the array would need to be from a lobster to not see an effect. This raises questions on the use of Day *et al*. (2016) as the definite limit of sound exposure. Therefore, we request an independent review of the impact buffer.

5. Are there any considerations that must be made for the species you fish for, migration patterns, reproductive phases, etc..?

Spawning/Aggregation/Larvae concerns:

There are a number of critically important processes that occur in the waters off Western Victoria during the spring-summer period. Particularly November-January, is the most important period of the year for spawning and larval dispersal of most species. Some species aggregate to spawn and undertake an annual migration to spawning areas, which must occur over a period prior to initiation of spawning. Any disruption of the migration, spawning or larval life cycle while suspended in the water column has every possibility of significantly impacting recruitment and settlement into a fishery. This is a very serious matter that must be considered before any seismic operations occur.

While timings of reproduction and likely occurrence of larval stages can be defined from literature, for most species there is little information on the 'specific' locations and spatial extent of spawning along the western Victorian coast.

Richardson et al. (2017) - state their findings (95% recovery 3 days post survey) should not directly be applied quantitatively to other regions with different oceanographic conditions.

And stressed that a detailed study of a particular region would be needed to quantify the spatial and temporal impacts in a particular region and season.

Some cold and deep areas with slower growth rates / longer reproductive cycles it can take a year for plankton to regenerate. Denuding a large region could have recovery rates significantly hampered.

There is significant and alarming potential (noting that the Victorian fishing industry is currently being consulted on 4 different seismic proposals) that any denuding from the Otway Basin by the Schlumberger seismic survey will then be further impacted/compromised with 3D Oil's Dorigo MSS and Spectrum Geo's Otway Deep 3D survey in similar waters. How has this and any other cumulative impact been considered in your EP?

To meet ALARP and an Acceptable level – We seek commitment to undertake a regional study to quantify the spatial and temporal impacts, including water column testing for eggs & larvae of fisheries resources.

Note: See Table 1 below.

6. Do you have any further questions you would like to ask SIV or for SIV to ask Schlumberger on your behalf?

Can Schlumberger guarantee that there will be **no** effect on fish populations? With quota reductions, all fisheries being based on rebuilding trajectories and more consistent emphasis on sustainability why is seismic surveying still permitted? It has been proven time and again that seismic surveying has a serious impact on fish stocks, in particular fish spawn and larvae. It seems that if there is enough financial gain, fish stocks and sustainability become irrelevant.

Can Schlumberger please confirm that all seismic activity will only occur within the acquisition area? Will line turns be made within the primary acquisition area? If not will the seismic air-guns be completely switched off prior to existing the primary acquisition area on turning procedures or simply powered down?

The fishing industry has been concerned for a number of years as to the oil and gas industry using 'selective' research to promote their views and opinions – 'cheery picking'. We seek Schlumberger not to do this in their Environment Plan, but to present all the research in equal light. A precautionary approach, like what is used in fisheries management, would suggest recognising there may be an impact and working collaboratively with the fishing industry to arrive at mutually acceptable ground. We seek your acceptance of this, and also seek the opportunity to review your full EP prior to submission – noting the amendments to the consultation requirements on the horizon.

A recent study found that the current 24 hour period cumulative sound exposure levels (CSELs) values are shown to be reached in minutes. Noting that the proposed survey is for 2D, how is this study applicable, are the sound sources similar just not multi array, and what control measures will be adopted to addressed these findings?

- CSELs must be investigated on the already weakened lobsters under the new findings on cumulative sound exposure. Temporal impact spans three years 2018, 2019 and 2020. To what extent has this been considered by Schlumberger?

Curtain - Comparison study of cumulative sound exposure levels (CSELs) from typical 2D seismic surveys.[1]

To meet ALARP in the eyes of Victorian Rock Lobster fishers, Schlumberger must:

- negotiate towards compensation/quota retirement for displaced fishers.
- consider opportunities for funding re-seeding programs for Rock Lobster - given the scientific uncertainty of the long-term impact an appropriate precautionary mitigation would be to make contribution to the upcoming rock lobster reef re-seeding program which seeks to assist in restoring the marine environment following the damage done by seismic air-guns.

To meet ALARP for Victorian Giant Crab fishers, Schlumberger must:

- Extract Giant Crab habitat from the survey.
- Engage in compensation/quota retirement for displaced fishers.

Other commentary on Victorian Southern Rock Lobster

Catch history is the only Economical evaluation used and is limited to only 5 years of catch records. Fishers will fish to the Market. The catch data assessed was during a period when small red lobsters (found in shallow water) was preferred by the market. This has swung back with the market now wanting the larger lobsters which are found in deeper in waters. Catch history is not the only indicator for fishers, the economic realities of the market heavily impact future fishing.

Southern Rock Lobster is harvested as a percentage of biomass. Placing 15% of the biomass at known risk threatens the both the long-term and short-term economic value of the Western Zone Rock Lobster Fishery.

Evidence: As a measure of impact Western Zone Rock Lobster Total Allowable Catch (TACC) halved since heavy seismic activities in the Otway Basin in the past decades.

The potential impact to future recruitment of Rock Lobster, Giant Crab and other fisheries resources. The free-swimming larval stages do not know boundaries and are suspended in the moving currents for up to 24 months, well beyond the 'fishing depths' referred to above.

Our Rock Lobster fisheries management decisions are based on the best available science, and for example we know that for Rock Lobster approximately 1% of the larvae that are produced (between September and November) ever survive to settle on the reef. This process for years has supported a strong, vibrant commercial fishery, and we cannot support any activity that will put this process in jeopardy, without some form of mutually agreeable recompense.

Seafood Industry Victoria comments:

There is a level of mis-understanding across the oil and gas sector of the operation, sustainability and management of fisheries. We (industry and Government) manage our fisheries to sustainability, economic, social and environmental targets – and the generic vision presented by most oil and gas operators is 'use alternative fishing grounds', which is not acceptable to our industry.

[1] A comparison study of cumulative sound exposure levels (CSELs) from typical 3D seismic surveys. Curtin University. Centre for Marine Science and Technology.

Victorian fishers and managers use the best available scientific evidence to base their decisions of future management arrangements for fisheries. This includes continued rebuild of stocks, through managing recruitment and also ensuring spread of effort as to avoid any possibility of localised depletion (not good). And what is generally presented in response to our concerns is that 'fishers will be ok, they can just move and fish alternative grounds', a change that is not supported by industry. This option is continually rejected and if there is direct impact on fishing operations there must be consultation with those operators around adequate compensation or other means.

Significant concern has been raised with SIV in regards to the area being shot by the 2D survey. In discussions between SIV and Schlumberger there is a tendency to respond with 'X% of the survey is outside of fishable grounds', which is significantly concerning. Even with a large part of the survey area being in water depths greater than 700 meters, fishers can still operate in these areas using a wide range of gears at all times of the year.

SIV has been leading industry representation and consultation with oil and gas institutions for many years now, and the fishing industry has recognised there is a need to work collaboratively. Hence the presentation in our earlier report of the options (specific to Rock Lobster) that need to be considered across the impacted species.

For example: The Origin Crowes Foot and Enterprise II survey of 2016/17 saw industry engagement like never before, and we are happy to consider options relevant to this survey to apply to the fishing industry.

- We would expect negotiations to begin to discuss compensation/quota retirement for displaced fishers.
  - This would require one-on-one consultation and negotiation with any impacted fishers to determine previous effort and opportunity in the survey area, not supporting simply displacing this effort to another area. The fishers would retire their quota 'for the benefit of the resource' and Schlumberger would compensate them accordingly.

- Schlumberger must consider opportunities for assisting funding re-seeding programs for Rock Lobster - given the scientific uncertainty of the long-term impact an appropriate precautionary mitigation would be to make contribution to the upcoming rock lobster reef re-seeding program which seeks to assist in restoring the marine environment following the damage done by seismic air-guns.
  - At present the Victorian Rock Lobster Association are working with science experts, Government and industry to operationalise a rock lobster reef reseeding program – noting the lack of understanding of impacts to recruitment and on larvae/settlement – they are getting on the front foot and looking at further opportunities to rehabilitate impacted areas. This has been possible due to 'Community Benefit monies' from Oil and Gas companies, with fishing industry research money to provide a positive collaboration and hopefully future benefit for our fisheries resources.
  - While the impact of such work is yet to be seen, the collaboration is positive, and we would welcome other parties' interest to grow the scale of this work.

- We also seek the discussion on other potential programs of scientific nature that could be collaboratively progressed through this work.

Next steps:

- Schlumberger to consider the information provided by industry (via SIV) and appropriately respond in due course.

- Schlumberger to further consider the presentation of sound reach maps and confirm how these will be complied with or measured (similar to those provided above for Crowes Foot Survey).

- Schlumberger to consider options for working with industry in a pre/post survey assessment which will contribute scientifically to the knowledge of interaction of seismic operations with fisheries resources.

- Schlumberger to act in 'good faith', noting the upcoming changes to consultation requirements, provide SIV and industry with a draft copy of the Full Environment Plan, and allow an opportunity to comment.

- Schlumberger to provide industry with their sound modelling work to consider potential sound reach and total area affected – noting this has not been provided yet.

- Schlumberger to work with SIV on opportunities for fisheries 're-seeding' work, in particular the work being undertaken for Rock Lobster at present.
    - With further information presented in this report, we seek continued discussion on this, and seek Schlumberger's interest in engaging in the work being undertaken to rehabilitate Rock Lobster reefs.
    - We also seek consultation and ongoing engagement to consider other avenues for stock replenishment and environmental rehabilitation projects.

Table 1. Summary of main reproductive and larval dispersal periods for some key fishery species, not all.

Species Common/Scientific Names	Main reproductive/larval dispersal periods												References
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
	Summer			**Autumn**			**Winter**			**Spring**			
Pilchard, *Sardinops sagax* (formerly *Sardinops neopilchardus)*													Blackburn 1950a; Hoedt and Dimlich 1985; Fletcher 1990; Niera et al. 2000
Anchovy, *Engraulis australis*													Blackburn 1950b; Hoedt and Dimlich 1985; Anott and McKinnon 1985; Niera et al. 2000
Whiting (King George), *Sillaginodes punctatus*						Spawning			Larval dispersal				Jenkins et al. 2000 (Note: this species has prolonged ocean dispersal stage)
Snapper, *Chrysophrys auratus* (formerly *Pagrus auratus)*													Jenkins 1986; Neira et al. 2000; Coutin et al. 2003; Fowler et al. 2003, Hamer et al. 2004
Blue throat wrasse, *Notolabrus tetricus*													Smith et al. 2003
Southern rock lobster, *Jasus edwarsii*						Larval dispersal stages all year				Eggs being carried/released			Hobday and Ryan 1997; Bruce et al. 2000; Bruce et al. 2007
Scallops, *Pecten fumatus*													Young et al 1988

APPENDIX I

SLB Response to SIV Consultation Feedback Report

Schlumberger Responses to Concerns Raised in the Seafood Industry Victoria Communication and Engagement Document

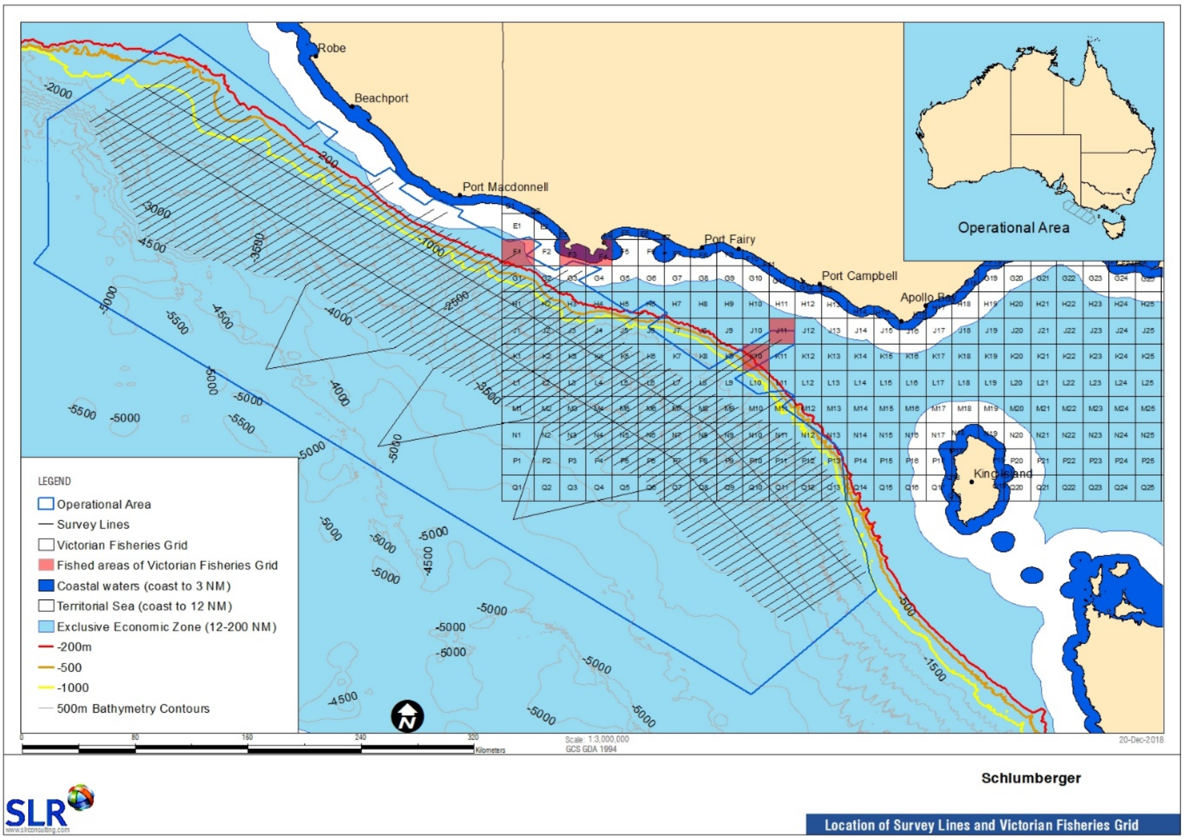
1 General Comments

On behalf of Schlumberger to assess potential impacts from a proposed 2D marine seismic survey, Seafood Industry Victoria (**SIV**) asked their licence holders whether they had ever fished in the area of Schlumberger's proposed seismic survey, and if so for what species. A range of responses were received, some fishers provided grid references for the Victorian fisheries reporting grids. Out of all the grid references, F3, F4, F1, J11 and K10 were identified as the areas that are fished or will be fished, and these locations are shown in relation to the survey area in **Figure 1**.

Other fishers did not provide grid references as part of the submission but stated that they actively fish in the proposed survey area. In these cases it is difficult to assess the area of potential conflict with commercial fishers; hence any additional information relating to specific grid references in which fishing occurs would be beneficial and has been requested.

When SIV initially distributed the questions to licence holders, Schlumberger's proposed seismic survey was scheduled for January 2019; this has since been delayed to October 2019 to April 2020 as a result of extending the engagement period and lack of vessel availability as a result. This change in timeframe could alter the extent of overlap between the survey and commercial fishing interests. The feedback was not limited to this time frame and remains relevant to assess potential impacts.

Figure 1 Victoria Fisheries Reporting Grid



The main questions that were raised from the SIV Communication and Engagement Document are listed below. A response to each question has been provided and will be the starting point for further discussion with SIV and their members as the engagement process continues.

1.1 Why is the survey required?

Although Otway basin is a producing gas province, deeper parts of the basin are underexplored with minimal seismic data and no wells. Existing interpretation and petroleum systems modelling is limited due to sparse legacy data, hence poor confidence in interpretation and petroleum systems elements. More data is needed by industry to better investigate the prospective outboard portion. The proposed Schlumberger Otway 2D survey will provide a regional data set to better understand its geology and potential for hydrocarbons.

1.2 Why is the area so big?

The proposed Operational Area is for the acquisition of a 2D seismic survey. Generally 2D seismic surveys occur in the early stages of exploration, so are often large in scale and have sparse data collection points (i.e. they have long survey lines that are spaced well apart across the Operational Area). A 2D survey is utilised to provide a general understanding of a prospective area to identify whether it requires further investigation.

The original Operational Area that Schlumberger proposed has been reduced considerably following stakeholder engagement and the assessment of environmental sensitivities in the area. There have been two revisions to the Operational Area, resulting in an overall reduction of approximately 100,000 km^2. In particular, survey lines were moved further offshore to avoid a number of sensitive environments that were identified. The shallowest sections of the Operational Area accommodate 'well ties', where single survey lines extend inshore to a previously drilled well. Following the revisions, the shallowest water depth in the Operational Area is now 50 m.

The revised Operational Area has resulted in a considerable reduction in overlap with the Bonney Upwelling, which was raised in the SIV submission as being of importance to fisheries. The revision to the Operational Area removed 6,162 km^2 of the survey area from the Bonney Upwelling Zone, so the Operational Area now only overlaps with 1,357 km^2 or 9% of this zone. However, the actual survey lines within this zone cover an even smaller area (discussed further in **Section 3.1**).

The revisions that Schlumberger made to the Operational Area (based on stakeholder feedback and the assessment of sensitivities), can be summarised as:

- 95% of Operational Area is in water depths greater than 200 m;
- 89% of Operational Area in water depths greater than 1,000 m;
- 98 % of survey lines are in water depths greater than 200 m; and
- 91 % of survey lines are in water depths greater than 1,000 m.

1.3 Can Schlumberger please confirm that all seismic activity will only occur within the acquisition area?

The acoustic source will only be active within the Operational Area. If the vessel is outside of this area, the acoustic source will not be active. This is the area that has been assessed in the Environment Plan (**EP**) and also the area that has been modelled for within the underwater Sound Transmission Loss Modelling programme.

1.4 Will line turns be made within the primary acquisition area? If not will the seismic air-guns be completely switched off prior to existing the primary acquisition area on turning procedures or simply powered down?

During line turns the acoustic source will be turned off to reduce additional noise into the marine environment. As per comment above, the acoustic source will only be active within the Operational Area.

1.5 Significant concern has been raised with SIV in regards to the area being shot by the 2D survey. In discussions between SIV and Schlumberger there is a tendency to respond with 'X% of the survey is outside of fishable grounds', which is significantly concerning. Even with a large part of the survey area being in water depths greater than 700 meters, fishers can still operate in these areas using a wide range of gear at all times of the year.

Most of the references throughout our discussions and EP are in regard to water depths of either 200 m or 1,000 m. The reference to 700 m has only recently been discussed due to information from squid fishers in that this is the maximum depth that squid may lay eggs.

References to the percentage of the survey in relation to depth contours is intended to represent the amount of time the vessel is likely to be in the area relative to the areas that are fished. From discussions we have had with some fishers, it was our understanding that most of the fishing effort took place in water depths less than 1,000 m, which is why this depth contour has been used as a reference.

However, the intention is to meet with the fishers in the area and discuss the proposed Operational Area with them. If fishing routinely occurs in waters deeper than 1,000 m, then we will reassess this to understand potential physical disturbance to fishing gear in these deeper waters. Please note that the potential disturbance from underwater noise has already been assessed and is summarised within this document (see **Section 1.6**).

1.6 What is the modelled outermost area of seismic sound exposure?

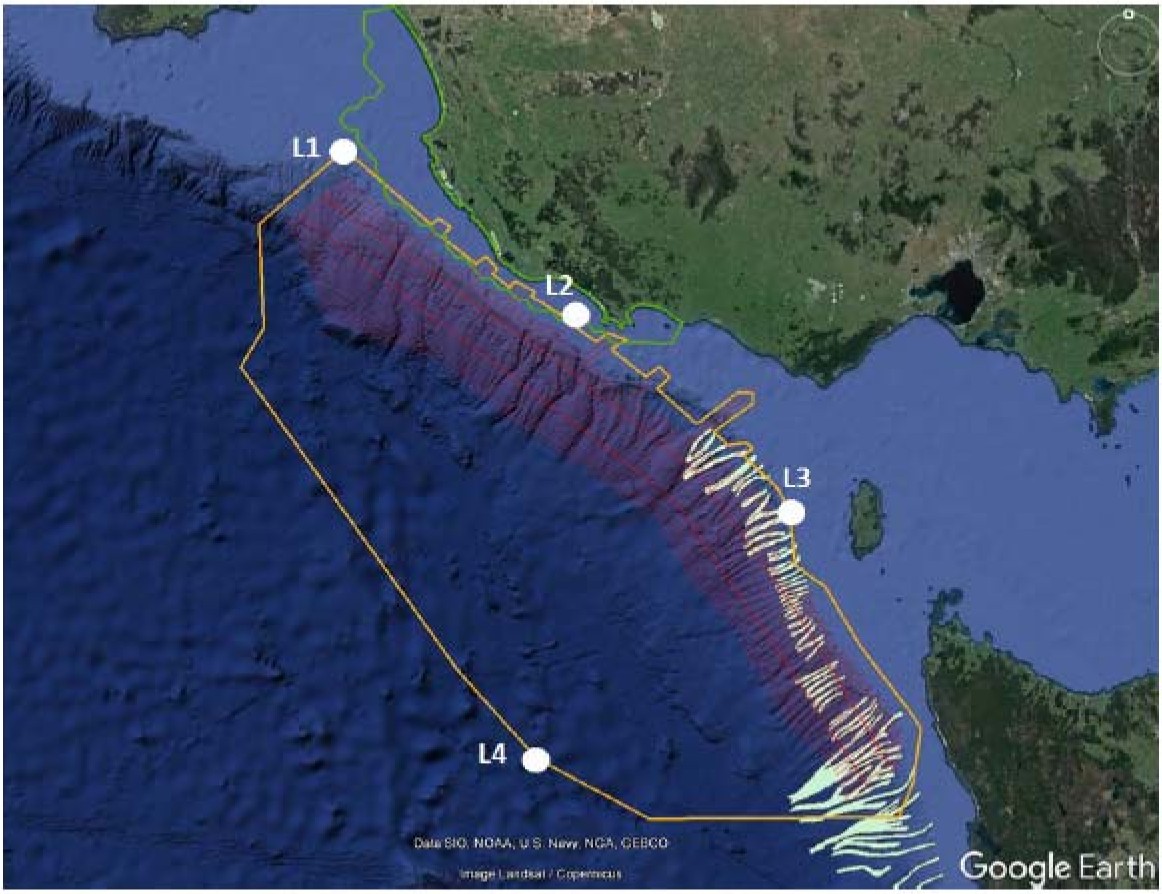
Both long and short range sound modelling was undertaken for the seismic survey to predict the received Sound Exposure Levels (**SELs**) and the spread of noise emissions or the footprint of acoustic emissions from the acoustic array.

The short range modelling predicts the received SELs at distances out to four kilometres, and is used to assess impacts in the vicinity of the active source and whether the proposed mitigation measures and precaution zones are adequate. This was done over eight different depth ranges within the Operational Area.

Long range modelling predicts the received SELs out to 200 km from four locations within the Operational Area and assesses the noise impacts to more distant sensitive marine areas.

The long range modelling locations are shown in **Figure 2** and displayed as L1-L4.

Figure 2 Long Range Modelling Locations within the Otway Basin Operational Area



A request was made for a survey map similar to what was provided for the Crowes Foot Survey. In response to this, **Figure 3** and **Figure 4** show the two reductions that Schlumberger have made to both the Operational Area and the survey lines to reduce conflict with stakeholders (i.e. commercial fishers) and impact on environmental sensitivities.

Figure 3 First revision to the Operational Area to move the survey area further offshore

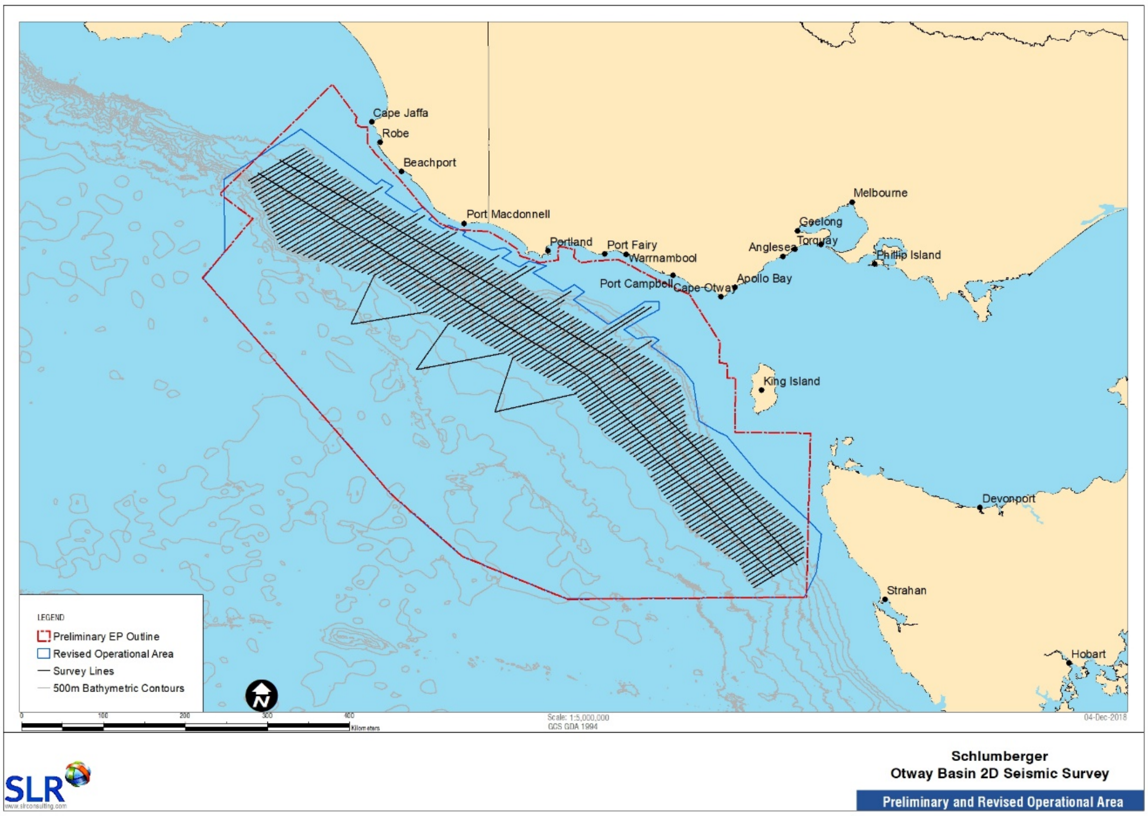
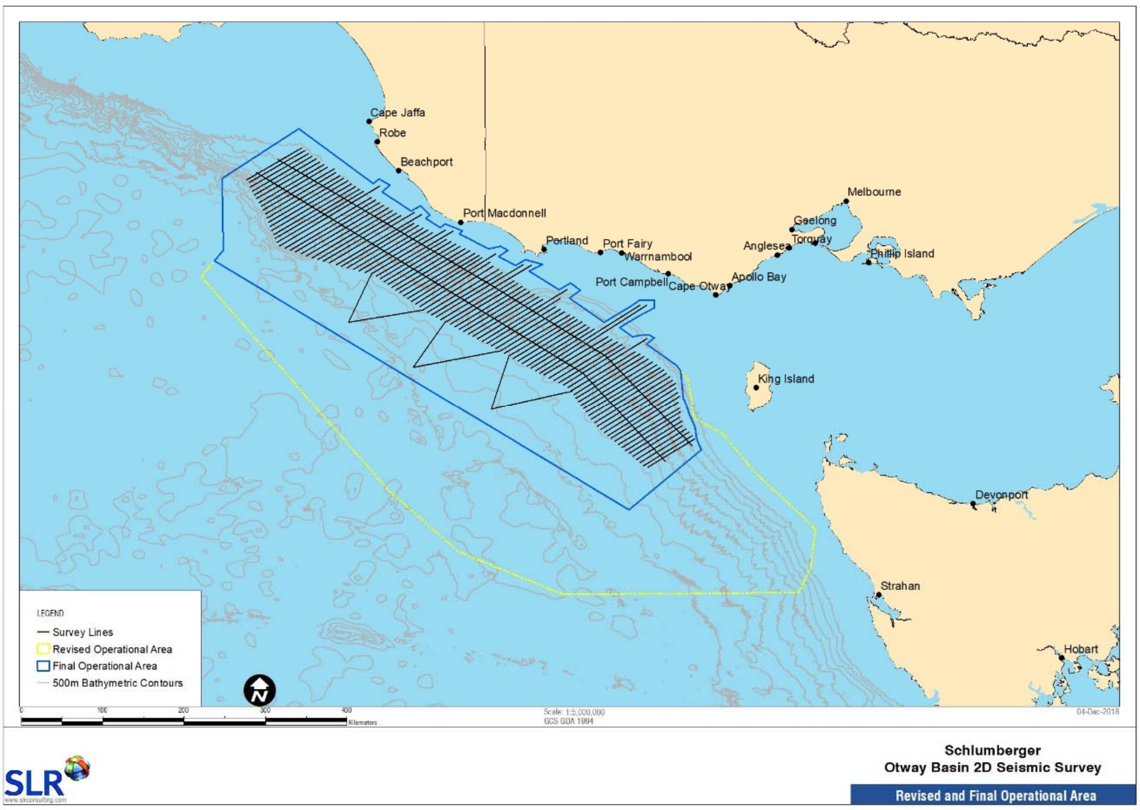


Figure 4 Second revision to the Operational Area and Survey Lines



A summary of Schlumberger's sound transmission loss modelling is provided below. The modelling is specific to the Operational Area, and inputs to the model include water column characteristics (so that the speed of sound through the water column can be determined), the geology of the seabed and underlying layers (so that the reflection of sound can be determined) and the bathymetry of the Operational Area and surrounding areas (as the bathymetry also influences how the sound waves are reflected as they travel into either shallower or deeper waters).

Sound propagation, or spread of sound, occurs in a downslope direction into the deeper waters. A reduction in sound speed with increasing depth results in downward refraction, so the highest sound levels occur in the lower portion of the water column. This means that the SELs are generally focused in the mid water column, and are considerably lower near the surface. This is shown in **Figure 5**, which is a cross section from the Operational Area, for noise vs depth out to 200 km from the modelling location in **Figure 5**.

In this model output, only a small part of the water column is exposed to SELs above the ambient noise, as the sound is focused into a channel and travels horizontally. In this modelled example, the noise levels at about 50 km from the acoustic source in the offshore direction are approaching ambient noise levels.

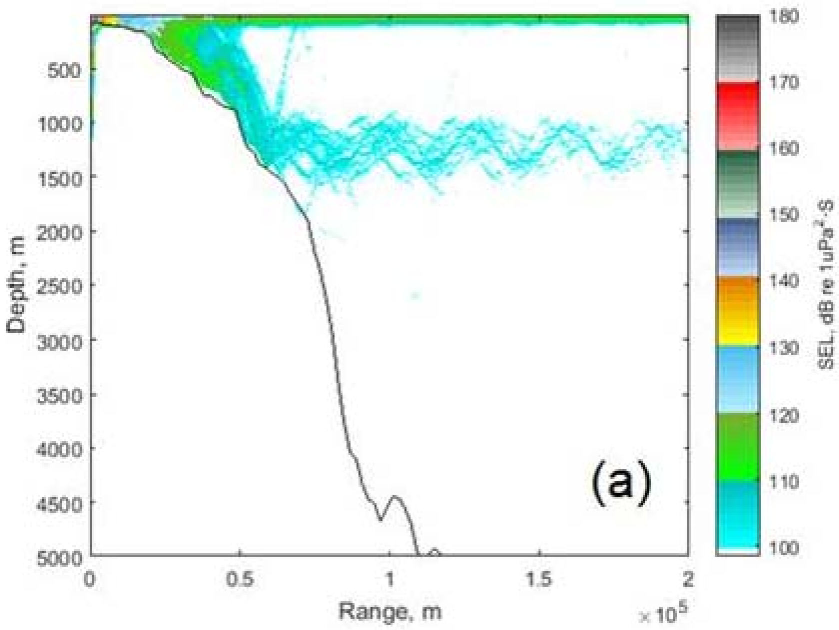
The model outputs provide specific information about how sound will propagate within the survey area. From these outputs we conclude that survey sound should not influence the diurnal pattern of squid between the seabed and surface waters; the sound waves generated from the survey should not force any squid to the surface, as SELs will not be high throughout the entire water column. The sound levels will not be significantly elevated above ambient levels, where ambient levels are reasonably high in this region due to high levels of maritime shipping (verified by the plot we have extracted from Marinetraffic.com).

For sound that is travelling upslope and into shallower waters once released from the acoustic source, the rays steepen on each subsequent seabed reflection rate and causes rapid attenuation as the sound travels into inshore waters. This is what happens when the sound waves are heading up the continental shelf from survey lines being acquired over the shelf edge and the sound waves are travelling inshore to the shallower waters. The modelling outputs show that sound will not travel as far inshore into the shallower water depths as it does in the offshore direction.

There are known noise exposure thresholds or indicative noise levels at which there is the potential for certain effects (i.e. mortality, temporary hearing impairment, injury, behavioural changes) to occur to marine fauna. The threshold criteria used are based on current relevant scientific literature, accepted industry and international standards and are considered to be appropriate for the assessment process in the EP.

Further discussions on the potential effects of acoustic disturbance on squid are discussed in **Section 4**.

Figure 5 Cross section of long range noise modelling plot – distance vs water depth



2 Rock Lobsters

2.1 "All Western Zone Rock Lobster fishers' rights are displaced by this survey, reducing their economic opportunities." And there was significant concern as to how this will impact the Rock Lobster fishery with the extent of the activity.

Schlumberger appreciate that there is an important rock lobster fishery through the Victoria and South Australia region, and at the start of the project investigations, upon identifying these sensitivities, the survey area was moved further offshore.

Schlumberger wish to further engage with the fishers as part of upcoming port visits to better understand the areas that are fished, potential conflict, timings etc. which will be managed through SIV. Likewise, Schlumberger are committed to continual engagement throughout the survey programme (i.e. pre, during and post survey).

As part of the SIV consultation feedback some fishers provided grid references for where they fish for rock lobster, with grids F3 and F4 being important (**Figure 1**).

There is no published scientific evidence that indicates seismic exposure has resulted in a reduction in rock lobster catch rates. Parry and Gason (2006) examined catch rate data for the southern rock lobster and found no significant effects of seismic surveys on commercial catch rates in western Victoria, Australia, between 1978 and 2004, during which time multiple marine seismic surveys (**MSS**) occurred (a total of 28 2D and five 3D MSSs). In this study, the number of seismic pulses was correlated to catch per unit effort data over 12 depth stratified regions. Catch per unit effort data detected no significant change in catch rates during the weeks and years following seismic surveys, leading the authors to conclude there was a lack of apparent impact on rock lobster fisheries from seismic surveys in that region.

Rock lobsters have limited potential to suffer any increase in mortality from sound exposure as they are not influenced by the pressure component of a sound source, only by the vibration component. As a result, they have to be very close to the source to be impacted, with no increase in mortality at the noise levels expected from Schlumberger's proposed survey based on the sound modelling results (within 350 m of the active source or up to 500 m of the source if an infill line results in a "double dose" exposure at a particular location).

Due to the absence of sound pressure-detecting structures in rock lobsters, the large separation distances between the seismic source and the seabed across most of the Operational Area (89% of the Operational Area is in water depths greater than 1,000 m), and that any significant acoustic impacts on benthic invertebrates (including rock lobster) are likely to be confined to close ranges to the source and be short to medium term (hours to days) in duration, it is considered that population level effects are unlikely.

Potential effects on rock lobster larvae/embryonic development are addressed in **Section 2.2** below.

2.2 Does Schlumberger realise that summer is right after the Rock Lobster spawning period (our closed season) and this has the potential to significantly impact our fishery recruitment of larvae?

The survey timing has now changed, with commencement now planned for October 2019. This revised timing means that the survey will now occur when the eggs are still being carried/released by the females. There is limited literature available to assess the effects of seismic outputs on egg-bearing rock lobsters however a relevant study is discussed below.

Day *et al.* (2016) exposed egg-bearing female spiny lobsters to signals from three seismic source configurations at various distances, all of which exceeded SELs of 185 dB re 1 $\mu Pa^2 \cdot s$. Berried female lobsters were randomly allocated into control and exposed treatments and placed *in situ* in lobster pots. Seismic source runs were made (at realistic levels with the source run towards and over the pots). Control runs emulated the exposure runs with the source deployed and pressurised but not operated. Following the control and exposure runs, the lobster pots were recovered and the lobsters were kept in holding tanks until hatching. Once hatched, the effects of the exposure treatments on spiny lobster embryonic development were assessed by examining the number, morphology, energy content and competency of hatched larvae. The main results of this study are outlined below:

- There were no mortalities of the adult berried female lobsters in either control or exposed treatments for any of the three experiments;
- All females had successful hatches with no incidence of loss or removal of the egg bundle;
- Lobsters in both treatments over all three experiments hatched over the course of a 5–6 day period, with a peak in the number of larvae hatched around days 3–4;
- There were no morphological abnormalities in any of the hatches;
- There were some differences in larval body length between control and exposed larvae in the 45 in^3 experiment (exposed larvae were approximately 1.5% longer than control larvae), but not in the other two experiments;
- There were no differences in larval width between treatments for all three experiments;

- There were no differences in length-to-weight and width-to-weight ratios between treatments for all three experiments;
- There were no significant differences between the dry masses of any of the treatments;
- Larval energy content did not differ between treatments in any of the exposure levels; and
- There was no difference in larval competency (i.e. activity test results) between treatments in any of the exposure levels.

Overall, the results of the Day *et al.* (2016) study found no differences in the quantity or quality of hatched spiny lobster larvae. The authors concluded that seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster larvae.

The effect of seismic survey activity on rock lobster catch rates is discussed in **Section 2.1**.

2.3 "Rock Lobster fishers raised serious concerns following the research published by McCauley et al. (2016) and the potential impact on not only Rock Lobsters, but also Giant Crabs. Southern Rock Lobster will be impacted sub-lethally based on McCauley et al. (2016). These findings found mortality did not occur post exposure when kept in an ideal controlled environment, but questioned survival in the wild - catch ability, reproduction etc. Lack of scientific certainty should not be used to avoid adopting mitigation control measures. Research on damage to rock lobster concludes that this damage is likely to be applicable to all crustaceans which includes Giant Crab".

In regards to the above comments we cannot source a McCauley *et al*. (2016) paper in relation to rock lobster. There is a McCauley et al. (2016)[1] paper; however, it doesn't cover rock lobster within the content; so we have assumed his reference is meant to be Day et al. (2016)[2]?

As noted in the submission, Day et al. (2016) found that adult rock lobsters exposed to seismic sound levels up to a maximum SEL of 186 dB re 1 μPa^2.s did not show any increase in mortality, even at close proximities to the sound source. The study concluded that seismic surveys are unlikely to result in immediate large-scale mortality in the southern rock lobster fishery and, on their own, do not appear to result in any degree of mortality.

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[1] McCauley RD, Duncan AJ, Gavrilov AN, Cato DH (2016) Transmission of marine seismic survey, air gun array signals in Australian waters. Proceedings of ACOUSTICS 2016, 9-11 November, Brisbane, Australia.
[2] Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., 2016. 'Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries'. Report to the Fisheries Research and Development Corporation. Report prepared by the University of Tasmania, Hobart.

However, there was evidence of sub-lethal effects occurring following seismic sound exposure; specifically, impairment of reflexes involved with tail control and righting, damage to the sensory hairs of the statocysts (balance organ), and a reduction in numbers of haemocytes (indicative of reduced immune response function). The ecological impacts of the sub-lethal effects were not examined and therefore the existence and/or magnitude of any potential impacts on catch rates are not known. It is important to note that this study was undertaken in water depths of 10 – 12 m, which is significantly shallower than Schlumberger's Operational Area. There are large separation distances between the seismic source and the seabed across most of Schlumberger's MSS (89% of the Operational Area is in water depths greater than 1,000 m) and as such these same physiological effects on rock lobsters are considered unlikely or are at least predicted to occur much less frequently.

In a more recent study, in February 2018, CarbonNet carried out a 14 day seismic survey in Australia's Gippsland Basin. As part of their EP, CarbonNet committed to completing pre- and post-survey offshore habitat assessments to determine if there were any effects on key biological receptors (i.e. commercial scallops, southern rock lobster, finfish, and zooplankton) which could be attributable to the seismic survey. An Advisory Panel was established to ensure that the assessments were conducted in a scientifically robust manner with appropriate methodologies and interpretation of the results. This Panel consisted of representatives from regulatory agencies, academia and the fishing industry. With respect to rock lobsters, ten sites (six sites within the survey area and four reference sites) were monitored at known or potential areas of rock lobster habitat. The results showed that 81 individuals were obtained during the pre-survey assessment compared to 122 individuals post-survey. It was concluded that the increased number post-survey was most likely attributable to seasonal effects rather than any effects of the MSS.

2.4 There is currently no known safe range for fish resources from seismic operations, i.e. we don't know how far beyond 500 m the array would need to be from a lobster to not see an effect. This raises questions on the use of Day et al. (2016) as the definite limit of sound exposure. Therefore, we request an independent review of the impact buffer.

As discussed in **Section 1.6** sound modelling is used to determine zones of impact based on threshold criteria. There are known noise exposure thresholds or indicative noise levels at which there is the potential for certain effects (i.e. mortality, temporary hearing impairment, injury, behavioural changes) to occur to marine fauna when expose to those levels of noise. The threshold criteria used are based on current relevant scientific literature, accepted industry and international standards and are considered to be appropriate for the assessment process in the EP.

NOPSEMA have a set of standard threshold criteria which they consider acceptable for a wide range of marine fauna, and sound transmission loss modelling determines the maximum threshold distances for those SELs, and is then used as part of the assessment of effects to determine impacts on marine fauna and implementation of controls where required to reduce the potential impacts to As Low As Reasonably Practicable or an Acceptable Level.

NOPSEMA are an independent body and have to approve an EP before a seismic survey can proceed. They take into account all available literature and whether it has been incorporated into the EP as part of their review process, as well as concerns raised during stakeholder engagement.

At the moment, the Day et al. (2016) literature is the best available information that can be utilised for determining potential SEL effects on rock lobster. The potential threshold levels identified by Day et al. (2016) have been incorporated into Schlumberger's specific sound transmission loss modelling to determine maximum threshold distances. These distances are then used to determine what the likely effects are in terms of distance, however, the literature, in combination with the modelling results has indicated that the actual physiological impacts to rock lobster from seismic sound exposure will be low.

3 Bonney Upwelling

3.1 The area under consideration includes the Bonney Upwelling which as you would be aware is a major food source for many animals along the western Victorian coast

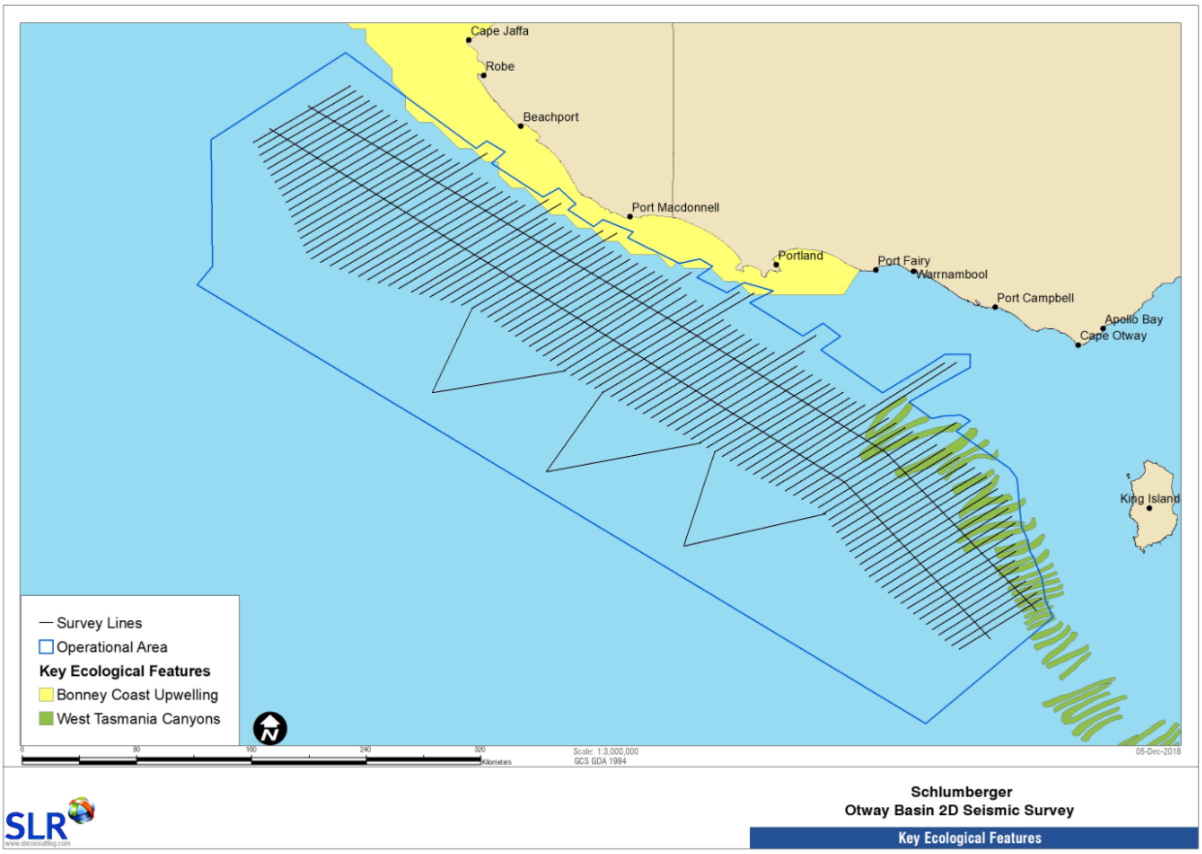
As mentioned in **Section 1.2**, there have been two revisions to the Operational Area resulting in an overall reduction of approximately 100,000 km^2; with approximately 6,000 km^2 of this area being removed from the Bonney Upwelling Zone. Schlumberger are aware of the importance of the Bonney Upwelling Zone and its recognition as a Key Ecological Feature due to the high productivity associated with the upwelling of nutrient-rich water. This awareness formed a key part of the decision in reducing the Operational Area through this zone.

These revisions to the Operational Area and moving the survey lines further offshore were a result of stakeholder feedback and identification of the sensitivities following an extensive literature search which confirmed the importance of the Bonney Upwelling to the wider region.

Only six tie lines (to previously drilled wells) overlap with the Bonney Upwelling Zone, so although the Operational Area overlaps by 9%, the actual tie lines entering the Bonney Upwelling Zone cover a much smaller area (**Figure 6**) and the time the survey vessel will spend in this upwelling zone will be minimised. So the revisions to the Operational Area and survey line design, moving away from the more sensitive environments inshore, will also ensure impacts are reduced to As Low As Reasonably Practicable (**ALARP**) and an Acceptable Level.

The Bonney Upwelling is strongest during the summer months (November-March), so as part of the survey planning, Schlumberger will make best endeavours to acquire the tie lines in October 2019. This will enable the vessel to complete the acquisition of this inshore area before the upwelling traditionally commences.

Figure 6 Bonney Upwelling Zone and overlap of 2D Seismic Survey Lines



4 Squid

4.1 Concerns have been raised on the impacts of spawning success of squid, given that 10% of survey lines are in less than 700 m of water and this covers the entire western Victorian squid fishery

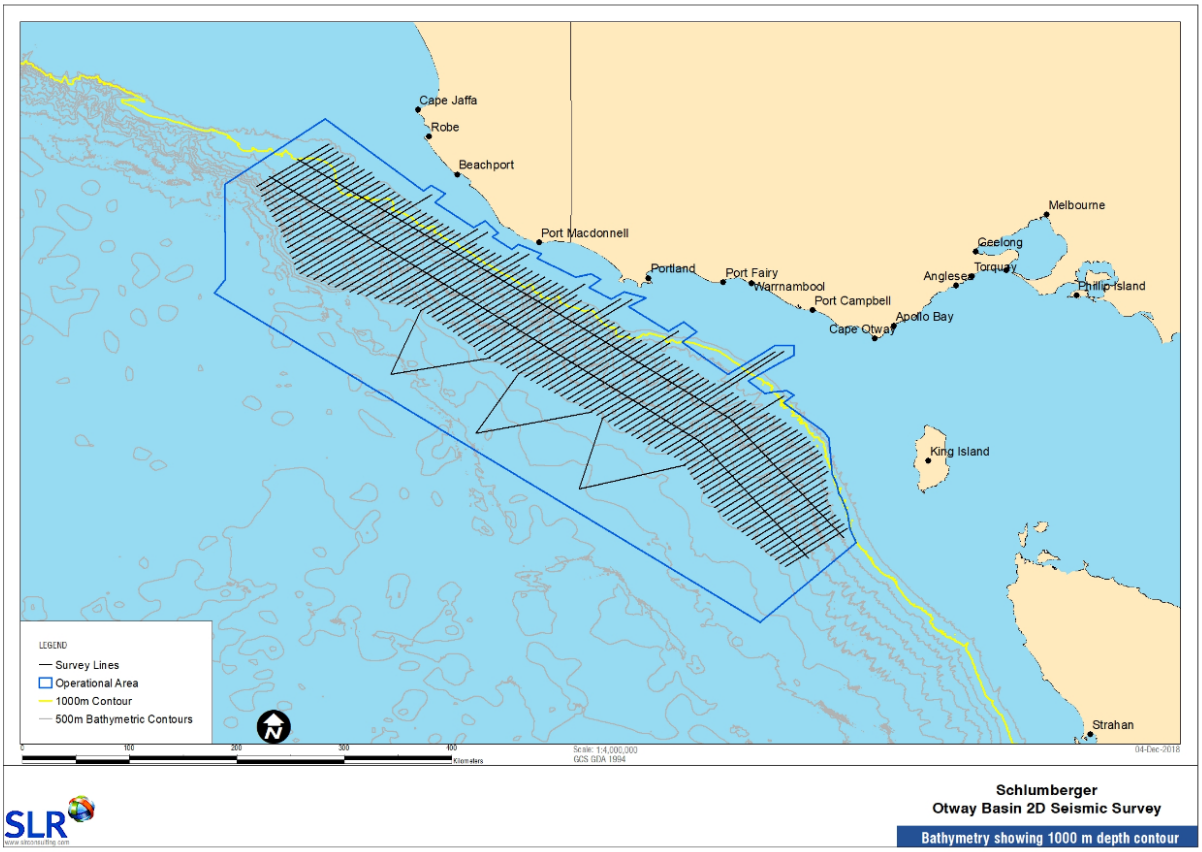
Figure 7 defines the 1,000 m bathymetry contour and it shows that Victorian waters have few lines survey lines shallower than the 1,000 m contour line.

There are four relatively short tie lines that cross the 1,000 m contour line in the Victorian region and do not contribute to 10% of the survey lines. All other survey lines are deeper than 1,000 m east of Portland.

From investigations into the southern squid jig fishery as part of the EP development, and following discussions with squid fishers it is understood that fishing effort is largely concentrated on the edge of the continental shelf, particularly near Portland in water depths between 60 and 120 m. However, we appreciate that some fishing effort will occur outside this region and outside these water depths at times.

Squid spawning success is covered in **Section 4.2** and **Section 4.3**.

Figure 7 Survey area with 1,000 m contour defined



4.2 How will Schlumberger address the short term (i.e. seasonal) decline in (squid) catches?

Determining short term (i.e. seasonal) declines in a fishery such as squid is extremely difficult to do when there are so many variables at play, both environmental and socio-economic, both of which can play key roles in defining the success of a fishery. Determining and defining the effects from sound combined with environmental and socio-economic variables is very difficult and would be a significant undertaking that would require a joint collaboration between the petroleum and seafood industry to assess over multiple years, as a single activity such as the proposed Schlumberger seismic survey, as one data point would be insufficient to draw conclusions from. For this reason we consider costs for any such limited study to be grossly disproportionate to the environmental benefit gained from implementing this control measure.

Carroll *et al*. (2017) recently published a critical review of the potential impacts of marine seismic surveys on fish and invertebrates. This review concluded that studies investigating the potential effects of seismic signals on catch rates or abundances on cephalopods, bivalves, gastropods, decapods, stomatopods, and ophiuroids have all detected no significant differences between sites exposed to seismic operations and those not exposed. This review was based on a large number of studies, which are detailed in the EP.

Despite the above information, Schlumberger acknowledges that it is possible that there may be some short-term localised effects on catch rates of squid and other commercially important species in the Operational Area due to temporary distributional or quantitative changes in fisheries stocks. However, due to the nature of the survey (i.e. long survey lines and large line spacing) these potential effects are considered to be temporary in nature if they were to occur.

Schlumberger are fully committed to effectively engaging with the commercial fishing industry and have done so throughout the development of the EP and will continue to do so through the implementation of the ongoing stakeholder engagement plan. Schlumberger have been engaging with SIV to distribute the information to its licence holders and will continue to do so throughout the survey programme. Schlumberger will keep the fishers fully informed of the survey schedule and vessel movements (i.e. 48 hour look-ahead plans) and will remain flexible while developing the operational schedule to minimise temporal conflict with fishers in inshore waters of the Operational Area.

This continual engagement and provision of information throughout Schlumberger's proposed MSS will enable fishers to schedule their activities around the seismic operations with the aim of reducing conflict through the displacement of fishing activities. The 48 hour look-ahead reports that Schlumberger will provide, which will be updated every 24 hours, and will detail the vessel's planned survey lines within the Operational Area with GPS coordinates of line start and end points.

4.3 How will Schlumberger address the possible catastrophic impact on larvae and squid eggs?

There are known noise exposure thresholds or indicative noise levels at which there is the potential for certain effects (i.e. mortality, temporary hearing impairment, injury, behavioural changes) to occur to marine fauna when exposed to levels of noise. The threshold criteria used are based on current relevant scientific literature, accepted industry and international standards and are considered to be appropriate for the assessment process in the EP.

The effect of acoustic energy on cephalopod larvae and eggs is however unknown as studies have not yet defined sound thresholds for acoustic damage to these early life stages of squid. It is also considered that once squid hatch, the larval and juvenile stages of the squid will move into the shallower coastal regions, which also moves them further away from the proposed Operational Area.

Studies have shown arrow squid can produce eggs year-round, if there were any potential for loss in recruitment over a three-month period then the squid's life history traits (generally short-lived, fast growing with high fecundity rates) mean they are well adapted to disturbance and the population would not be at the same risk as those species which only spawn once a year.

We have assessed the effects of sound levels produced from the sound modelling on fish eggs and larvae, which could be used as a proxy for squid eggs and larvae.

It is acknowledged that there are differences between squid and fish but this is currently the best available information, and it is considered that these sensitive life stages will be somewhat similar in terms of assessing the potential impact from acoustic disturbance.

Using the mortality criteria for fish eggs and larvae, zones of impact were determined by comparison of the predicted received levels to the noise exposure criteria. In this instance we have used the zones of impact for immediate impact from single pulses of noise exposure, to the maximum horizontal distance from the acoustic array.

It does have to be remembered that all of these thresholds, zones of influence, modelling inputs and modelling outputs are all highly conservative, as they each have been assumed as worst case. Noise validation studies consistently indicate that modelling results over-predict the actual SELs.

The Peak Sound Pressure Level threshold for mortality and potential mortal injury to fish eggs and larvae is >207 dB re 1µPa. From the modelling results, this equates to a maximum horizontal distance from the acoustic source of 130 m in the 50 m water depth modelled, and 250 m in the 4,800 m water depth modelled. These differences result due to the different sound propagations with water depth, where noise travels further in the deeper waters.

As the survey vessel goes along, any fish eggs or larvae that are within this distance (dependent on depth) either side of the acoustic source could be exposed to sound pressure levels that may be enough to cause mortality or potential mortal injury.

The survey design of 5 km line spacing's that Schlumberger have proposed, with long line lengths which will take approximately 11 hours to acquire will also assist in reducing any focused effects in a given area, and on this spatial scale would not cause any population effects to fish eggs or larvae. We would expect similar zones of impact to apply to squid.

There is no mortality threshold for squid that is used in sound modelling, but behavioural thresholds are used so zones of behavioural disturbance can be determined. The criteria for squid that was used was 156 RMS SPL dB re 1µPa. The modelling suggested that in water depths of 50 m that squid may show some form of behavioural response out to maximum distance of 3.2 km, whereas in 4,800 m of water that distance for a behavioural response could extend out to 5.8 km. These distances do not predict mortality or hearing loss, just simply behavioural changes. These thresholds are a lot lower than those required to elicit mortality or permanent damage. A typical behavioural response could involve being startled, but studies have shown that squid quickly become habituated, and acoustic disturbance does not appear to influence feeding (McCauley et al., 2000); hence catch rates should not be influenced by behavioural changes. The other point to remember is that the seismic vessel (and source) is continuously moving, so this level of noise will always be moving away once it was at the closest point to any receptor.

Utilising the modelling results and literature, it is not considered there will be any significant long term impacts on larvae and squid eggs, with no population level effects expected. Further details on the sound modelling and how the emitted acoustic noise behaves in the water column is provided in **Section 1.6**.

4.4 Concerns were raised about the impacts of seismic on squid reproductive organs and squid eggs

The potential impacts of seismic activity on squid's reproductive organs is more related to the physiological effects and reproductive success following seismic activities. This is discussed in **Section 4.1**.

Potential impacts of seismic activities on squid eggs are discussed in **Section 4.3**.

4.5 Significant weight needs to be given to concerns about the proven impact of seismic on plankton, which is a major food source for squid.

In 2017 McCauley et al. published the first large-scale field experiment investigating the impact of seismic activity on zooplankton and found that impacts were not as limited and localised as previously reported. In this study, the health of the plankton community in relation to exposure to a single 150 in^3 acoustic source was assessed using sonar surveys, net tows for zooplankton abundance, and counts of dead zooplankton both before and after seismic exposure. Key findings from this study included:

- There was a statistically significant lower abundance of zooplankton after exposure;
- 50% reduction in zooplankton abundance detected within ~500-700 m of the source;
- The range at which no impact detected on zooplankton was at ~1,000-1,100 m; and
- Impacts were observed out to 1,200 m.

There were some concerns over these findings and further research was commissioned by APPEA, who engaged CSIRO. Richardson *et al*. (2017) investigated the spatial and temporal impact of a large-scale seismic survey on zooplankton on Australia's Northwest Shelf during summer via hypothetical simulation. The results showed that zooplankton populations were substantially impacted within the seismic survey area out to a distance of 15 km (there was a 14% maximum decline within 15 km of the survey area). Impacts were barely discernible within 150 km of the survey area (2% maximum decline) and there was no apparent effect at a regional scale. The simulation showed that, following exposure, there was a rapid recovery of zooplankton populations due to their fast growth rates and the dispersal and mixing of individuals from inside and outside of the impacted region.

These authors state that MSS conducted in areas of high energy ocean circulation (such as the Otway Basin) are likely to have less net impact on zooplankton due to the continual movement of the water mass, and that seismic lines conducted perpendicular to the prevailing current flow (as proposed for Schlumberger's MSS) reduce the chance of zooplankton being exposed multiple times because the zooplankton are moving across the line of seismic travel. The authors also indicated that surveys off the shelf edge are likely to have less absolute impact due to lower biomass in the water column offshore.

Without conducting sophisticated modelling it is impossible to predict how widely zooplankton in the vicinity of the Operational Area will be affected. Given the acoustic source that is proposed for the Schlumberger survey, it may seem logical to assume that some mortality will occur at a larger distance from the source, over a larger area, and over a greater period of time than what was modelled by Richardson *et al.* (2017). However, other factors, such as the configuration of the sound source, time of year, bathymetry and substrate type, are also important in determining the potential impact of emitted sound on zooplankton. Likewise, the 5 km line spacing will mean that the acoustic source is not concentrated in any particular area of the Operational Area for a significant period of time, and given the seismic vessel is continually moving at 4-5 knots, this will have no regional impact on zooplankton communities.

The survey design of Schlumberger's proposed MSS will contribute towards minimising adverse effects since the survey lines run perpendicular to the prevailing currents and are relatively long, with each line taking approximately 11 hours to complete and lines spaced 5 km apart. This means that the survey vessel will not be passing through the same part of the Operational Area continuously. Even if an infill line is required, most individual locations will only be affected by the active noise source on one day, or two days in total for locations crossed by the longer lines at 90 degrees to the majority of the survey lines.

When assessing the acoustic effects of seismic survey activity on zooplankton and fish eggs and larvae, the naturally high mortality rates (>50% per day in some species) of marine fish eggs and larvae must be considered. In addition, the high energy nature of the offshore marine environment in the Operational Area will help promote rapid recovery of zooplankton populations on account of dispersal and mixing.

4.6 "Squid and scallops have similar sensory organs and we know what happened to scallops"

As marine invertebrates, scallops and squid are most sensitive to the vibrational component of sound; the anatomical structures involved in detecting the pressure component of sound have not been found in these organisms. As such, benthic invertebrates are unlikely to suffer serious adverse physiological effects from exposure to seismic acoustic outputs. A recent review by Carroll et al. (2017) reported that no studies employing realistic acoustic exposure levels reported any physical response in bivalves. One study reported a behavioural (startle) response, and another reported a physiological response in stress bio-indicators (although two other studies reported conflicting results).

With respect to scallops, Day *et al*. (2016) reported that repeated exposure to a seismic acoustic source where maximum sound levels were in the range of 181 to 188 dB re 1 μPa^2 s SEL caused physiological damage, changes in behaviour and reflexes, and increased the risk of mortality (although mass mortality of scallops did not occur during the experiment). Compared with unexposed scallops, the daily mortality odds were found to be 0.1%, 1.2% and 1.3% higher in scallops exposed to 1, 2, and 4 acoustic passes, respectively. Injured scallops did not recover over the four-month period of the experiment.

In 2010, mass mortality of scallops and other benthic invertebrates occurred in the months following a seismic survey in Bass Strait. The western and eastern scallop beds within the survey area suffered high mortality rates whereas the southern scallop bed which lay approximately 50 km away remained healthy. As fishing groups were concerned that the seismic survey had caused the mass mortality event, Przeslawski *et al*. (2018) carried out a study to investigate the potential impact of marine seismic surveys on scallops in the Bass Strait region. One component of the study specifically addressed the 2010 mass mortality event by using satellite data to examine patterns of sea surface temperatures over a ten year period from 2006 – 2016. The data showed that there was a pronounced thermal spike in the eastern Bass Strait between February and May 2010, and that the thermally impacted area overlapped the scallop beds where mass mortality occurred with respect to both space and time. As such, it is not clear whether the mass mortality event resulted from the thermal spike, which occurred in the same region on almost exactly the same dates of the seismic survey operation, or from the seismic survey.

In another Australian study, Przeslawski *et al*. (2016) examined the short-term impacts of marine seismic surveys on scallops in the Gippsland Basin and found no adverse effects on mortality, or any negative physiological effects in the variables measured (scallop shell size, adductor muscle diameter, gonad size and stage). However, this study did not examine any long-term sub-lethal effects.

In 2010, the Tasmanian Aquaculture and Fisheries Institute conducted a study to assess the immediate impact of seismic surveys on the survival and health of commercial scallops in Bass Strait following seismic surveys in the area. The results showed that in the two months post-survey, there were no impacts on the survival, health, abundance, size frequency distribution, macroscopic gonad and meat condition of the scallops (Harrington *et al*., 2010).

For Schlumberger's proposed MSS, only one pass of each survey line will take place (two in isolated infill scenarios), and each survey line will be approximately 5 km apart, so the benthic invertebrates will not be exposed to more than one pass of the acoustic source. In addition, given the water depth of Schlumberger's Operational Area, there are unlikely to be too many scallops living on the seabed in that depth, with most commercial and recreational scallop fishing being conducted well inshore of the Operational Area. During the engagement process it was discussed that most of the scallops are living in water depths of less than 80 m of water, although it is understood they can live in water depths down to 120 m.

In relation to noise exposure levels on scallops, NOPSEMA have a set of threshold criteria which are used for assessing potential impacts to both scallops and lobsters from exposure to the pulses from the acoustic source during the survey. These thresholds are based on studies by Day et al. (2016) and are then used within the model to derive a Zone of Impact, which defines the environmental footprint of the noise generating activities, and indicates the locations within which the activities may have an adverse impact on marine fauna species of interest. For Scallops the zones of potential impact, caused by the immediate exposure to individual pulses from the acoustic source are predicted to be 120 m – 220 m away from the array source based on a threshold of 186 dB re 1 $\mu Pa^2.s$.

With respect to squid, as covered in previous responses, and studies undertaken by Virtue et al. (2011) have shown that arrow squid can produce eggs year-round. So if there was any potential for injury or mortality (of which there is no evidence) which led to a large-scale loss in recruitment over a three month period then the squid's life history traits (i.e. short-lived and fast growing with high fecundity rates) mean they are well adapted to disturbance and that there would be a low risk of any population effects.

4.7 Concerns about the impact of seismic testing on squid migratory patterns

In regards to these concerns, it is assumed both vertical and horizontal migrations of squid. The daily vertical migrations through the water column have been discussed in **Section 1.6**.

Behavioural changes have been documented for cephalopods (squid and octopus species) in response to acoustic disturbance. Caged cephalopods that were exposed to acoustic sources demonstrated a startle response above 151-161 dB re 1 µPa and tended to avoid acoustic disturbance exhibiting surface behaviours (McCauley et al., 2000). It has been shown that species such as cephalopods will go to the surface during a seismic survey and this has been shown during a number of experiments, and this is due to the Lloyd Mirror effect, which results in noise levels at the surface being lower than those deeper in the water column. During the McCauley et al. (2000) study it was found that the use of soft-starts (slowly increasing the source volume when the seismic survey first starts) effectively decreased the startle response in cephalopods. Schlumberger will be operating in accordance with the EPBC Act and hence is required to undertake soft starts when commencing a survey line if the source is not already active. Once the survey is operational, the moving sound source effectively becomes a soft start as it increases in volume as it approaches; hence, if squid are not comfortable with the approaching sound source, they have the opportunity to move to avoid any significant physiological disturbance.

Caged studies on squid have also shown that squid become habituated to acoustic source noise after continued noise (Fewtrell & McCauley, 2012; Mooney et al., 2016), and this did not result in any mortality. However, habituation is not likely to occur in the proposed survey given the long survey lines, large line spacing's and continuously moving vessel. It is completely different to the test situation in terms of the period of exposure.

In terms of long lasting effect on squid following exposure to noise such as seismic, a study undertaken by Fewtrell (2003) found that squid ate immediately after being exposed to seismic noise, suggesting rapid recovery, where it was noted in the study that food appeared to be a powerful stimulus to the squid. And that the presence of food in an area could override the stimulus to leave an area affected by seismic survey noise.

5 Fish

5.1 There must also be serious considerations of the impacts to other finfish and their reproductive, spawning and aggregation phases. 'December to April is when the gummies come up the shelf into the local waters, a survey at this time of year could be potentially devastating for us.'

As part of the extensive literature review undertaken whilst developing the EP, it was demonstrated that a number of fish species will show avoidance behaviour, in the form of vertical or horizontal movements away from vessel noise. In regards to behavioural studies on fish around seismic surveys there are little indications of long-term behavioural disruptions, but short-term disruptions are common, such as startle responses, modification of schooling patterns and swimming speeds and changes in vertical distributions in the water column (Pearson et al., 1992; McCauley et al., 2000, Fewtrell & McCauley, 2012)). This behavioural response to acoustic disturbance varies depending on species traits, particularly sensory systems and the presence or absence of a swim bladder. Species with a swim bladder (or other gas filled chamber) are generally more sensitive to sound exposure than fish which don't (i.e. sharks, skates, rays, some flatfish, and some others) (McCauley et al., 2000). These species which have no swim bladder are more likely to detect particle motion rather than sound pressure.

Most pelagic fish are expected to avoid the area if sound levels become uncomfortable. The moving nature of the source and the use of soft starts also provide an opportunity for fish to move away from the source before being exposed to a full power noise impulse.

It is important to note that there are currently no documented cases of fish mortality upon exposure to seismic sound under field operating conditions. Studies have shown that exposure to seismic sound is considered unlikely to result in direct fish mortality; this may be because the moving character of the source and requirement for soft starts allow time for fish to avoid the highest theoretically possible exposures.

A review of the potential impacts of low-frequency seismic sound on the physical and physiological attributes of fish is provided by Carroll *et al*. (2017) and this shows that studies have reported varying results. The majority demonstrate no evidence of physical or physiological responses at either realistic or unrealistic exposure levels. Others however, report evidence of otolith/inner ear damage, temporal threshold shifts and stress bio indicators when exposed to low-frequency seismic sound at realistic exposure levels.

Essentially, from these studies it is derived that if there are no physiological effects to the fish from seismic disturbance, then any acoustic noise associated with a MSS should not impact reproductive or spawning success.

With respect to the effects of the proposed seismic survey on fish larvae, the sound transmission loss modelling results predict that exposure to a single pulse of the acoustic source could elicit mortality and potential injury to fish larvae and fish eggs out to distances of 250 m from the source in deep water, or out to 130 m from the source in shallow water. Cumulative exposure to multiple pulses from the moving noise source or infill lines does not increase the potential for mortality or injury to fish eggs and larvae, as even if an infill line is required, the peak noise effects result in threshold exceedances over greater distances than the cumulative noise effects.

The survey design of Schlumberger's proposed MSS will contribute towards minimising adverse effects since the survey lines are relatively long, with each line taking approximately 11 hours to complete and lines spaced 5 km apart. This means that the survey vessel will not be passing through the same part of the Operational Area continuously. Even if an infill line is required, most individual locations will only be affected by the active noise source on one day, or two days in total for locations crossed by the longer lines at 90 degrees to the majority of the survey lines.

When assessing the acoustic effects of seismic survey activity on fish eggs and larvae, the naturally high mortality rates (>50% per day in some species) of marine fish eggs and larvae must be considered, and this is the reason these species release many millions of eggs to try and offset the losses resulting from natural variables.

In relation to the concern about the gummies coming up into the shallower shelf waters, the survey lines have been modified intentionally to minimise acquisition in shallow water. It would be good to discuss this further with the fishers to gain an appreciation of the areas and water depths of concern so that we can assess the potential overlap and consider whether any further modification is required. In addition, the sound modelling results and the properties of acoustic noise in the marine environment have shown that as noise travels into the shallower water environment it will drop in volume quickly when it heads upslope.

5.2 Can Schlumberger guarantee that there will be no effect on fish populations?

When it comes to the natural environment with the multitude of variables present, it is not possible to make any absolute guarantees. However, a summary of the literature in relation to the proposed seismic activities and how this is likely to influence fish is provided below.

Acoustic disturbance associated with seismic surveys can modify fish behaviour (**Section 5.1**). Such changes in behaviour associated with seismic surveys can temporarily influence local abundances, distributions and, consequently has the potential to have an impact on catch rates. If this did occur, it would most likely be a short-term effect and would only be noticed within and around a survey area. However, fish behavioural responses are often observed to be temporary and short-term, with fish returning to their original area after a short time period. For example, studies by Engås *et al.* (1996) and Slotte *et al*. (2004) have observed fish species moving back to their original areas within five days following the completion of seismic activity.#

A number of studies have examined the effects of seismic activities on catch rates of fish species. A recent review by Carroll *et al*. (2017) concluded that studies have found positive, inconsistent, or no effects of seismic surveys on catch rates or abundance of fish. There are no documented cases of long-term displacement in commercially fished species or of fish mortality upon exposure to seismic sound under field operating conditions.

Further to this, from the literature review that has been undertake as part of the EP development, in some circumstances behavioural displacement reduces catch rates while in other circumstances catch rates increase. A number of studies also show no change in catch rates. This summary agrees with the conclusion reached by Przeslawski et al. (2016b) who concluded that "...[their] results support previous work in which the effects of seismic surveys on catch seem transitory and vary among studies, species, and gear types". Although some studies have linked reductions in catch rates to the effects of seismic activities, the body of peer reviewed literature on this topic does not support any long-term abandonment of fishing grounds by commercial fish species. There are a number of studies indicating that post-survey catch levels return to pre-survey levels following the cessation of seismic activities (Carroll et al. 2017). Also important to note is that although some fish may be temporarily displaced during seismic activities, the total number of fish within the fishery stock will remain unchanged (Przeslawski et al., 2016a).

Using sound transmission loss modelling results specific to Schlumberger's proposed seismic survey, the potential for fish mortality due to peak noise exposure has been identified within up to 250 m of the active source at full power. However, studies show that exposure to seismic sound is considered unlikely to result in direct fish mortality; this may be because the moving character of the source and requirement for soft starts allow time for fish to avoid the highest theoretically possible exposures.

To further reduce the potential for any impacts on fish at the population level, Schlumberger have also taken steps to ensure that Schlumberger's proposed MSS takes place in the shortest time possible (i.e. 24 hour operations); and through stakeholder engagement has identified sensitive areas for fisheries, and has made a commitment through the ongoing stakeholder engagement plan to continually engage with the fishers so that any impacts on the fishers and fisheries can be considered as part of the survey design during the acquisition phase if required.

Given the evidence of fish returning to survey areas following the cessation of seismic/acoustic activities, it is highly likely that any effects on fish will be temporary and fish will return to normal behaviour and distributions within days of any acoustic exposure. There are unlikely to be any population level effects for fish and subsequently, effects on catch rates are expected to be minimal.

6 Plankton/Spawning/Larval Dispersal

6.1 Richardson et al. (2017) - state their findings (95% recovery 3 days post survey) should not directly be applied quantitatively to other regions with different oceanographic conditions. And stressed that a detailed study of a particular region would be needed to quantify the spatial and temporal impacts in a particular region and season.

Yes, it is important to put the results from Richardson *et al*. (2017) into context in order to be able to understand how those results might be relevant to Schlumberger's proposed MSS in the Otway Basin. See **Section 4.5** for further discussion on this study.

6.2 Concerns over disruption to spawning/migration/life cycle processes and the flow-on effects that may occur with regards to fisheries

Schlumberger understands that there are a number of critically important processes that occur in the waters in and around the Operational Area, particularly during the spring/summer period. A detailed literature review and sound transmission loss modelling has been undertaken during the development of the EP to determine the likelihood of potential impacts to larvae and adult fish, and the effects that seismic surveys could have on catch rates.

Each of these concerns have been covered in the sub-sections above.

6.3 In some cold and deep areas with slower growth rates / longer reproductive cycles it can take a year for plankton to regenerate. Denuding a large region could have recovery rates significantly hampered.

There are many factors which are important in determining the potential impact of emitted sound on zooplankton. These include the configuration of the sound source, time of year, bathymetry, substrate type and temperature.

In comparison to fish and mammals, less research has been conducted on the effects of seismic outputs on zooplankton, as they do not have hearing structures, but can detect changes in pressure. Given that zooplankton are generally the same density as the surrounding water column, it is assumed that pressure changes associated with seismic activity will not cause physical damage (Parry & Gason, 2006).

With the survey design of Schlumberger's proposed MSS, the 5 km line spacing will mean that the acoustic source is not concentrated in any one particular area of the Operational Area for a significant period of time, and given the seismic vessel is continuously moving at 4-5 knots, this will have no regional impact on zooplankton communities.

When assessing the effects of MSS activity on plankton, the naturally high mortality rates (>50% per day in some species) must be considered. In addition, the high energy nature of the offshore marine environment in the Operational Area will help promote rapid recovery of zooplankton populations on account of dispersal and mixing. As a result, it is considered that the residual risk to zooplankton physiology and subsequent reproductive cycles, at a population level arising from acoustic disturbance from Schlumberger's proposed MSS is low.

Also, after undertaking an extensive literature search, the reference in the question where it was stated it can take a year for cold water plankton a year to regenerate was not able to be sourced. Could these papers be provided for our review?

6.4 The potential impact to future recruitment of Rock Lobster, Giant Crab and other fisheries resources. The free-swimming larval stages do not know boundaries and are suspended in the moving currents for up to 24 months, well beyond the 'fishing depths' referred to above.

The potential impacts to rock lobster have been discussed in **Section 2**.

7 Cumulative Effects

7.1 There is significant and alarming potential (noting that the Victorian fishing industry is currently being consulted on 4 different seismic proposals) that any denuding from the Otway Basin by the Schlumberger seismic survey will then be further impacted/compromised with 3D Oil's Dorigo MSS and Spectrum Geo's Otway Deep 3D survey in similar waters. How has this and any other cumulative impact been considered in your EP?

Schlumberger are aware there are other operators looking to undertake exploration activities within the Otway Basin. Cumulative effects have been considered within the EP, and it is one of the requirements that NOPSEMA will review as part of their assessment against the regulations and requirements.

Acoustic energy from multiple seismic surveys, as well as shipping traffic are the two most likely potential contributors to cumulative effects of underwater noise in the Otway Basin.

Because low frequency acoustic energy from seismic surveys travel large distances underwater, the overall acoustic footprint associated with a seismic survey is typically extensive. With regard to the potential temporal and spatial overlap of Schlumberger's proposed MSS and another operator if conducting a MSS in the basin, it is important to consider how multiple acoustic footprints from seismic surveys combine. In such circumstances, cumulative acoustic effects are not iterative; in fact they are somewhat counterintuitive whereby the survey that produces the highest SEL would dominate. For instance, if Survey A produces an SEL that is 6 dB re 1 μP^2 s higher than Survey B, then the combined level of both surveys is 1 dB re 1 μP^2 s higher than the higher of the individual SELs (i.e. Survey A) (A. Duncan (Curtin University), *pers comm*.).

To reduce the risk of cumulative impacts from concurrent MSS, recent best practice is to maintain a spatial separation of at least 40 km between the active seismic sources (BOEM, 2014). Schlumberger will manage seismic data acquisition during the proposed MSS to maintain this separation distance. Maintaining a separation distance of this magnitude will ensure multiple active sound sources do not overlap and therefore will not cause higher SEL's. This approach reduces the risk from cumulative noise effects to ALARP.

7.2 A recent study found that the current 24 hour period cumulative sound exposure levels (CSELs) values are shown to be reached in minutes. Noting that the proposed survey is for 2D, how is this study applicable, are the sound sources similar just not multi array, and what control measures will be adopted to addressed these findings? CSELs must be investigated on the already weakened lobsters under the new findings on cumulative sound exposure. Temporal impact spans three years 2018, 2019 and 2020. To what extent has this been considered by Schlumberger? Curtain - Comparison study of cumulative sound exposure levels (CSELs) from typical 2D seismic surveys.

For the proposed Schlumberger MSS, 24 hour cumulative sound modelling was undertaken as part of the sound transmission loss modelling.

During the proposed survey, the acoustic array will generate an impulsive noise every 12 seconds during active data acquisition, moving horizontally a distance of 25 m between each noise pulse, and covering a total distance of the order of 180 km in 24 hours. The received peak and Root Mean Square (**RMS**) noise levels do not change for repeated impulses, except as a result of the changing distance from the moving noise source. The SEL parameter that is modelled describes accumulated sound energy, so each successive noise pulse increases the cumulative SEL.

Cumulative modelling accounts for the moving noise source, and has been undertaken by accumulating the received noise exposure at a representative stationary location from successive pulses generated over two consecutive survey lines (5 km apart), over a time period of up to 24 hours.

24 hours is a reasonable limit to place on cumulative SEL and is recommended for impact assessment purposes by many guidelines, such as NMFS (2016). For Schlumberger's proposed survey, a maximum of two survey lines 5 km apart could feasibly be completed in any 24 hour period. The next line would be another 5 km away, so would contribute considerably less to cumulative impacts at the representative stationary location than the first two adjacent lines. Therefore, considering a 24 hour period for cumulative noise corresponds well to the proposed movement of the survey vessel past a particular receiving location.

In the event that data acquisition is halted temporarily, an infill line may be required. Using the modelling outputs and available literature, it has been determined that in this scenario a minimum delay of five hours would occur before resuming data acquisition at the same location, with some overlap. This possibility is considered by identifying the increased zones of impact resulting from a double-dose exposure (plus 3 dB in SELcum) within 24 hours affecting any particular location. With reference to the noise propagation with distance effects calculated using the short range model; doubling the exposure dose to complete an infill line at any individual location is expected to result in an increase in the cumulative SEL zone of impact distance by a factor of 1.4.

This approach to cumulative modelling is inherently highly conservative for marine mammal and fish species with the ability to move away from the noise source. For less mobile species, this approach represents the worst case cumulative effect to assess multiple noise exposures from this survey.

The cumulative impacts of noise are species specific. The extents of impacts of cumulative noise exposure including scenarios for infill lines are described in the following sections on a species-specific basis. Within the sound transmission loss modelling, cumulative noise exposure threshold criteria for individual species has been included and calculated as a distance away from the acoustic source and this has been interpreted within the EP.

In addition, it is also important to note that cumulative exposure to multiple pulses from a moving acoustic source or if the seismic vessel is doing an infill line, does not increase the potential for mortality or injury to zooplankton, fish eggs or larvae. This is because if an infill line is required, the peak noise effects result in threshold exceedances over greater distances than the cumulative noise effects.

8 Commitment Requests

8.1 To meet ALARP and an Acceptable level – We seek commitment to undertake a regional study to quantify the spatial and temporal impacts, including water column testing for eggs & larvae of fisheries resources.

A very similar study to this is already being undertaken by AIMS/CSIRO and findings will be available much sooner than if an additional study was sanctioned. The findings are expected to be analogous and would make a second study redundant. For this reason we consider costs for an additional study to be grossly disproportionate to the environmental benefit gained from implementing this control measure.

8.2 The fishing industry has been concerned for a number of years as to the oil and gas industry using 'selective' research to promote their views and opinions – 'cheery picking'. We seek Schlumberger not to do this in their Environment Plan, but to present all the research in equal light. A precautionary approach, like what is used in fisheries management, would suggest recognising there may be an impact and working collaboratively with the fishing industry to arrive at mutually acceptable ground. We seek your acceptance of this, and also seek the opportunity to review your full EP prior to submission – noting the amendments to the consultation requirements on the horizon.

Our industry utilizes all available science to assess the potential for impacts and appropriately implement controls to ensure they can be mitigated. Schlumberger prides itself on direct engagement to ensure we address all concerns and delayed the original proposed commencement to extend the time frame for appropriate engagement with all parties. We are seeking feedback on the proposed operation to incorporate into the EP to ensure all concerns can be addressed prior to submission. Once we have your direct feedback and how it relates to our proposed survey we are happy to share the relevant sections of the report once completed. NOPSEMA regulates offshore activities and EP's are assessed against the requirements of the Environment Regulations.

8.3 To meet ALARP in the eyes of Victorian Rock Lobster fishers, Schlumberger must:

8.3.1 Negotiate towards compensation/quota retirement for displaced fishers.

As outlined in the above supporting documentation Schlumberger will ensure appropriate mitigation measures are established such that the potential for impacts are minimized. Based on the available research and our modelling results we do not assess the impacts to be at a level that would significantly displace fishers to the extent that this control measure would be considered appropriate for this activity.

8.3.2 Consider opportunities for funding re-seeding programs for Rock Lobster - given the scientific uncertainty of the long-term impact an appropriate precautionary mitigation would be to make contribution to the upcoming rock lobster reef re-seeding program which seeks to assist in restoring the marine environment following the damage done by seismic air-guns.

Based on the available research we assess the potential for damage to the marine environment to be as low as reasonably practicable given the proposed mitigation measures and the conclusions from the modelling study. We propose to continue discussions with all stakeholders in good faith to identify and fund projects that will add value to the local industry, although do not consider it a necessary control measure for the purposes of the proposed activity. We are currently in discussions with industry bodies to identify appropriate projects and would like to discuss these projects in more detail to develop these future projects further.

8.4 To meet ALARP for Victorian Giant Crab fishers, Schlumberger must:

8.4.1 Extract Giant Crab habitat from the survey.

We have excluded all areas not critical to the current survey objectives and believe with the proposed mitigation measures that the potential impacts to this habitat to be ALARP.

8.4.2 Engage in compensation/quota retirement for displaced fishers

Answered in **Section 8.3.1**, the survey and mitigation measures to be adopted will not result in displaced fishers with potential impacts assessed to be ALARP.

8.5 SIV has been leading industry representation and consultation with oil and gas institutions for many years now, and the fishing industry has recognised there is a need to work collaboratively. Hence the presentation in our earlier report of the options (specific to Rock Lobster) that need to be considered across the impacted species. For example: The Origin Crowes Foot and Enterprise II survey of 2016/17 saw industry engagement like never before, and we are happy to consider options relevant to this survey to apply to the fishing industry. We would expect negotiations to begin to discuss compensation/quota retirement for displaced fishers. This would require one-on-one consultation and negotiation with any impacted fishers to determine previous effort and opportunity in the survey area, not supporting simply displacing this effort to another area. The fishers would retire their quota 'for the benefit of the resource' and Schlumberger would compensate them accordingly.

Answered in **Section 8.3.1**, the survey and mitigation measures to be adopted will not result in displaced fishers with potential impacts assessed to be ALARP.

9 References

CarbonNet, 2018. '*Executive Summary of the CarbonNet Pelican 3D Marine Seismic Survey (MSS) Offshore Habitat Assessments Final Report*'. Accessed from: http://earthresources.vic.gov.au/earth-resources/victorias-earth-resources/carbon-storage/the-carbonnet-project/marine-seismic-survey-habitat-impact-assessment-outcomes

Carroll, A. G., Przeslawski, R., Duncan, A., Gunning, M., & Bruce, B., 2017. '*A critical review of the potential impacts of marine seismic surveys on fish & invertebrates*'. Marine pollution bulletin, 114(1), 9-24.

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., 2016. '*Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries*'. Report to the Fisheries Research and Development Corporation. Report prepared by the University of Tasmania, Hobart.

Engas, A., Lokkeborg, S., Ona, E., Soldal, A., 1996. '*Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus)'*. Canadian Journal of Fisheries and Aquatic Sciences, 53: 2238-2249.

Fewtrell, J.L., 2003. '*The response of marine finfish and invertebrates to seismic survey noise'* (Doctoral dissertation, Curtin University).

Fewtrell, J.L., McCauley, R.D., 2012. 'Impact of air gun noise on the behaviour of marine fish and squid'. Marine pollution bulletin, 64(5), 984-993.

Harrington, J. J., McAllister, J., Semmens, J.M., 2010. *'Assessing the short-term impact of seismic surveys on adult commercial scallops (Pecten fumatus) in Bass Strait'*. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., McCabe, K., 2000. 'Marine Seismic Surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid'. Prepared for Australian Petroleum Production Exploration Association, Project CMST 163, Report R99-15.

Mooney, T.A., Samson, J.E., Schlunk, A.D., Zacarias, S., 2016. 'Loudness-dependent behavioural responses and habituation to sound by the longfin squid (Doryteuthis pealeii)'. Journal of Comparative Physiology A, 202(7), 489-501.

Pearson, W., Skalski, J., Malme, C., 1992. 'Effects of sounds from geophysical survey device on behaviour of captive rockfish (Sebastes spp.)'. Canadian Journal of Fisheries and Aquatic Sciences, 49: 1343-1356.

Parry, G.D., Gason, A., 2006. '*The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia*'. Fisheries Research, 79:272 – 284

Przeslawski, R., Bruce, B., Carroll, A., Anderson, J., Bradford, R., Brock, M., Durrant, A., Edmunds, M., Foster, S., Huang, Z., Hurt, L., Lansdell, M., Lee, K., Lees, C., Nichols, P., Williams, S., 2016a. 'Marine Seismic Survey Impacts on Fish and Invertebrates'. Final Report for the GippslandMarine Environmental Monitoring Project. Geoscience Australia, Canberra.

Przeslawski ,R., Brooke, B., Carroll, A.G., Fellows, M., 2018. 'An integrated approach to assessing marine seismic impact: Lessons learnt from the Gippsland Marine Environmental Monitoring project'. Ocean and Coastal Management 160, 117-123.

Przeslawski, Z., Huang, J., Anderson, A.G., Carroll, M., Edmunds, L., Hurt, S., Williams., 2018a. 'Multiple field-based methods to assess the potential impacts of seismic surveys on scallops'. Mar. Pollut. Bull. 129: 750-761Richardson, A.J., Matear, R.J., Lenton, A., 2017. '*Potential impacts on zooplankton of seismic Surveys'*. CSIRO, Australia. 34 pp.

Slotte, A., Hansen, K., Dalen, J., Ona, E., 2004. '*Acoustic Mapping Of Pelagic Fish Distribution And Abundance In Relation To A Seismic Shooting Area Off The Norwegian West Coast'*. Fisheries Research 67(2): 143-150.

Virtue, P., Green, C., Pethybridge, H. R., Moltschaniwskyj, N. A., Wotherspoon, S. J., Jackson, G., 2011. 'Arrow squid: stock variability, fishing techniques, trophic linkages-facing the challenges'.

APPENDIX J

TSIC Industry Communication and Engagement Report

Tasmanian Seafood Industry Council

Industry Communication & Engagement

Concerning

Proposed Schlumberger 2D Seismic Survey in the Otway Region

Background

In 2018, TSIC and Schlumberger first discussed the Schlumberger proposal to conduct a 2D seismic survey within the Otway Basin, with a particular focus on the area to the W/NW of mainland Tasmania and to the West of King Island.

Since the preliminary discussions, Schlumberger have changed their proposal significantly in terms of both the spatial outlay and timing of survey.

In March 2019, after ongoing discussions, Schlumberger, through the subcontracted [redacted] from consulting company SLR, reached an agreement for the Tasmanian Seafood Industry Council (TSIC) to conduct an agreed level of engagement and consultation with their members.

To meet Environmental Plan (EP) deadlines with NOPSEMA, TSIC agreed to provide a preliminary report to Schlumberger, noting that this did not provide adequate time for a complete consultation process.

This report provides the outcomes of this industry engagement and consultation process, inclusive of a TSIC position and concerns.

It also contains some recommendations for Schlumberger to consider as part of this consultation process and proposed seismic activity in the Otway Basin.

Communication & Engagement Strategy

The TSIC communication strategy was to engage with as many potentially impacted TSIC members as possible, with a particular focus on the rock lobster and giant crab industry. The short timeframe for submission of the preliminary report did create some issues with respect to the engagement strategy, but ultimately did not hinder TSICs ability to provide information to members.

TSIC sent an information package to all TSIC members living in the NW or Tasmania and on King Island. This information package included:

- A TSIC cover letter, which included a questionnaire (see questions in the section below).
- The Schlumberger document Schlumberger Stakeholders Factsheet Otway Basin 4 Feb 2019.

Questionnaire:

1. **Name:**
2. ***Are you willing to provide your name and contact details to Schlumberger? (yes / no)***
3. ***Do you fish in the proposed Operational Area?***
4. ***What fish species do you target between the months of October and April each* year?**
5. **What method of fishing do you use?**
6. **What depth range do you fish for your target species?**
7. **Do you have any further concerns around the impacts of the proposed seismic activity on your fishery or fishing operations?**
8. **Are there any broader concerns you have around seismic activity?**
9. **Do you have any specific questions for Schlumberger?**
10. **Any other comments?**

Results

Number of people engaged

TSIC directly consulted with:

- 123 TSIC members who live in the NW of Tasmania or King Island and across all wild catch fisheries (22% of TSIC wild catch fisher members statewide)
- This consisted of 58 emails and 65 hard copy mailed packages.
- Rock lobster and giant crab fishers were the key focus of follow-up phone calls.
- The document was also sent to the Tasmanian Rock Lobster Fishermen's Association for a more targeted distribution to members with an interest in fishing in the proposed 2D seismic survey location.
- Other information was gained during general phone calls and meetings with members (estimated 20 extra people)

Number of responses

A total of 60 responses were received from TSIC, some formal some not. Majority of these were from the Giant Crab and Rock Lobster Fishery.

Responses to questions

1. **Name:**

18 individuals representing 26 people agreed to provide their name and contact number.

Name	Contact
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted] on behalf of 8 King Island fishers	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

2. Do you fish in the proposed Operational Area?

Only 3 fishers indicated that they fish in the operational area, while one other indicated they have fished in the area in the past.

Vast majority of respondents noted:

- They fish in relatively close proximity at certain times of the year
- Have concerns about deeper water rock lobster and giant crab stocks that live within or close to the proposed seismic survey area.

3. *What fish species do you target between the months of October and April each* year?

Southern Rock Lobster (crayfish) and Giant Crab were the two key species identified. One person mentioned scallops.

4. What method of fishing do you use?

Lobster or crab traps

5. What depth range do you fish for your target species?

Rock lobster fishers noted they fish in depths up to 150 metres
Giant crab fishers noted they will fish out to 365 metre (200 fathom).

These responses indicate that some fishers fish over the shelf break (for giant crab).

6. Do you have any further concerns around the impacts of the proposed seismic activity on your fishery or fishing operations?

The general viewpoint was that seismic has an impact on all aspects of marine life. Specific comments that reflect this included:

- Concerned about ALL seismic activity as it impacts juveniles of all species.
- I believe trawl fisheries will be even more impacted (noting that this is a commonwealth fishery not captured by TSIC membership).
- Seismic adversely affects and kills giant crabs and other species.
- Huge impact on rock lobster and crab larvae.
- Also impacts juveniles and adults rock lobster and giant crab stocks.
- No scientific research on the impacts of seismic on giant crabs
- Always affects catch rates after a seismic survey

7. Are there any broader concerns you have around seismic activity?

Again, there were synergies with answers in this section. Commonalities included:

- We know that seismic kills larvae and adults, what we don't know is the recovery time, that is assuming it will recover.
- Continued seismic activity will decimate my industry.
- We cannot understand why the government continues to allow company after company conduct seismic – time and time again. We need it done once and the data get shared by all. The legislation must be changed and no new surveys allowed.
- There are alternative ways to conduct seismic activity – albeit slower and more expensive. Streamers can be laid on the bottom instead of the surface of the water. If things are done on the bottom it at least stops the damage in the water column.

And for amusement the following comment was made:

- I suggest we put these guys (seismic proposers) in budgie smugglers into a bath of water and let off 2000psi and see how they fare.

8. Do you have any specific questions for Schlumberger?

The key comments from this section revolved around the gas and oil industry having their own agenda and that the interests of fishermen are ignored. There is a general perspective amongst industry that the gas and oil industry do not care less about the environment, and that this sort of consultation process is simply ticking boxes, and does not produce any meaningful changes.

The seafood industry find this hard to digest given that it is scientifically proven (IMAS research) that seismic does cause significant damage.

9. Any other comments?

Comments from this line of questioning was diverse and can be condensed into the following comments:

- Seismic testing has killed the giant crab fishery of the West Coast of Tasmania before, and I can see it happening after this survey again.
- Other fisheries, such as the Alaskan Crab Fishery, took decades to recovery.
- I have been fishing since 1973 across a diverse range of fisheries and states. I have trawl fished after a large scale seismic activity, and caught nothing but dead fish and shells.
- Schlumberger keep quoting scientific evidence that seismic testing does no damage by citing a Norwegian Survey, but no one can find any evidence of this survey.
- As fishermen, we get charged to access the fishery, and are implemented to all sorts of management to ensure the resource is sustainable. Then this sort of activity comes through and everything is compromised.
- We stop fishing to protect the breeding females, and eggs then stay in the water for 18+ months. Seismic will compromise all this eggs.
- Not sure why we bother with this process as the government has already decided to support the gas and oil industry and provide approvals before this process anyway.
- Seismic surveys will impact future recruitment, but we will not see that impact until some years down the track.
- We need the offset principle applied to seismic to help rehabilitate the damage of seismic on eggs and larvae (future recruits).
- Pay 5 boats to tie up for the year = $500,000 per boat. This will leave 50 tonne of adult lobster in the water to breed and contribute to future recruitment, which will offset the impacts of seismic.
- The Tasmanian rock lobster fishery is working hard to improve stocks in the NW of Tasmania, to improve egg production in this area. This compromises all the benefits made as it will larvae.
- There are other proposals for seismic in the same area
- I don’t fish in the area but I participated to show my support to those who will be impacted.
- One fisher made the comment “I 100% support this”.

TSIC Viewpoint

Consultation fatigue & industry disengagement

TSIC had hoped for a better response rate than achieved for the questionnaire and engagement process. It is the view of TSIC that the poorer than expected outcome is a consequence of 'consultation fatigue.' This is the consequence of multiple seismic proposal processes overlapping the NW / King Island region. This has resulted in a number of individuals, companies, consultants, TSIC and the Government transferring information onto fishers.

The end result is the obvious disengagement by the seafood industry.

Sound exposure & Cumulative Sound Exposure Levels

The Tasmanian seafood industry remains uncertain about the outer limits of any sound exposure from the proposed seismic survey. Noting comments from many members that they fish within or in close proximity to seismic survey region, it is important that we fully understand any outer limits of exposure.

A recently released consultant report[1] provided significant insight into the potential inadequacies of Cumulative Sound Exposure Level (CSELs) modelling and reporting within gas and oil exploration Environmental Plans. The report identifies the need for sound modelling at longer accumulation times and also shows there is a fast accumulation on first pass. Over a 24 hour period, CSELs values provided in Environment Plans are reached in minutes, meaning the CSELs are less a precautionary level in 24 hours, and more a certainty, as the survey vessel passes in a matter of minutes.

These results suggest that the potential impacts from 3D seismic surveys are greatly underestimated. TSIC is uncertain about the applicability of this outcome on 2D seismic activity.

Impacts on Southern Rock Lobster

Recent research published by the Institute for Marine and Antarctic Studies showed that adult southern rock lobster suffered a range of sub-lethal impacts when exposed to seismic. Impacts included:

- Reduced ability to maintain tail extension
- Impacted ability for lobsters to 'right themselves'
- Righting impact was related to observed significant impact to the statocyst or hair cells
- Haemocyte counts showed significant response. Reduction in cell numbers typified a response to trauma or stress and leave lobsters more vulnerable to infection
- Lobsters kept for 365 days post experiment showed 100% increase in haemocyte count, suggesting seismic exposure may effect immune system leaving them vulnerable to pathogens.

[1] A comparison study of cumulative sound exposure levels (CSELs) from typical 3D seismic surveys. Curtin University. Centre for Marine Science and Technology.

In acknowledging that there is minimal direct overlap of the planned seismic activity with known or fished Tasmanian rock lobster grounds, there are significant rock lobster populations in what industry believe is relatively close proximity. Furthermore, uncertainties around source and sink dynamics of rock lobster larvae means that adults stocks in the Victorian zone of the seismic survey area may be very important, in any given year, to recruitment in the NW region including around King Island.

There is no doubt that the results from the recently published IMAS research open a diverse number of questions and uncertainties around the impacts of seismic on rock lobsters stocks within the Tasmanian and Victorian fisheries.

TSIC would like the following issues to be considered:

- An independent review of any spatial limits to sound exposure. That is, how far from seismic activity is exposure expected to impact rock lobster.
- Noting previous seismic activity and other proposed activity within the survey region, what are the cumulative sound exposure impacts on rock lobsters, noting that adults could already be weakened from previous seismic activity?
- Deep water stocks to the west of King Island and in the Victorian jurisdiction have not been targeted in recent years as demand has been for smaller red rock lobster (which is found inshore). As such 5 year catch statistics do not reflect lobster stock available. Furthermore, deeper water, lobster stocks may provide an important broodstock, which is vital for recruitment dynamics.

Impacts on Giant Crabs

Noting the above impacts of seismic activity on rock lobsters, it is reasonable to assume that seismic sound would have at very least a similar impact on giant crabs, if not a greater impact.

The proposed survey region partially overlaps and is in close proximity to giant crab habitat and fishing grounds in both Tasmanian and Victorian waters.

Fishers have expressed concern that they will be directly impacted by the location and timing of the proposed survey activity.

Furthermore, giant crab stocks are currently at an all-time low, and the potential impacts of seismic on even a small portion of the stock could have dire consequences for the longer term recovery.

Impacts on scale fish

Tasmanian based fishers do hold access rights to Commonwealth Southern and Eastern Scalefish and Shark Fishery, which overlaps the proposed seismic survey area.

The proposed seismic survey activity overlaps the peak catching period for this region.

There will be displacement of fishing activity for these fishers.

This should be captured through consultation with commonwealth fishers.

Impacts on zooplankton and larvae

Day et al (2016) showed that seismic surveys had no adverse impact on the development of spiny lobster embryos; that is eggs underneath the tail of a rock lobster. It could be inferred that seismic will not adversely impact the development of giant crab embryos, but only under the assumption that seismic does not adversely impact adult giant crab at levels greater than that observed on rock lobster. It is only with further research that we can be assured that seismic does not impact giant crab embryos.

McCauley et al. (2017) showed that seismic surveys could cause a two to three –fold increase in mortality of adult and larval zooplankton; and impacts were observed to the maximum 1.2 kilometer test range. This is 100 times greater than the previous assumed impact range of 10 metres. During their tests, all larval krill were killed by seismic.

These results certainly raise questions about the impact of seismic on zooplankton and the flow-on impact on broader ecosystem services.

The impact of seismic activity on the larvae of commercial species remains unknown, but it is reasonable to assume that given the above information for zooplankton and larval krill, there would be catastrophic impacts on fish and crustacean larvae.

Of particular concern is rock lobster larvae, which has an 18 month to 2 year larval stage. Furthermore, the source and sink dynamics for this species is relatively unknown, but recent genetic research shows both mixing of stocks between different jurisdictions (South Australia, Victoria and Tasmania), as well as a high level of self-recruitment for the NW Tasmania stock ([redacted], IMAS, Pers comms). The dynamics of rock lobster larval distribution in space and time are still unknown, so there may be a reliance on high densities of rock lobster larvae within the proposed seismic activity zone for successful recruitment in the NW region.

Of further note, the NW region of Tasmania currently has low egg production and virgin biomass, so any impact on larvae or adult stocks could be detrimental to stocks in this region.

Application of the Offset Principle

It is the strong view of TSIC and the Tasmanian seafood industry that seismic activity is having an impact on the larvae of key commercial species, which in turn has an impact on future recruitment activity. Understanding the full impacts is time consuming and exceptionally costly, and hugely confounded by natural environmental influences.

TSIC and the Tasmanian seafood industry strongly support the application of the Offset Principle to seismic activity in recognition that the practice of seismic surveys is having an impact on the environment that the Tasmanian seafood industry rely, and future recruitment into these fisheries.

The establishment of an Offset Fund would allow a range of projects to be established to support our marine environment and the resources in that environment.

Potential projects that could support rock lobster stocks in the NW of Tasmania could include:

- An extension of the current translocation program, where juvenile rock lobsters are caught in slow growing deep water regions in southern Tasmania and relocated to shallow fast growing regions of the NW.
- The establishment of a program that collects newly settled rock lobster (puerulus) from marine farm infrastructure, ongrow these within an on land nursery and then releases back into the wild population. This concept is currently being discussed with the Institute for Marine and Antarctic Studies as a very viable strategy to support rock lobster stocks in Tasmania.

Conclusions

The key conclusions from this consultation process are:

- Tasmanian seafood industry has consultation fatigue with respect to seismic activity proposals in NW Tasmania. This has created a seafood industry that is currently disengaged with the gas and oil industry.
- There appears to be limited direct impact for the Schlumberger proposal on Tasmanian fishers' capacity to operate, as the proposed zone just overlaps Giant Crab fishing grounds.
- There is widespread concern about the impact of seismic on adult giant crabs and rock lobster from the proposed activities.
- The biggest concern is the impact of seismic on the larvae of commercial species. In particular, there is concern for rock lobster larvae as it has an 18 – 24 month larval cycle, and the source / sink dynamics of this larvae are still unknown. However, the area to the West of King Island does appear important for source sink dynamics.
- Should Schlumberger continue with this proposal, they should contribute to an Offset Policy to help remediate damage caused.

Next Steps

TSIC will determine the next steps once Schlumberger has consider the issues and concerns articulated by industry and TSIC, as documented in this report.

APPENDIX K

SLB Response to TSIC Industry Communication and Engagement Report

Schlumberger Responses to Concerns Raised in the Tasmanian Seafood Industry Council Communication and Engagement Document

1 General Comments

The Tasmanian Seafood Industry Council (**TSIC**) sent an information package to all of their members living in the north-west (**NW**) of Tasmania and on King Island. This information package included:

- A TSIC cover letter, which included a questionnaire; and
- The Schlumberger document 'Schlumberger Stakeholders Factsheet Otway Basin 4 Feb 2019'.

The questionnaire contained the following questions:

1. Name:
2. Are you willing to provide your name and contact details to Schlumberger? (yes / no)
3. Do you fish in the proposed Operational Area?
4. What fish species do you target between the months of October and April each year?
5. What method of fishing do you use?
6. What depth range do you fish for your target species?
7. Do you have any further concerns around the impacts of the proposed seismic activity on your fishery or fishing operations?
8. Are there any broader concerns you have around seismic activity?
9. Do you have any specific questions for Schlumberger?
10. Any other comments?

Sixty responses were received by TSIC, both formal and informal, with the majority of these from the Giant Crab and Rock Lobster Fisheries. Eighteen individuals representing 26 people agreed to provide their name and contact number. TSIC attributed the poorer than expected response rate to 'consultation fatigue'; a consequence of the multiple seismic proposal processes occurring in the NW/King Island region.

Only three fishers indicated that they currently fish in the Operational Area. Most of the respondents said that they fish in relatively close proximity to the Operational Area at certain times of the year. The concerns were generally centred around the deeper water rock lobster and giant crab stocks that live within, or close to, the proposed seismic survey area. These stocks are targeted between October and April each year using traps in depths of up to 150 m (rock lobster) and 365 m (giant crab).

Overall, it was concluded that there appears to be limited direct impact of the Schlumberger proposal on Tasmanian fishers' capacity to operate, with the proposed zone just overlapping the giant crab fishing grounds. However, there remained widespread concern about the impact of the proposed activities on adult giant crabs and rock lobsters. The biggest concern was the impact of seismic on the larvae of commercial species, in particular on rock lobster larvae, which have an 18 –

24 month larval cycle, and for which the source / sink dynamics remain unknown. It was noted that the area to the West of King Island appears important for source sink dynamics.

The questions that were raised from the TSIC Communication and Engagement Document have been grouped into topics and are addressed in the sections below. At the beginning of each section, the concerns reported by TSIC members are listed and the viewpoint of TSIC is presented (where given). Schlumberger's response is then provided and this will act as a starting point for further discussion with TSIC and their members as the engagement process continues.

2 Impacts on Larvae/Recruitment/Zooplankton

TSIC Member Feedback

Concerned about ALL seismic activity as it impacts juveniles of all species."

"Huge impact on rock lobster and crab larvae."

"Also impacts juveniles and adult's rock lobster and giant crab stocks."

"We know that seismic kills larvae and adults, what we don't know is the recovery time, that is assuming it will recover."

"We stop fishing to protect the breeding females, and eggs then stay in the water for 18+ months. Seismic will compromise all this eggs."

"Seismic surveys will impact future recruitment, but we will not see that impact until some years down the track."

"The Tasmanian rock lobster fishery is working hard to improve stocks in the NW of Tasmania, to improve egg production in this area. This compromises all the benefits made as it will larvae."

TSIC Viewpoint

"Day et al. (2016) showed that seismic surveys had no adverse impact on the development of spiny lobster embryos; that is eggs underneath the tail of a rock lobster. It could be inferred that seismic will not adversely impact the development of giant crab embryos, but only under the assumption that seismic does not adversely impact adult giant crab at levels greater than that observed on rock lobster. It is only with further research that we can be assured that seismic does not impact giant crab embryos.

McCauley et al. (2017) showed that seismic surveys could cause a two to three –fold increase in mortality of adult and larval zooplankton; and impacts were observed to the maximum 1.2 kilometer test range. This is 100 times greater than the previous assumed impact range of 10 metres. During their tests, all larval krill were killed by seismic.

These results certainly raise questions about the impact of seismic on zooplankton and the flow-on impact on broader ecosystem services.

The impact of seismic activity on the larvae of commercial species remains unknown, but it is reasonable to assume that given the above information for zooplankton and larval krill, there would be catastrophic impacts on fish and crustacean larvae.

Of particular concern is rock lobster larvae, which has an 18 month to 2 year larval stage. Furthermore, the source and sink dynamics for this species is relatively unknown, but recent genetic research shows both mixing of stocks between different jurisdictions (South Australia, Victoria and Tasmania), as well as a high level of self-recruitment for the NW Tasmania stock [redacted], IMAS, Pers comms). The dynamics of rock lobster larval distribution in space and time are still unknown, so there may be a reliance on high densities of rock lobster larvae within the proposed seismic activity zone for successful recruitment in the NW region.

Of further note, the NW region of Tasmania currently has low egg production and virgin biomass, so any impact on larvae or adult stocks could be detrimental to stocks in this region."

Schlumberger's Response

Rock Lobster Larvae

Due to both logistical and financial difficulties of field based experiments, most scientific investigations to date into the impact of seismic outputs on rock lobster larvae (and other marine invertebrates) have been largely confined to laboratory environments.

As mentioned above in the TSIC Viewpoint, Day *et al.* (2016) studied the impact of seismic exposure on the embryonic development of southern rock lobster (*Jasus edwardsii*) larvae in Storm Bay, Southern Tasmania, in water depths of 10 – 12 m. Egg-bearing female rock lobsters were exposed to signals from three seismic source configurations at various distances, all of which exceeded Sound Exposure Levels (**SELs**) of 185 dB re 1 $\mu Pa^2 \cdot s$.

The effects on embryonic development were assessed by examining the number, morphology, energy content and competency of hatched larvae. Overall, the results of the study found no differences in the quantity or quality of hatched rock lobster larvae and these authors concluded that seismic air gun exposure during early-stage embryonic development does not negatively affect rock lobster larvae.

The SEL_{cum} levels in this experiment emulate exposure levels equivalent to those of a large commercial air gun array passing within a few hundred metres and certainly within 500 m of the experimental site (Day *et al.,* 2016). These values are similar to, and often higher than, other published values (Day *et al*., 2016) and are similar to the shallow water SEL_{cum} levels (i.e. worst case scenario) modelled for the Schlumberger's proposed Marine Seismic Survey (**MSS**) in the Otway Basin.

Crab Larvae

It is agreed that there is a lack of literature available on the impact of seismic activity on crab larvae but it is assumed that the effects will be similar to those for rock lobster larvae (above) given the sensitive life stages. There is no reason to assume the impacts would be at a greater level than rock lobster, but without any specific research results a lot of the assumptions are based on the modelling data and that crustaceans (and invertebrates in general) respond in similar ways.

Schlumberger are currently in discussions with industry bodies to identify appropriate projects for further research. We would like to discuss these projects in more detail with TSIC members if there is the potential to develop them with both the fishing and petroleum industries in the future.

The impacts of seismic activity on adult crabs and crab catch rates of crabs are discussed in **Section 5** and **Section 7** respectively.

McCauley et al. (2017) and Subsequent Related Studies

Regarding the McCauley *et al*. (2017) study, this was the first large-scale field experiment investigating the impact of seismic activity on zooplankton and the results showed that the impacts were not as limited and localised as previously reported. In this study, the health of the plankton community in relation to exposure to a single 150 in^3 acoustic source was assessed using sonar surveys, net tows for zooplankton abundance, and counts of dead zooplankton both before and after seismic exposure. Key findings from this study included:

- There was a statistically significant lower abundance of zooplankton after exposure;

- There was a 50% reduction in zooplankton abundance detected within ~500-700 m of the source;
- The range at which no impact detected on zooplankton was at ~1,000-1,100 m; and
- Impacts were observed out to 1,200 m.

Marine seismic surveys conducted in areas of high energy ocean circulation (such as the Otway Basin) are likely to have less net impact on zooplankton due to the continual movement of the water mass (Richardson *et al*. 2017). Seismic lines conducted perpendicular to the prevailing current flow (as proposed for Schlumberger's MSS) reduce the chance of zooplankton being exposed multiple times because the zooplankton are moving across the line of seismic travel.

Schlumberger's survey design is comprised of 90 km long survey lines with 5 km line spacing, so the acoustic source is not concentrated in any particular area for a significant period of time. Given the seismic vessel is continually moving at 4-5 knots, this will have no regional impact on zooplankton communities.

Each of the seismic lines will take approximately 11 hours to complete and because they are spaced 5 km apart, the survey vessel will not pass through the same part of the Operational Area again. The closest it will be is 5 km away, and in the order of nearly 24 hours later taking into account line turns and start-up procedures.

When assessing the acoustic effects of seismic survey activity on zooplankton and fish eggs and larvae, the naturally high mortality rates (>50% per day in some species) of marine fish eggs and larvae must be considered. In addition, the high energy nature of the offshore marine environment in the Operational Area will help promote rapid recovery of zooplankton populations on account of dispersal and mixing.

Schlumberger's Sound Transmission Loss Modelling in Relation to Larval Receptors

An understanding into the behaviour of underwater sound emitted from the acoustic source to be used in Schlumberger's proposed MSS is important when assessing effects on the different receptors in the marine environment. To provide some context into this, a summary of Schlumberger's sound transmission loss modelling is provided below.

The sound transmission loss modelling is specific to the Operational Area. Inputs to the model include water column characteristics (so that the speed of sound through the water column can be determined), the geology of the seabed and underlying layers (so that the reflection of sound can be determined) and the bathymetry of the Operational Area and surrounding areas (as the bathymetry influences how the sound waves are reflected as they travel into either shallower or deeper waters).

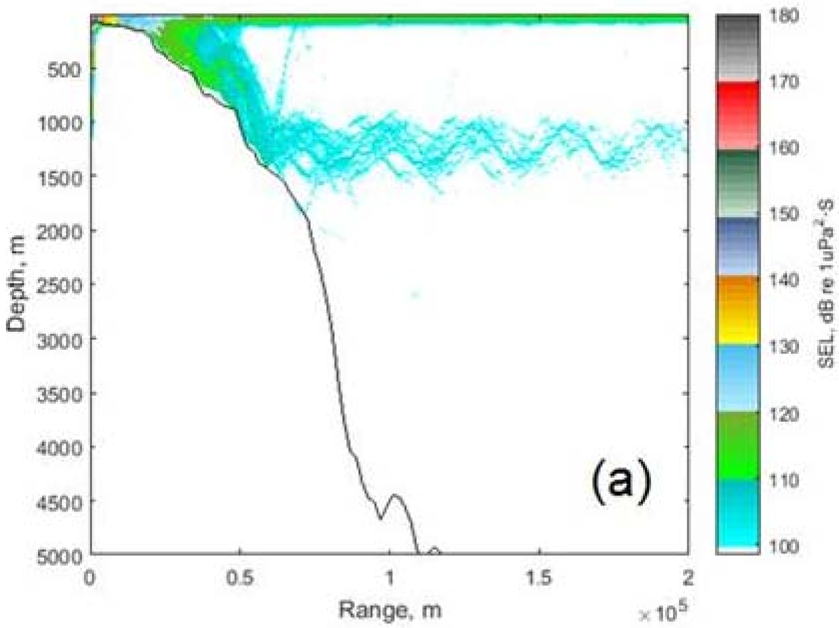
Sound propagation, or spread of sound, occurs in a downslope direction into the deeper waters. A reduction in sound speed with increasing depth results in downward refraction, so the highest sound levels occur in the lower portion of the water column. This means that the SELs are generally focused in the mid water column, and are considerably lower near the surface. This is shown in **Figure 1**, which is a cross section from the Operational Area, for noise vs depth out to 200 km from the modelling location.

In this model output, only a small part of the water column is exposed to SELs above the ambient noise, as the sound is focused into a channel and travels horizontally. In this modelled example, the noise levels at about 50 km from the acoustic source in the offshore direction are approaching ambient noise levels.

The model outputs provide specific information about how sound will propagate within the survey area, and it can be seen that the SELs will not be high throughout the entire water column. The sound levels will not be significantly elevated above ambient levels, where ambient levels are reasonably high in this region due to high levels of maritime shipping (verified by the plot we have extracted from www.Marinetraffic.com).

For sound that is travelling upslope and into shallower waters once released from the acoustic source, the rays steepen on each subsequent seabed reflection rate which causes rapid attenuation as the sound travels into inshore waters. This is what happens when the sound waves are heading up the continental shelf from survey lines being acquired over the shelf edge and the sound waves are travelling inshore to the shallower waters. The modelling outputs show that sound (or SELs) will not travel as far inshore into the shallower water depths as it does in the offshore direction.

Figure 1 Cross section of long range noise modelling plot – distance vs water depth



There are known noise exposure thresholds or indicative noise levels at which there is the potential for certain effects (i.e. mortality, temporary hearing impairment, injury, behavioural changes) to occur to marine fauna. The threshold criteria used are based on current relevant scientific literature, accepted industry and international standards and are considered to be appropriate for the assessment process in the Environment Plan.

There are currently no noise exposure thresholds for rock lobster or crab larvae but for this discussion fish eggs and larvae have been used as a proxy. It is acknowledged that there are differences between rock lobster larvae and fish eggs but it is considered that these life stages will be somewhat similar in terms of sensitivity when assessing the potential impact from acoustic disturbance.

Using mortality criteria for fish eggs and larvae, zones of impact were determined by comparison of the predicted received levels to the noise exposure criteria. The zones of impact for immediate impact from single pulses of noise exposure, to the maximum horizontal distance from the acoustic array were used in the modelling assessment.

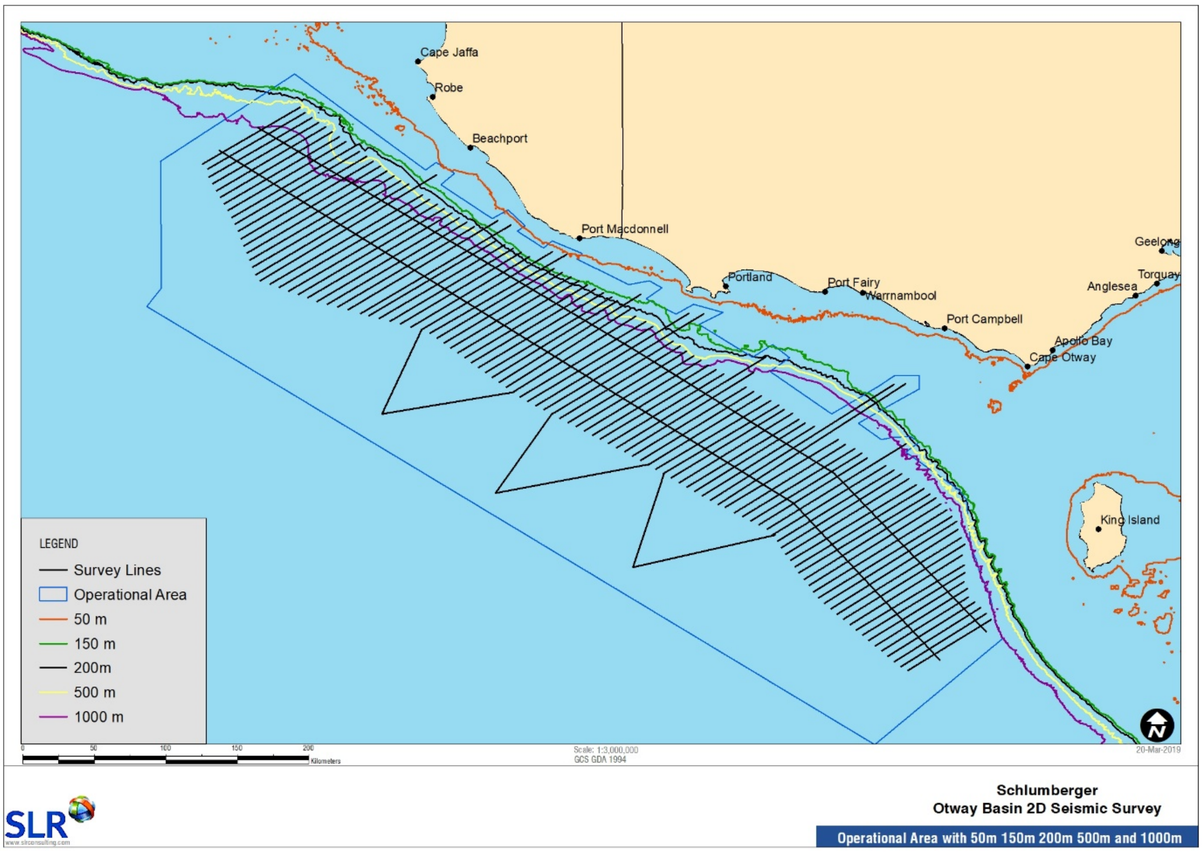
It does have to be remembered that all of these thresholds, zones of influence, modelling inputs and modelling outputs are all highly conservative based on the inputs to the model, as they each have been assumed as worst case. This is supported by noise validation studies, which consistently indicate that sound transmission loss modelling results over-predict the actual SELs that arise from a MSS.

The Peak Sound Pressure Level threshold for mortality and potential mortal injury to fish eggs and larvae is >207 dB re 1µPa. From the sound transmission loss modelling results, this equates to a maximum horizontal distance from the acoustic source of 130 m in the 50 m water depth modelled, and 250 m in the 4,800 m water depth modelled. These differences result due to the different sound propagations with water depth, where noise travels further in the deeper waters.

What these results mean, is that as the survey vessel is operational with an active source, any fish eggs or larvae that are within this threshold distance (dependent on depth) either side of the acoustic source could be exposed to sound pressure levels that may be enough to cause mortality or potential mortal injury.

In the waters off Tasmania, following the reduction to Schlumberger's Operational Area, all of the survey lines are located beyond the 1,000 m contour line (**Figure 2**).

Figure 2 Schlumberger Marine Seismic Survey Lines with Bathymetry



The survey design of 5 km line spacing's that Schlumberger have proposed, with long line lengths which will take approximately 11 hours to acquire will also assist in reducing any focused effects in a given area, and on this spatial scale would not cause any population effects to fish eggs or larvae. We would expect similar zones of impact to apply to rock lobster larvae.

Rock lobster larvae have a long larval development stage where they can spend close to two years in oceanic waters before metamorphosing to the postlarval stage (i.e. puerulus). At this time they swim towards the coastline and settle (Booth *et al*., 2003). As a result of rock lobster larvae being poor swimmers, they are at the mercy of the currents, drifting large distances during their development, where South Australian rock lobster larvae are known to have been transported over 2,000 km to New Zealand waters (Booth *et al*., 2003).

On the assumption that rock lobster larvae can tolerate similar SELs to fish eggs and larvae, then the there is only anticipated to be a potential zone for mortality around the acoustic source in the order of 130-250 m, depending on the water depth that the seismic vessel is in. This zone of influence would be present along each survey line, but only when the larvae are within that zone, and as was found in Booth *et al*., (2003) within the vast volume of the ocean, the densities of larvae within the water column are sometimes not as high as you would expect (one larvae per 500 m^3) due to mixing and different vertical migration patterns.

3 Impacts on Adult Commercially Fished Species

TSIC Member Feedback:

"Seismic adversely affects and kills giant crabs and other species"

Schlumberger's Response

The potential biological impacts of the proposed seismic activity have been considered for all groups of marine species relevant to the Operational Area, risk assessed and control measures implemented to reduce any potential impacts to ALARP where possible. Full descriptions and assessments are presented in the Environment Plan. A brief discussion of the impacts on rock lobster, giant crab and scale fish are provided in the sections below.

4 Impacts on Southern Rock Lobster

TSIC Viewpoint

"Recent research published by the Institute for Marine and Antarctic Studies showed that adult southern rock lobster suffered a range of sub-lethal impacts when exposed to seismic. Impacts included:

- *Reduced ability to maintain tail extension;*
- *Impacted ability for lobsters to 'right themselves';*
- *Righting impact was related to observed significant impact to the statocyst or hair cells;*
- *Haemocyte counts showed significant response. Reduction in cell numbers typified a response to trauma or stress and leave lobsters more vulnerable to infection; and*
- *Lobsters kept for 365 days post experiment showed 100% increase in haemocyte count, suggesting seismic exposure may effect immune system leaving them vulnerable to pathogens.*

In acknowledging that there is minimal direct overlap of the planned seismic activity with known or fished Tasmanian rock lobster grounds, there are significant rock lobster populations in what industry believe is relatively close proximity. Furthermore, uncertainties around source and sink dynamics of rock lobster larvae means that adults stocks in the Victorian zone of the seismic survey area may be very important, in any given year, to recruitment in the NW region including around King Island. There is no doubt that the results from the recently published IMAS research open a diverse number of questions and uncertainties around the impacts of seismic on rock lobsters stocks within the Tasmanian and Victorian fisheries."

Schlumberger's Response

In the study referred to above, Day et al. (2016) found that adult rock lobsters exposed to SELs from an acoustic source up to a maximum of 186 dB re 1 µPa^2.s did not show any increase in mortality, even at close proximities to the sound source. The study concluded that seismic surveys are unlikely to result in immediate large-scale mortality in the southern rock lobster fishery and, on their own, do not appear to result in any degree of mortality.

However, there was evidence of sub-lethal effects occurring following seismic sound exposure; specifically, impairment of reflexes involved with tail control and righting, damage to the sensory hairs of the statocysts (balance organ), and a reduction in numbers of haemocytes (indicative of reduced immune response function). The ecological impacts of the sub-lethal effects were not examined and therefore the existence and/or magnitude of any potential impacts on catch rates are not known. It is important to note that this study was undertaken in water depths of 10 – 12 m, which is significantly shallower than Schlumberger's Operational Area. There are large separation distances between the seismic source and the seabed across most of Schlumberger's MSS and all of the survey lines are in water depths deeper than 1,000 m off Tasmanian waters. Across the entire Operational Area, 89% is in water depths greater than 1,000 m and, as such, these same physiological effects on rock lobsters that were observed in the Day et al. (2106) study are considered unlikely or are at least predicted to occur much less frequently.

The threshold levels for potential impacts to rock lobster are provided in **Table 1**. The sound transmission loss modelling has determined the zones of impact from the acoustic source for Schlumberger's proposed MSS, based on these maximum threshold levels and these distances are also provided in **Table 1**. The maximum threshold distances provided are relevant to the shallower water depths where rock lobster may be present. However, these water depths are not within Tasmanian waters due to the revisions made to the Operational Area.

Three different parameters have been assessed for acoustic impacts to rock lobster. These different parameters are used to review the distances of impacts generated by different effects, being the total energy contained in a single pulse (per-pulse SEL), the peak to peak rapid change in sound pressure level from a single pulse (Pk-Pk SPL), and also the cumulative impacts of multiple pulses (SEL_{24}) including a worst-case infill line scenario. The resulting zone of impact is determined by the largest identified threshold distance, which is the result of cumulative exposure to multiple acoustic pulses, i.e. the SEL_{24} threshold of 192 re 1 µPa^2.s. The resulting maximum threshold distance of 350 m corresponds to the distance from the noise source at which the noise levels would not result in any increase in rock lobster mortality.

Table 1 Noise exposure criteria (Day et al., 2016) and Zones of Potential Impacts of Seismic Exposure to Rock Lobster

Rock lobster	Potential impacts threshold levels	Maximum threshold distance
Based on Day *et al.* (2016) - thresholds are noise levels confirmed not to increase mortality	Per-pulse SEL: 186 dB re 1 µPa^2.s (impact due to total energy in a single pulse)	120 m
	Pk-Pk SPL: 209 dB re 1 µPa (impact due to rapid change in sound pressure)	240 m
	SEL_{24}: 192 dB re 1 µPa^2.s (impact due to cumulative energy from multiple pulses)	350 m (490 m with infill line)

Based on these sound transmission loss modelling results, the absence of sound pressure-detecting structures in benthic invertebrates and the water depths off the Tasmanian coast are all greater than 1,000 m, the residual risk of physiological impacts to adult rock lobster has been considered as low within the risk assessment framework of the Environment Plan.

In a more recent study, in February 2018, CarbonNet carried out a 14 day seismic survey in Australia's Gippsland Basin. As part of their Environment Plan, CarbonNet committed to completing pre- and post-survey offshore habitat assessments to determine if there were any effects on key biological receptors (i.e. commercial scallops, southern rock lobster, finfish, and zooplankton) which could be attributable to the seismic survey. An Advisory Panel was established to ensure that the assessments were conducted in a scientifically robust manner with appropriate methodologies and interpretation of the results. This Panel consisted of representatives from regulatory agencies, academia and the fishing industry. With respect to rock lobsters, ten sites (six sites within the survey area and four reference sites) were monitored at known or potential areas of rock lobster habitat. The results showed that 81 individuals were obtained during the pre-survey assessment compared to 122 individuals post-survey. It was concluded that the increased number post-survey was most likely attributable to seasonal effects rather than any effects of the MSS.

A discussion on the potential impacts of seismic on rock lobster larvae is provided in **Section 2**.

TSIC would like the following issues to be considered:

- *An independent review of any spatial limits to sound exposure. That is, how far from seismic activity is exposure expected to impact rock lobster.*

Sound modelling is used to determine zones of impact based on threshold criteria. There are known noise exposure thresholds or indicative noise levels at which there is the potential for certain effects (i.e. mortality, temporary hearing impairment, injury, behavioural changes) to occur to marine fauna when expose to those levels of noise. The threshold criteria used are based on current relevant scientific literature, accepted industry and international standards and are considered to be appropriate for the assessment process in the Environment Plan. The thresholds for injury criteria are provided in **Table 1**.

NOPSEMA have a set of standard threshold criteria which they consider acceptable for a wide range of marine fauna, and sound transmission loss modelling determines the maximum threshold distances for those SELs, and is then used as part of the assessment of effects to determine impacts on marine fauna and implementation of controls where required to reduce the potential impacts to As Low As Reasonably Practicable (**ALARP**) or an Acceptable Level.

NOPSEMA are an independent body and have to approve an Environment Plan before a seismic survey can proceed. They take into account all available literature and whether it has been incorporated into the Environment Plan as part of their review process, as well as concerns raised during stakeholder engagement.

At the moment, the Day et al. (2016) literature is the best available information that can be utilised for determining potential SEL effects on rock lobster. The potential threshold levels identified by Day et al. (2016) have been incorporated into Schlumberger's specific sound transmission loss modelling to determine maximum threshold distances. These distances are then used to determine what the likely effects are in terms of distance, however, the literature, in combination with the modelling results has indicated that the actual physiological impacts to rock lobster from seismic sound exposure will be low.

- *Noting previous seismic activity and other proposed activity within the survey region, what are the cumulative sound exposure impacts on rock lobsters, noting that adults could already be weakened from previous seismic activity?*

A discussion on Cumulative Effects and Cumulative Sound Exposure Level (**CSELs**) is provided in **Section 8**.

- *Deep water stocks to the west of King Island and in the Victorian jurisdiction have not been targeted in recent years as demand has been for smaller red rock lobster (which is found inshore). As such 5 year catch statistics do not reflect lobster stock available. Furthermore, deeper water, lobster stocks may provide an important broodstock, which is vital for recruitment dynamics."*

Based on the understanding of the literature, studies, and sound transmission modelling reports, any seismic activities in deep waters are not expected to cause any damage to large broodstock of rock lobster. This is supported by the study results of Day et al. (2016), where berried rock lobster were exposed to an acoustic noise of 185 dB re 1 $\mu Pa^2 \cdot s$ and the results showed that following exposure there was no egg bundle loss, decreased fecundity, comprised larvae and/or morphological abnormalities. In addition, the Day *et al.* (2016) study found no differences in the quantity or quality of hatched rock lobster larvae following exposure to the acoustic noise from a seismic source suggesting this type of noise exposure during early-stage embryonic development does not negatively affect rock lobster larvae.

5 Impacts on Giant Crabs

TSIC Member Feedback
"No scientific research on the impacts of seismic on giant crabs"
"Seismic testing has killed the giant crab fishery of the West Coast of Tasmania before, and I can see it happening after this survey again."
"Other fisheries, such as the Alaskan Crab Fishery, took decades to recovery."

TSIC Viewpoint
"Noting the above impacts of seismic activity on rock lobsters, it is reasonable to assume that seismic sound would have at very least a similar impact on giant crabs, if not a greater impact. The proposed survey region partially overlaps and is in close proximity to giant crab habitat and fishing grounds in both Tasmanian and Victorian waters. Fishers have expressed concern that they will be directly impacted by the location and timing of the proposed survey activity. Furthermore, giant crab stocks are currently at an all-time low, and the potential impacts of seismic on even a small portion of the stock could have dire consequences for the longer term recovery."

Schlumberger's Response

There is a lack of available literature on the impacts of seismic activity on giant crabs; however, crabs are a marine invertebrate so assumptions on seismic effects on invertebrates have been drawn on what the potential effects on giant grabs are likely to be. Marine invertebrates are most sensitive to the vibrational component of sound; as the anatomical structures involved in detecting the pressure component of sound have not been found in these organisms. As such, benthic invertebrates are unlikely to suffer serious adverse physiological effects from exposure to seismic acoustic outputs.

Two studies that investigated the effects of seismic activity on the catch rates of crab (Christian *et al*., 2003 & Morris *et al*., 2018) found no negative catch rates, and these studies are further discussed in **Section 7**.

As a result of the absence of sound pressure-detecting structures in benthic invertebrates (i.e. crabs), the 5 km line spacing and the large separation distances between the seismic source and the seabed across most of the Schlumberger's proposed MSS area (89% of the Operational Area is in water depths greater than 1,000 m), the residual risk of impacts to crabs from seismic sound exposure has been assessed as Low within the Environment Plan.

6 Impacts on Scale Fish

TSIC Viewpoint

"Tasmanian based fishers do hold access rights to Commonwealth Southern and Eastern Scalefish and Shark Fishery, which overlaps the proposed seismic survey area.

The proposed seismic survey activity overlaps the peak catching period for this region.

There will be displacement of fishing activity for these fishers.

This should be captured through consultation with commonwealth fishers."

Schlumberger's Response

In preparing the Environment Plan, a number of fish behavioural studies were reviewed. In general, these showed little indication of long-term behavioural disruption as a result of exposure to acoustic noise. Short-term responses were relatively common and included startle responses; modification in schooling patterns and swimming speeds; freezing; and changes in vertical distribution in the water column.

Behavioural responses of fish to acoustic disturbance vary depending on species traits, particularly sensory systems and the presence or absence of a swim bladder. Species which have swim bladders (or other gas-filled chambers) are generally more sensitive to sound exposure and more likely to suffer adverse effects from such exposure.

Importantly, studies generally report short-term and localised impacts of acoustic disturbance on fish behaviour, with normal behaviour returning within approximately one hour after the removal of the acoustic source (McCauley *et al*., 2000; Pearson *et al*., 1992; Wardle *et al*., 2001).

In 2007, Woodside engaged a team of more than 20 specialists in the fields of underwater acoustics, coral reef ecology and reef fish biology to design and execute comprehensive investigations into the impacts of seismic airgun noise on (amongst other things) fish behaviour (Woodside, 2007). Behavioural observations of free-swimming fish showed that at close range, airgun noise emissions appeared to cause prominent, short-term effects on fish behaviour. As the vessel approached, fish ceased normal behaviours and moved downward from the water column towards the seabed. Fish began to feed and behave normally again within 20 minutes after the survey vessel had passed. Once the vessel had travelled beyond a distance of ~1.5 km fish numbers and behaviour had returned to normal baseline levels (Woodside, 2007). The overall conclusion from the behavioural seismic acoustic exposure experiments was that there was minimal impact on fish behaviour and that any changes that were observed were short term and unlikely to have caused any significant biological or ecological impacts (Woodside, 2007).

The Gippsland Marine Environmental Monitoring project was developed in Australia in 2015 to provide a more ecologically realistic view of the impact of seismic surveys on (amongst other things) fish behaviour (Przeslawski *et al*., 2016). A component of this project involved monitoring the behaviour of unrestrained fish before, during and after the April 2015 seismic survey in Gippsland Basin, Bass Strait. The study monitored multiple sites in an experimental and control zone, with tiger flathead, gummy shark and swellshark individuals being tagged and released. The results showed little evidence of behavioural changes induced by the seismic survey in the species studied. Individuals of both shark species moved in and out of the monitored areas across the study period, and gummy sharks were detected returning to the experimental zone during the period of seismic survey operations. The tiger flathead did show increased swimming speed during the seismic survey period, probably indicating a startle response, but if so the range of movement was not sufficient to generate a significant difference in displacement (travel) across the monitored array.

The Gippsland Marine Environmental Monitoring project also acquired baseline observational data on marine communities in the field before, during and after a seismic survey in the Gippsland Basin. Catch rates in the six months following the seismic survey were different than predicted in nine out of the 15 species examined across both Danish Seine and Demersal Gillnet sectors. In the majority of these cases (six species) this manifested in an increase in reported catch. Overall, the results showed no clear evidence of adverse effects on commercial catch rates due to the seismic survey.

A number of other studies have also examined the effects of seismic activities on catch rates of fish species. A recent critical review by Carroll *et al*. (2017) concluded that such studies have found positive, inconsistent, or no effects of seismic surveys on catch rates or abundance of fish.

The pelagic fish species occurring within Schlumberger's proposed MSS Operational Area are generally highly mobile and are likely to move away from the acoustic source if sound levels become uncomfortable. As such, some short-term distributional changes for fish are possible during Schlumberger's proposed MSS. However, any effects are expected to be short-lived and fish are expected to resume normal behaviour in the days following acoustic exposure and are expected to move back to their normal habitats once the vessel has passed. Given the large line spacing, the vessel will not be concentrated in any particular area within Schlumberger's proposed MSS Operational Area for a long period of time and in terms of occupation of space it has been estimated that the seismic vessel and the entire extent of the streamer and tail buoy will have passed through a particular area in under 1.5 hours.

To further reduce the potential for any impacts on fish at the population level, Schlumberger have also taken steps to ensure that Schlumberger's proposed MSS takes place in the shortest time possible (i.e. 24 hour operations); and through stakeholder engagement has identified sensitive areas for fisheries, and has made a commitment through the ongoing stakeholder engagement plan to continually engage with the fishers so that any impacts on the fishers and fisheries can be considered as part of the survey design during the acquisition phase if required.

Given the evidence of fish returning to survey areas following the cessation of seismic/acoustic activities, it is highly likely that any effects on fish will be temporary and fish will return to normal behaviour and distributions within days of any acoustic exposure. There are unlikely to be any population level effects for fish and subsequently, effects on catch rates are considered to be minimal.

7 Impacts on Catch Rates

TSIC Member Feedback

"Always affects catch rates after a seismic survey"

"I have been fishing since 1973 across a diverse range of fisheries and states. I have trawl fished after a large scale seismic activity, and caught nothing but dead fish and shells."

Schlumberger's Response

Although the analysis of catch data does not reveal the underlying mechanisms that may cause changes in catch rates, such data are, understandably, the response type most directly of interest to the fishing industry.

There is no published scientific evidence that indicates seismic exposure has resulted in a reduction in rock lobster catch rates. Parry and Gason (2006) examined catch rate data for the southern rock lobster and found no significant effects of seismic surveys on commercial catch rates in western Victoria, Australia, between 1978 and 2004, during which time multiple marine seismic surveys occurred (a total of 28, 2D and five 3D MSSs). In this study, the number of seismic pulses was correlated to catch per unit effort data over 12 depth stratified regions. Catch per unit effort data detected no significant change in catch rates during the weeks and years following seismic surveys, leading the authors to conclude there was a lack of apparent impact on rock lobster fisheries from seismic surveys in that region.

Rock lobsters have limited potential to suffer any increase in mortality from sound exposure as they are not influenced by the pressure component of a sound source, only by the vibration component. As a result, they have to be very close to the source to be impacted, with no increase in mortality at the noise levels expected from Schlumberger's proposed survey based on the sound modelling results (within 350 m of the active source or up to 500 m of the source if an infill line results in a "double dose" exposure at a particular location).

With respect to crabs, Christian *et al*. (2003) found that catch rates of snow crabs (*Chionoecetes opilio*) in Newfoundland were higher following exposure to a seismic source, but noted that this was probably due to physical, biological or behavioural factors unrelated to the acoustic source.

Concerns from snow crab harvesters in Atlantic Canada that seismic noise from widespread hydrocarbon exploration was having negative effects on catch rates led Morris *et al*. (2018) to undertake a Before-After-Control-Impact study to examine the effects of industry-scale seismic exposure on catch rates. The study area and methodology were developed following consultation with industry-based snow crab harvesters and seismic surveying industries to ensure that the study design aligned with industry standards and was realistic. Results showed no evidence of negative effects of seismic activity on catch rates over both short (within days) and longer (over weeks) time frames. Significant differences in catch rates did occur across study areas and between years; however, it was concluded that, if seismic effects on snow crab harvests did exist, the magnitude of these effects was smaller (and less important) than changes related to natural spatial and temporal influences.

Due to the absence of sound pressure-detecting structures in benthic invertebrates, the large separation distances between the seismic source and the seabed across most of the Operational Area (89% of the Operational Area is in water depths greater than 1,000 m), and that any significant acoustic impacts on benthic invertebrates are likely to be confined to close ranges to the source and be short to medium term (hours to days) in duration, it is considered that population level/catch rate effects are unlikely.

The impacts of seismic activity on catch rates of fish have been discussed in **Section 6**.

8 Sound Exposure and Cumulative Sound Exposure Levels

TSIC Member Feedback

"There are other proposals for seismic in the same area"

TSIC Viewpoint

"The Tasmanian seafood industry remains uncertain about the outer limits of any sound exposure from the proposed seismic survey. Noting comments from many members that they fish within or in close proximity to seismic survey region, it is important that we fully understand any outer limits of exposure.

A recently released consultant report provided significant insight into the potential inadequacies of Cumulative Sound Exposure Level (CSELs) modelling and reporting within gas and oil exploration Environmental Plans. The report identifies the need for sound modelling at longer accumulation times and also shows there is a fast accumulation on first pass. Over a 24 hour period, CSELs values provided in Environment Plans are reached in minutes, meaning the CSELs are less a precautionary level in 24 hours, and more a certainty, as the survey vessel passes in a matter of minutes.

These results suggest that the potential impacts from 3D seismic surveys are greatly underestimated. TSIC is uncertain about the applicability of this outcome on 2D seismic activity."

Schlumberger's Response

8.1 Cumulative Effects

Schlumberger are aware there are other operators looking to undertake exploration activities within the Otway Basin. Cumulative effects have been considered within the Environment Plan, and it is one of the requirements that NOPSEMA will review as part of their assessment against the regulations and requirements.

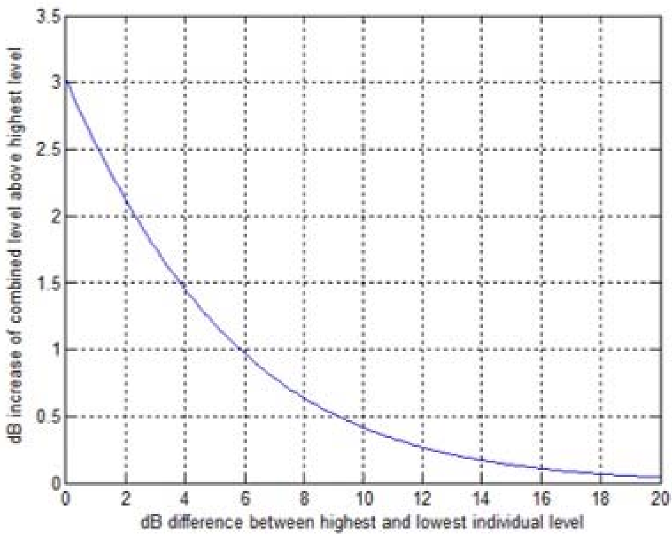
Acoustic energy from multiple seismic surveys and shipping traffic are the two most likely potential contributors to cumulative effects of underwater noise in the Otway Basin.

Because low frequency acoustic energy from seismic surveys can travel large distances underwater, the overall acoustic footprint associated with a seismic survey is typically extensive. With regards to the potential temporal and spatial overlap of Schlumberger's proposed MSS and another operator conducting a MSS in the basin, it is important to consider how multiple acoustic footprints from seismic surveys combine.

When acoustic outputs from two different seismic surveys combine, the outcome is counter-intuitive; the largest difference between the combined and individual SELs will be 3 dB re 1µP²s, and this will only occur at locations where both surveys produce the same SEL's. In other words, if at a given location, Survey A by itself would produce a SEL of 160 dB re 1µP²s, and Survey B by itself would also produce an SEL of 160 dB re 1µP²s, then the two surveys combined will produce an SEL at the same location of 163 dB re 1µP²s (Alec Duncan, pers. comm.).

However, if one survey produces a higher SEL, then the higher SEL will dominate to the point where if Survey A produces an SEL of 6 dB re 1µP²s higher than Survey B, then the combined level is 1 dB re 1µP²s higher than the higher of the individual SELs (i.e. Survey A) (**Figure 3**).

Figure 3 Combined Sound Exposure from Two Seismic Sources



Source: Alec Duncan, Curtin University.

An assessment has been undertaken to check for the potential occurrence of concurrent seismic surveys in the Otway Basin. An online search of NOPSEMA's 'Activity Status and Summaries' web page was undertaken to identify any Environment Plan applications, or recently approved Environment Plans that overlap with Schlumberger's proposed MSS Operational Area or are scheduled to occur within nearby areas.

Four Environment Plans were identified in this process. Two have been accepted by NOPSEMA, and these have been submitted by PGS and CGG. PGS's MSS area is located 300 km to the west of Schlumberger's Operational Area, so the potential for any spatial overlap in noise effects is not anticipated based on long range sound modelling results. The CGG survey area is located 400 km to the east, so this significant spatial separation is not expected to result in any cumulative effects of noise impacts.

The remaining two Environment Plan applications are still being assessed, Spectrum Geo have been given the opportunity to modify their Environment Plan, while 3D Oil have received a request for further information. It is uncertain as to when these two companies may resubmit their information, whether they will have their Environment Plan accepted and when their survey would commence if accepted.

Given the proposed survey location of Spectrum's survey area, there is potential for an overlap spatially with Schlumberger if the two surveys commenced at the same time; however, Schlumberger cannot comment when or if this Environment Plan will be approved, or when the MSS will commence, but will implement measures to prevent cumulative effects, both from occupation of space and acoustic disturbance.

To reduce the risk of cumulative impacts from concurrent MSS, recent best practice is to maintain a spatial separation of at least 40 km between the active seismic sources (BOEM, 2014). Schlumberger will manage seismic data acquisition during the proposed MSS to maintain this separation distance. Maintaining a separation distance of at least 40 km will ensure multiple active sound sources do not overlap and therefore will not cause higher SEL's.

8.2 Limits of Sound Exposure

Both long and short range sound modelling was undertaken for the proposed seismic survey to predict the received Sound Exposure Levels (**SELs**) and the spread of noise emissions or the footprint of acoustic emissions from the acoustic array. Sound transmission loss modelling in the context of this project and SELs is further detailed in **Section 2**.

The short range modelling was used to predict received SELs at distances out to four kilometres, to assess impacts in the vicinity of the active source and whether the proposed mitigation measures and precaution zones are adequate. This was done over eight different depth ranges within the Operational Area.

The long range modelling predicts the received SELs out to 200 km from four locations within the Operational Area and assesses the noise impacts to more distant sensitive marine areas.

8.3 Cumulative Sound Exposure Level (CSELs)

For the proposed Schlumberger MSS, 24 hour cumulative sound modelling was undertaken as part of the sound transmission loss modelling.

During the proposed survey, the acoustic array will generate an impulsive noise every 12 seconds during active data acquisition, moving horizontally a distance of 25 m between each noise pulse, and covering a total distance of the order of 180 km in 24 hours. The received peak and Root Mean Square (RMS) noise levels do not change for repeated impulses, except as a result of the changing distance from the moving noise source. The SEL parameter that is modelled describes accumulated sound energy, so each successive noise pulse increases the cumulative SEL.

Cumulative modelling accounts for the moving noise source, and has been undertaken by accumulating the received noise exposure at a representative stationary location from successive pulses generated over two consecutive survey lines (5 km apart), over a time period of up to 24 hours.

24 hours is a reasonable limit to place on cumulative SEL and is recommended for impact assessment purposes by many guidelines, such as NMFS (2016). For Schlumberger's proposed survey, a maximum of two survey lines 5 km apart could feasibly be completed in any 24 hour period. The next line would be another 5 km away, so would contribute considerably less to cumulative impacts at the representative stationary location than the first two adjacent lines. Therefore, considering a 24 hour period for cumulative noise corresponds well to the proposed movement of the survey vessel past a particular receiving location.

In the event that data acquisition is halted temporarily, an infill line may be required so that the survey line can be completed. Using the modelling outputs and available literature, it has been determined that in this scenario a minimum delay of five hours would be required before resuming data acquisition at the same location, with some overlap. This possibility is considered by identifying the increased zones of impact resulting from a double-dose exposure (plus 3 dB in SEL_{cum}) within 24 hours affecting any particular location. With reference to the noise propagation with distance effects calculated using the short range model, doubling the exposure dose to complete an infill line at any individual location is expected to result in an increase in the cumulative SEL zone of impact distance by a factor of 1.4.

This approach to cumulative modelling is inherently highly conservative for marine mammal and fish species with the ability to move away from the noise source. For less mobile species, this approach represents the worst case cumulative effect to assess multiple noise exposures from this survey.

The cumulative impacts of noise are species specific. Within the sound transmission loss modelling, cumulative noise exposure threshold criteria for individual species has been included and calculated as distance from the acoustic source and this has been interpreted within the Environment Plan.

In addition, it is also important to note that cumulative exposure to multiple pulses from a moving acoustic source or if the seismic vessel is doing an infill line, does not increase the potential for mortality or injury to zooplankton, fish eggs or larvae. This is because if an infill line is required, the peak noise effects result in threshold exceedances over greater distances than the cumulative noise effects.

9 Offset Principle

<u>TSIC Member Feedback</u>

"We need the offset principle applied to seismic to help rehabilitate the damage of seismic on eggs and larvae (future recruits)."

"Pay 5 boats to tie up for the year = $500,000 per boat. This will leave 50 tonne of adult lobster in the water to breed and contribute to future recruitment, which will offset the impacts of seismic."

<u>TSIC Viewpoint</u>

"It is the strong view of TSIC and the Tasmanian seafood industry that seismic activity is having an impact on the larvae of key commercial species, which in turn has an impact on future recruitment activity. Understanding the full impacts is time consuming and exceptionally costly, and hugely confounded by natural environmental influences.

TSIC and the Tasmanian seafood industry strongly support the application of the Offset Principle to seismic activity in recognition that the practice of seismic surveys is having an impact on the environment that the Tasmanian seafood industry rely, and future recruitment into these fisheries.

The establishment of an Offset Fund would allow a range of projects to be established to support our marine environment and the resources in that environment.

Potential projects that could support rock lobster stocks in the NW of Tasmania could include:

- *An extension of the current translocation program, where juvenile rock lobsters are caught in slow growing deep water regions in southern Tasmania and relocated to shallow fast growing regions of the NW.*
- *The establishment of a program that collects newly settled rock lobster (puerulus) from marine farm infrastructure, ongrow these within an on land nursery and then releases back into the wild population. This concept is currently being discussed with the Institute for Marine and Antarctic Studies as a very viable strategy to support rock lobster stocks in Tasmania."*

<u>Schlumberger's Response</u>

As outlined in the above supporting documentation, Schlumberger will ensure appropriate mitigation measures are established such that the potential for impacts are minimised. Based on the available research and sound transmission loss modelling results, the impacts have not been assessed at a level that would significantly displace fishers to the extent that an offset fund would be considered appropriate for this activity.

Based on the available research we assess the potential for damage to the marine environment to be as low as reasonably practicable given the proposed mitigation measures and the conclusions from the modelling study. We propose to continue discussions with all stakeholders in good faith to identify and fund projects that will add value to the local industry, although do not consider this is a necessary control measure for the purposes of the proposed activity. We are currently in discussions with industry bodies to identify appropriate projects and would like to discuss these projects in more detail to develop these future projects further.

10 Other Comments/Concerns

TSIC Member Feedback

"I believe trawl fisheries will be even more impacted (noting that this is a commonwealth fishery not captured by TSIC membership)"

"Continued seismic activity will decimate my industry."

"We cannot understand why the government continues to allow company after company conduct seismic – time and time again. We need it done once and the data get shared by all. The legislation must be changed and no new surveys allowed."

"There are alternative ways to conduct seismic activity – albeit slower and more expensive. Streamers can be laid on the bottom instead of the surface of the water. If things are done on the bottom it at least stops the damage in the water column."

"Schlumberger keep quoting scientific evidence that seismic testing does no damage by citing a Norwegian Survey, but no one can find any evidence of this survey."

"As fishermen, we get charged to access the fishery, and are implemented to all sorts of management to ensure the resource is sustainable. Then this sort of activity comes through and everything is compromised."

"Not sure why we bother with this process as the government has already decided to support the gas and oil industry and provide approvals before this process anyway."

Schlumberger's Response

A few of the general comments from the TSIC feedback report listed above have a brief response provided below.

The commonwealth fishers have been engaged with as part of the stakeholder engagement process and are well aware of the proposed seismic survey. We have undertaken a fisheries assessment specifically for the Operational Area to provide an understanding of the commonwealth fishing activity within the Operational Area and are working with those fishery representatives.

The proposed seismic survey is a single survey for a period of approximately 100 days and the cumulative effects from consecutive and concurrent seismic surveys have been considered and assessed within the Environment Plan and appropriate control measures have been implemented to reduce any potential impact to ALARP. From the assessments undertaken in regards to the proposed seismic survey, incorporating all of the latest literature and the specific sound transmission loss modelling results, it is unlikely to have significant impacts to the fishing industry. Our industries have co-operated in numerous jurisdictions globally with no evidence of significant impacts that could be directly related to survey activities. We fully expect this to be the case in this area we are proposing to acquire this survey which is supported by the sound modelling.

In all previous correspondence with TSIC and relevant stakeholders we have not referenced a Norwegian survey. Could more detail be provided on the study for us to respond to this statement?

The effects of the proposed seismic activity on the commercial fish and commercial fishery in the Otway Basin has been assessed and considered extensively within the Environment Plan. A large part of the proposed survey area (~100,000 km^2) has been removed to reduce potential impacts on commercial fisheries and other sensitivities in the area. As stated in previous responses, based on our assessment of the environment and the mitigations proposed, the impacts are considered to be as low as reasonably practicable and unlikely to have significant impacts to the fishing industry.

The alternative method to conduct a seismic survey by laying a streamer on the sea floor, also known as ocean bottom cable, as opposed to towing the streamer would still require an acoustic source to be towed behind a source vessel. The towed recording will not pose a significant risk to marine life within the water column and would require less source locations to deliver an equivalent data set and achieve the survey objectives. Deploying the recording array on the seabed takes significantly more time and will introduce additional health and safety risks. The proposed survey methodology is the most efficient approach to conduct the survey in the shortest amount of time and will reduce the time that the seismic vessel is in the area.

NOPSEMA assess whether appropriate consultation has been undertaken for a proposed activity and can only support an application if the consultation has addressed the concerns of all relevant persons. We hope though this process and the responses already provided that all your concerns have been addressed. If not, please provide additional details and we will respond in due course.

In addition, amendments to the Environment Regulations will come into force from April 25th to increase the transparency for offshore oil and gas Environment Plans. These amendments require that any Environment Plan submitted to NOPSEMA for regulatory approval has to undergo a 30 day public comment period. This public comment process enables the public with an opportunity to provide any comments before NOPSEMA begins their assessment process, and any public comments are taken into consideration by NOPSEMA as part of the assessment.

11 References

BOEM, 2014. '*Proposed Geological and Geophysical Activities, Mid-Atlantic and South Planning Areas, Final Programmatic Environmental Impact Statement*'. U.S. Department of the Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region. New Orleans.

Booth, J. D. 1994: *Jasus edwardsii* larval recruitment off the east coast of New Zealand. *Crustaceana* 66: 295-317.

Booth, J., Chiswell, S., Bradford, R., Bruce, B. 2003. The ups and downs of rock lobster larvae. NIWA, Water and Atmosphere 11(2) 2003.

Bruce, B.; Bradford, R.; Griffin, D.; Gardner, C.; Young, J. 2000: A synthesis of existing data on larval rock lobster distribution in southern Australia. Final Report, Project Number 96/107. Fisheries Research and Development Corporation. Hobart, CSIRO Marine Research.

Carroll, A. G., Przeslawski, R., Duncan, A., Gunning, M., & Bruce, B., 2017. '*A critical review of the potential impacts of marine seismic surveys on fish & invertebrates*'. *Marine pollution bulletin*, 114(1), 9-24.

Christian, J.R., Mathieu, A., Thompson, D.H., White, D., Buchanan, R., 2003. *'Effect of Seismic Energy on Snow Crab (Chionoecetes opilio)'*. Report No. SA694 to the Canadian National Energy Board (Calgary, Alberta) by LGL Ltd (King City, Ontario) and Oceans Ltd (St John's, Newfoundland). 106 pp.

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., 2016. '*Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries'*. Report to the Fisheries Research and Development Corporation. Report prepared by the University of Tasmania, Hobart.

McCauley, R., Day, R., Swadling, K., Fitzgibbon, Q., Watson, R., Semmens, J., 2017. '*Widely Used Marine Seismic Survey Air Gun Operations Negatively Impact Zooplankton'*. *Nature, Ecology & Evolution* 1, 0195. DOI: 10.1038/s41559-017-0195.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., McCabe, K., 2000. '*Marine Seismic Surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid'*. Prepared for Australian Petroleum Production Exploration Association, Project CMST 163, Report R99-15.

Morris, C.J., Cote, D., Martin, B., Kehler, D., 2018. '*Effects of 2D seismic on the snow crab fishery*'. Fisheries Research 197: 67-77.

NMFS, 2016. '*Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing – Underwater acoustic thresholds for onset of permanent and temporary threshold shifts*'. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

Parry, G.D., Gason, A., 2006. '*The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia*'. Fisheries Research, 79:272 – 284

Pearson, W., Skalski, J., Malme, C., 1992. '*Effects of sounds from geophysical survey device on behaviour of captive rockfish (Sebastes spp.*)'. Canadian Journal of Fisheries and Aquatic Sciences, 49: 1343-1356.

Pollock, D. E. 1986: Review of the fishery for and the biology of the cape rock lobster *Jasus lalandii* with notes on larval recruitment. Canadian Journal of Fisheries and Aquatic Science 43: 2107- 2117.

Przeslawski, R., Bruce, B., Carroll, A., Anderson, J., Bradford, R., Brock, M., Durrant, A.,Edmunds, M., Foster, S., Huang, Z., Hurt, L., Lansdell, M., Lee, K., Lees, C., Nichols, P., Williams, S., 2016. '*Marine Seismic Survey Impacts on Fish and Invertebrates*'. Final Report for the Gippsland Marine Environmental Monitoring Project. Geoscience Australia, Canberra.

Wardle, C., Carter, T., Urquhart, G., Johnstone, A., Ziolkowski, A., Hampson, G., Mackie, D., 2001. *'Effects of seismic air guns on marine fish*'. Continental Shelf Research, 21: 1005-1027.

Woodside, 2007. '*Impacts of seismic airgun noise on fish behaviour: a coral reef case study'*.

APPENDIX I

Onshore Protected Areas

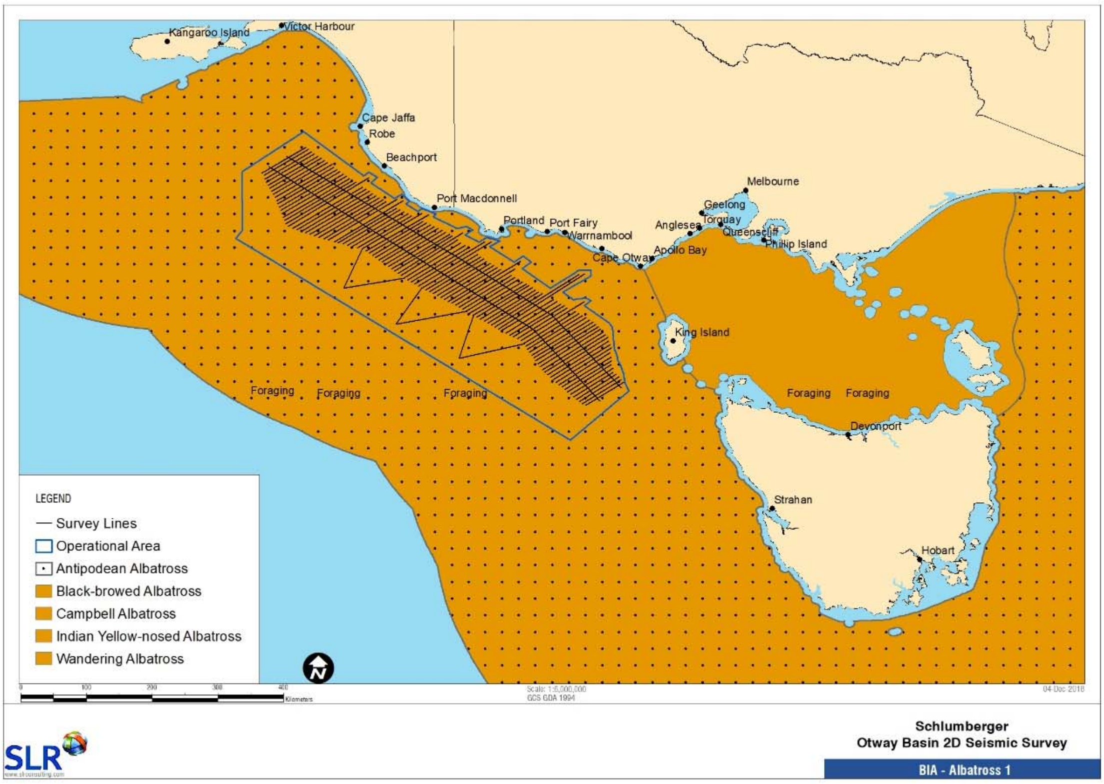
Feature	Name	IUCN Category	Distance from Operational Area
South Australia			
Conservation Park	Douglas Point	VI	6
National Park	Canunda	VI	8
Conservation Park	Nene Valley	III	10
Conservation Park	Piccaninnie Ponds	VI	19
Conservation Park	Beachport	VI	20
Conservation Park	Little Dip	VI	33
Conservation Park	Guichen Bay	III	46
Conservation Reserve	Bernouilli	VI	50
Conservation Park	Butcher Gap	III	65
National Park	Coorong	II	100
Conservation Park	The Pages	IA	150
Conservation Park	Lesueur	IA	148
Conservation Park	Cape Willoughby	N/A	148
Conservation Park	Lashmar	III	157
Conservation Park	Newland Head	III	157
Conservation Park	Cape Gantheaume	IA	161
Conservation Park	Deep Creek	II	163
Wilderness Protection Area	Cape Gantheaume	IB	165
Conservation Park	Seal Bay	VI	180
Conservation Park	Vivonne Bay	IA	186
Wilderness Protection Area	Cape Bouguer	IB	198
National Park	Flinders Chase	II	207
Wilderness Protection Area	Ravine des Casoars	IB	231
Tasmania			
State Reserve	Seal Rocks	III	55
Conservation Area	Cataraqui Point	V	56
Conservation Area	Stokes Point	V	57
Conservation Area	Porky Beach	VI	58
Nature Reserve	Christmas Island	IA	60
Conservation Area	Red Hut Point	V	60
Conservation Area	Cape Wickham	V	70
State Reserve	Disappointment Bay	II	74
Conservation Covenant	Red Hut Road #1	IV	75
Nature Reserve	Black Pyramid Rock	IA	84
State Reserve	Lavinia	II	84
Conservation Area	Sea Elephant	VI	84
Nature Reserve	Councillor Island	IA	85

Feature	Name	IUCN Category	Distance from Operational Area
Nature Reserve	The Doughboys	IA	112
Nature Reserve	Albatross Island	IA	112
Conservation Area	Nares Rocks	V	112
State Reserve	West Point	III	114
Conservation Area	Little Trefoil	V	114
Conservation Area	Hunter Island	V	115
State Reserve	Calm Bay	II	117
Conservation Area	Henderson Islets	V	117
Conservation Area	Harbour Islets	V	117
Conservation Area	Seacrow Islet	V	117
Conservation Area	Arthur-Pieman	VI	117
Conservation Area	Murkay Islets	V	118
Conservation Area	Shell Islets	V	119
Indigenous Protected Area	Preminghana	VI	119
Nature Reserve	Penguin Islet	IA	124
Conservation Area	Kangaroo Island	V	125
State Reserve	Three Hummock Island	II	127
State Reserve	Sundown Point	III	127
Conservation Area	Harcus Island	V	127
Conservation Area	Wallaby Islands	V	129
Conservation Area	Brick Islands	VI	129
Conservation Area	Montagu Island	IV	134
Conservation Area	Big Bay	V	140
Conservation Area	Howie Island	VI	140
Conservation Area	Bull Rock	V	165
Conservation Area	Tatlows Beach	VI	165
Conservation Area	Stanley	VI	165
State Reserve	The Nut	III	166
Conservation Area	Peggs Beach	VI	168
State Reserve	Little Peggs Beach	III	172
Conservation Area	Edgcumbe Beach	V	178
Conservation Area	Forwards Beach	V	180
Regional Reserve	Four Mile Beach	VI	183
Regional Reserve	Mount Heemskirk	VI	200
Conservation Area	Ocean Beach	V	218
Historic Site	Cape Sorell	V	236
Conservation Area	Southwest	VI	238

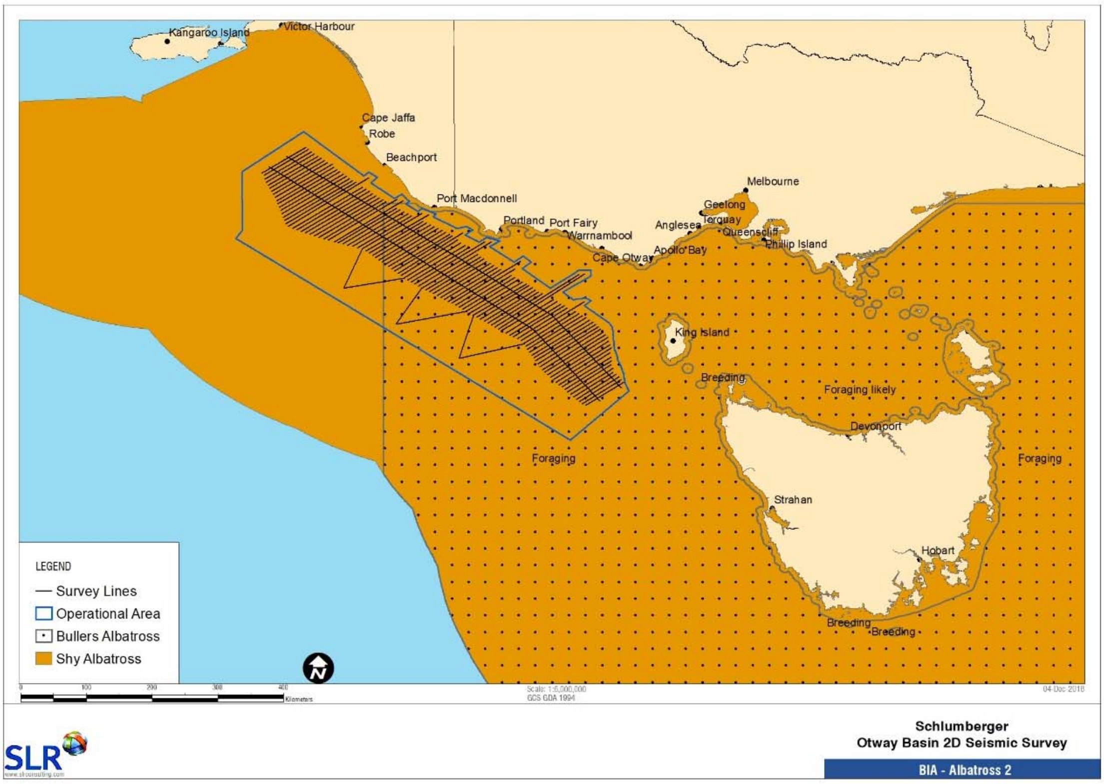
Feature	Name	IUCN Category	Distance from Operational Area
Victoria			
State Park	Cape Nelson	III	7
Conservation Park	Discovery Bay Coastal Park	III	8
Nature Conservation Reserve	Lawrence Rocks W.R.	IA	14
National Park	Port Campbell	II	33
Nature Conservation Reserve	Lady Julia Percy Island W.R.	IA	34
Conservation Park	Bay of Islands Coastal Park	III	35
National Park	Great Otway	II	37
Nature Conservation Reserve	Yambuk F.F.R.	IA	43
National Park	Mornington Peninsula	II	200
National Park	Point Nepean	II	201
Nature Park	Phillip Island Nature Park	III	215

APPENDIX M

Seabird Biologically Important Areas



Kangaroo Island
Victor Harbour
Cape Jaffa
Robe
Beachport
Port Macdonnell
Portland
Port Fairy
Warrnambool
Cape Otway
Apollo Bay
Anglesea
Torquay
Geelong
Melbourne
Queenscliff
Phillip Island
King Island
Devonport
Strahan
Hobart
Foraging
Foraging
Foraging
Foraging
Foraging
LEGEND
Survey Lines
Operational Area
Antipodean Albatross
Black-browed Albatross
Campbell Albatross
Indian Yellow-nosed Albatross
Wandering Albatross
Schlumberger
Otway Basin 2D Seismic Survey
BIA - Albatross 1



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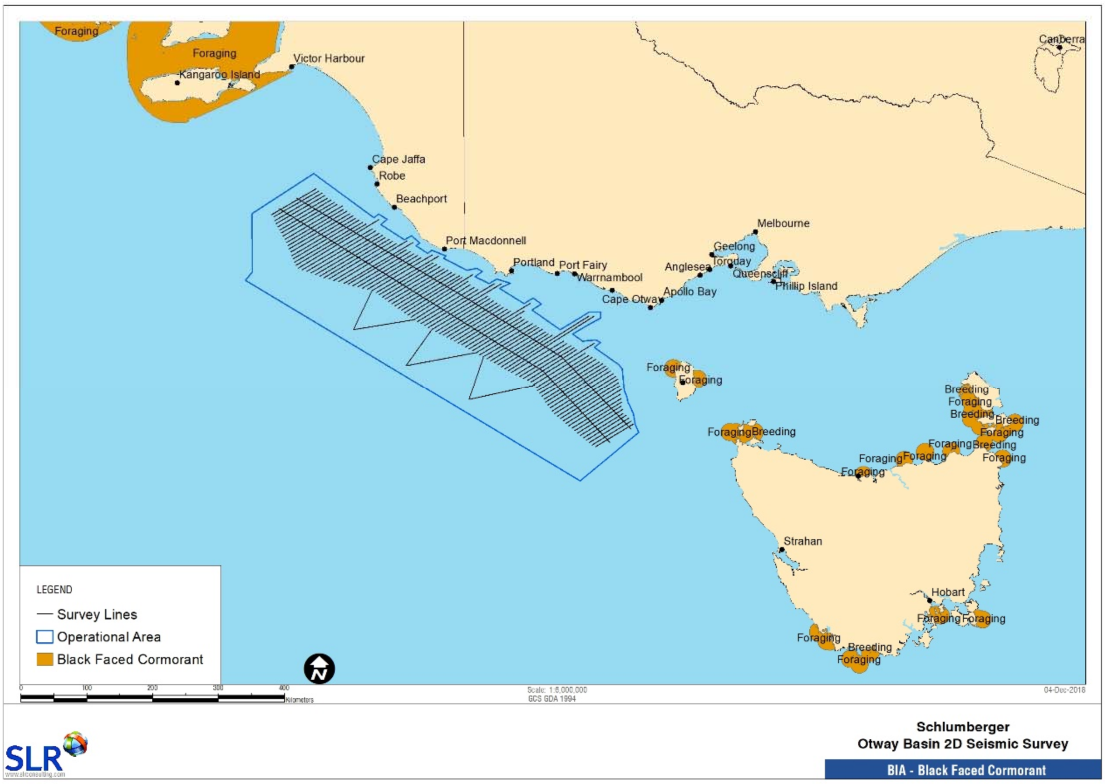
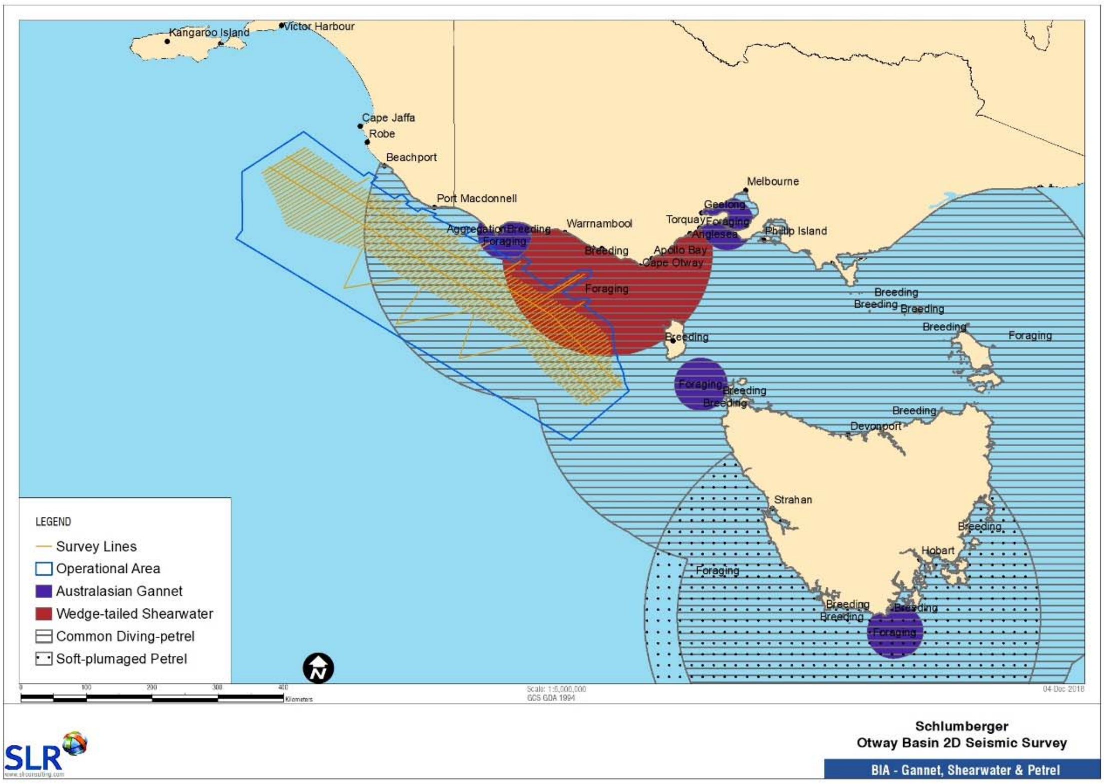
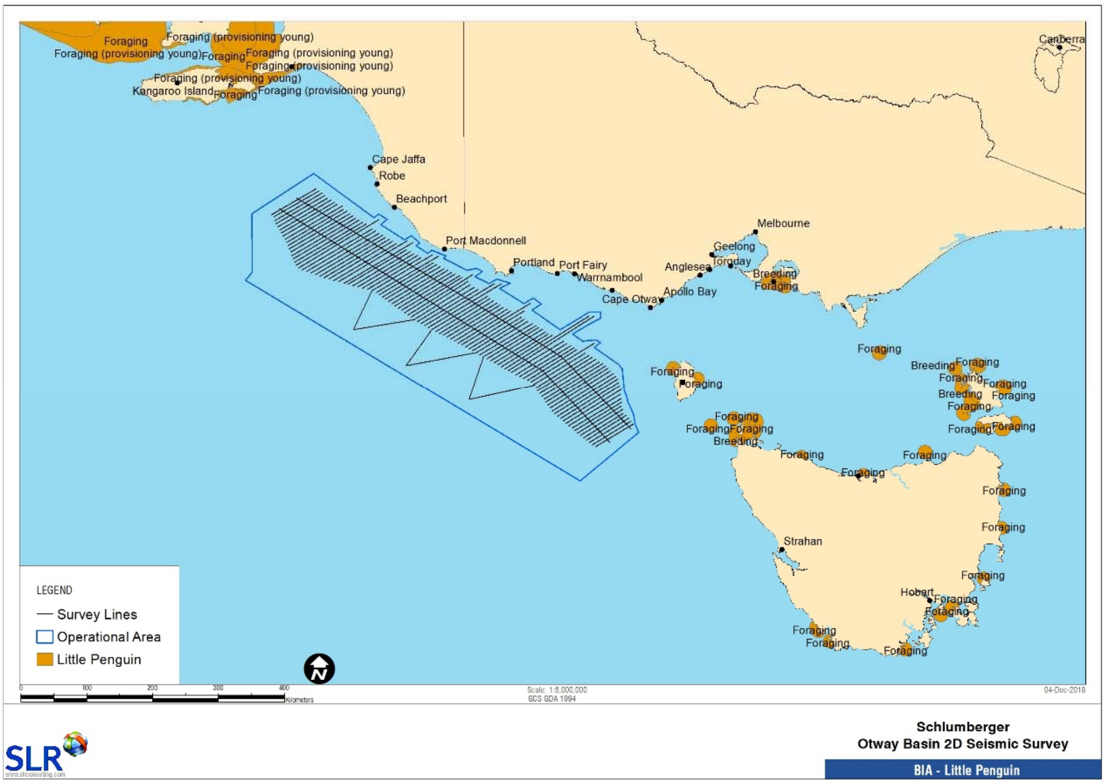
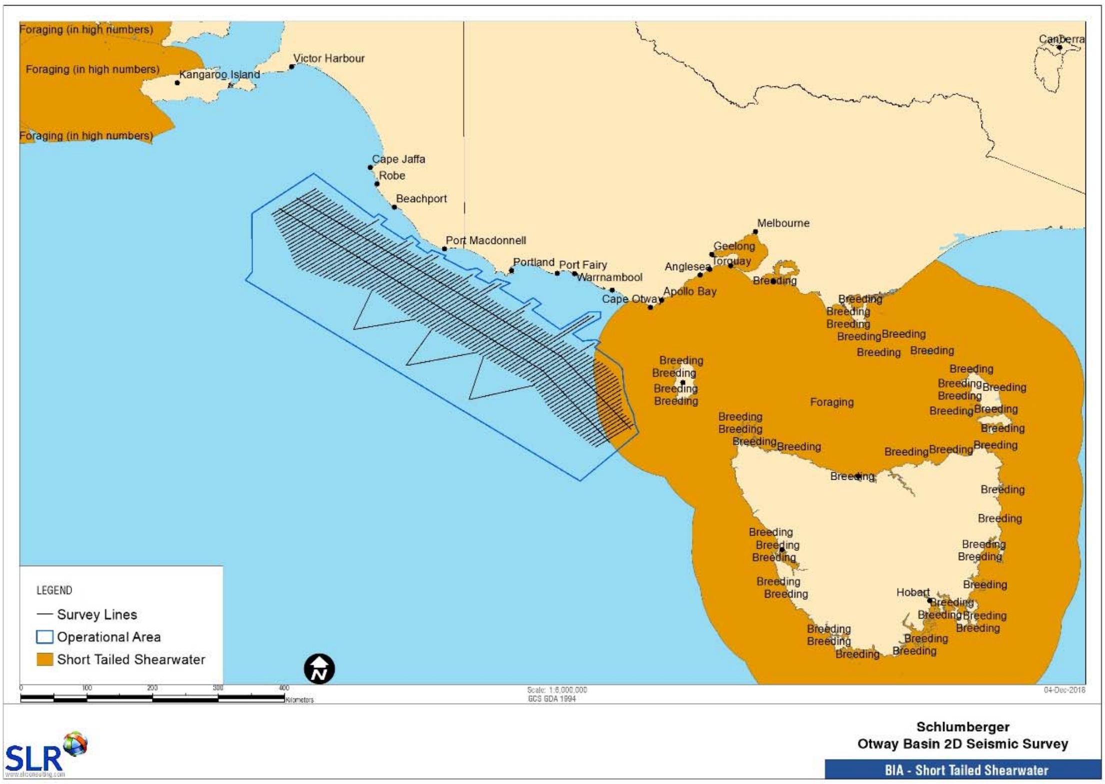
Victor Harbour
Cape Jaffa
Robe
Beachport
Port Macdonnell
Portland
Port Fairy
Warrnambool
Cape Otway
Apollo Bay
Anglesea
Torquay
Geelong
Melbourne
Queenscliff
Phillip Island
King Island
Breeding
Foraging likely
Devonport
Foraging
Foraging
Strahan
Hobart
Breeding
Breeding
LEGEND
Survey Lines
Operational Area
Bullers Albatross
Shy Albatross
Schlumberger
Otway Basin 2D Seismic Survey
BIA - Albatross 2


Victor Harbour
Kangaroo Island
Cape Jaffa
Robe
Beachport
Port Macdonnell
Portland
Port Fairy
Warrnambool
Cape Otway
Apollo Bay
Anglesea
Torquay
Geelong
Melbourne
Queenscliff
Phillip Island
Canberra
Strahan
Hobart
Foraging
Breeding
LEGEND
Survey Lines
Operational Area
Black Faced Cormorant
Scale: 1:6,000,000
GCS GDA 1994
04-Dec-2018
Schlumberger
Otway Basin 2D Seismic Survey
BIA - Black Faced Cormorant

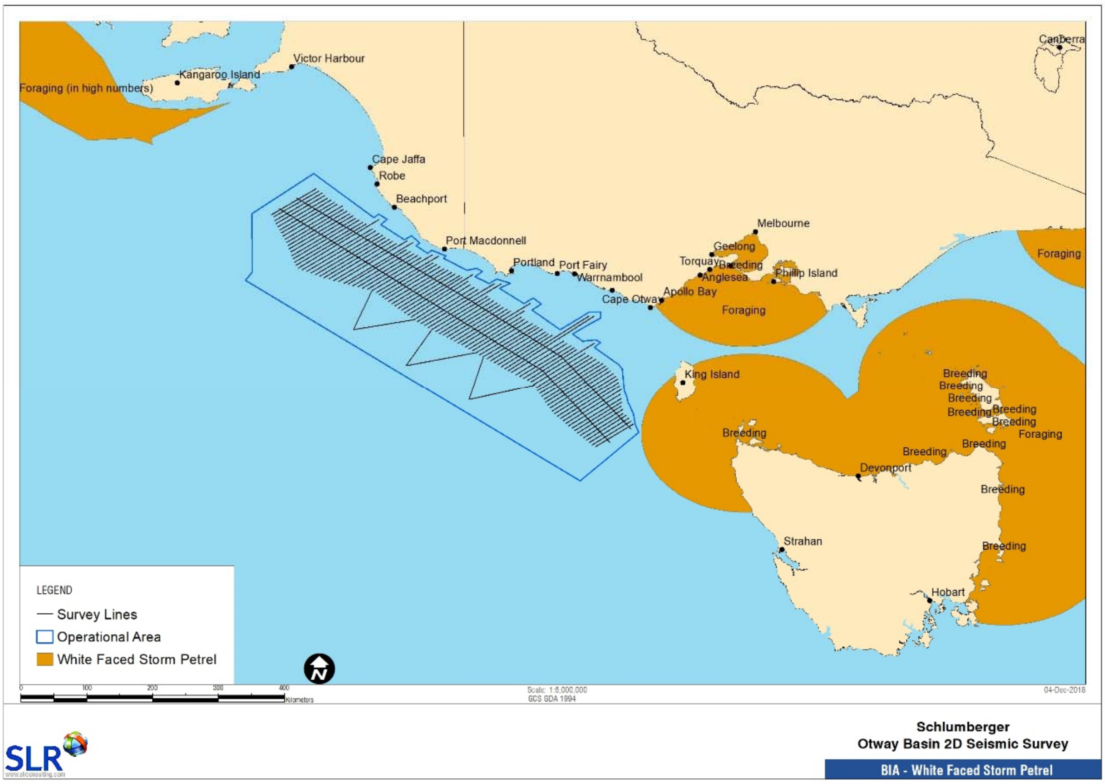

Kangaroo Island
Victor Harbour
Cape Jaffa
Robe
Beachport
Port Macdonnell
Warrnambool
Melbourne
Geelong
Torquay
Anglesea
Phillip Island
Apollo Bay
Cape Otway
Aggregation
Breeding
Foraging
Devonport
Strahan
Hobart
LEGEND
Survey Lines
Operational Area
Australasian Gannet
Wedge-tailed Shearwater
Common Diving-petrel
Soft-plumaged Petrel
Scale: 1:6,000,000
GCS GDA 1994
04-Dec-2018
Schlumberger
Otway Basin 2D Seismic Survey
BIA - Gannet, Shearwater & Petrel



LEGEND
Survey Lines
Operational Area
Little Penguin
Schlumberger
Otway Basin 2D Seismic Survey
BIA - Little Penguin



LEGEND
Survey Lines
Operational Area
Short Tailed Shearwater
Schlumberger
Otway Basin 2D Seismic Survey
BIA - Short Tailed Shearwater


Victor Harbour
Kangaroo Island
Foraging (in high numbers)
Canberra
Cape Jaffa
Robe
Beachport
Port Macdonnell
Portland
Port Fairy
Warrnambool
Cape Otway
Apollo Bay
Melbourne
Geelong
Torquay
Breeding
Anglesea
Phillip Island
Foraging
King Island
Breeding
Devonport
Strahan
Hobart
LEGEND
Survey Lines
Operational Area
White Faced Storm Petrel
Scale: 1:6,000,000
GCS GDA 1994
04-Dec-2018
Schlumberger
Otway Basin 2D Seismic Survey
BIA - White Faced Storm Petrel

APPENDIX N

Passive Acoustic Monitoring (PAM) Specifications

PAM Specifications

Cetacean Detection Capability

The vocalisations made by the full range of marine mammal species can be detected by our PAM systems. Typical system configuration has the capability of detecting sounds within a frequency range of 200 Hz to 200 kHz. This frequency band covers most marine mammal vocalisations. The system sensitivity may be extended to 10 Hz to 200 kHz for surveys in which it is necessary to monitor for baleen whales that vocalise at very low frequencies. However, in some circumstances, vessel noise at low frequencies can mask marine mammal vocalisations and limit the performance of PAM. The frequency response of some hydrophone channels is set to counter this (e.g. lower frequency response of 2 kHz for channels designed to detect the majority of species vocalisations). Seiche can readily tailor the frequency sensitivity of the hardware to suit the project application and the range of marine mammal species likely to be encountered. Additionally, PAMGuard software can be configured to focus on the detection of the vocalisations of particular species of interest or concern.

PAMGuard Software

PAMGuard software is integrated into all our PAM systems. PAMGuard is industry-standard software for the acoustic detection, localization and classification of vocalizing marine mammals. It is a sophisticated and extendible software package that assists trained operators in robust decision-making during real-time mitigation operations. As an open source development, PAMGuard is publicly owned and freely available. PAMGuard development is led by a team of specialists at the University of St Andrews, U.K. This has to date been funded by industry via the IOGP Sound and Marine Life Joint Industry Program. Funding is now transitioning to a self-funding mechanism operated through voluntary user contributions.

Table 1. Hydrophone elements frequency range

Hydrophone Elements	
H1	10 Hz to 200 kHz (-3 dB points)
H2	10 Hz to 200 kHz (-3 dB points)
H3	2 Hz to 200 kHz (-3 dB points)
H4	2 Hz to 200 kHz (-3 dB points)

Table 2. Hydrophone sensitivity

Hydrophone sensitivity	
Broadband channel sensitivity	-166 dB re 1V/μPa (nominal)
Standard channel sensitivity	-157 dB re 1V/μPa (nominal)

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