General Permit Application – Attachments

Attachment 1: Qualifications and experience of all people who will carry out activities

Dr Tara Martin – Research Group Leader (Scientific Data Systems), CSIRO Oceans and Atmosphere
Seismic Commissioning Lead, IN2019_E01

Ph.D. in Geophysics (2005), specialising in seismic. Deployed and operated seismic equipment on 5 research voyages (all to Antarctica or the subantarctic) over 19 years and has participated in almost 50 research voyages in that time. Has worked for CSIRO since 2010, heading up scientific support to the Marine National Facility. Is overseeing the commissioning of the recently procured seismic system on board RV *Investigator* in July 2019.

Emily Hart – Applications Geophysicist, Geometrics Inc.
Seismic Trainer, IN2019_E01

Currently functions as a Product Manager for marine seismic products at Geometrics Inc. (San Jose, CA), which includes providing support for US and International customers. Conducted training for Geometrics marine seismic products for customers in Turkey, Taiwan and England. Seismograph Operator for UHR Marine seismic surveys on the coast of England and the River Thames. Has previous experience as a Field Geophysicist with Green Geophysics Inc. and the National Geoelectromagnetic Facility at the Oregon State University.

Dr Eric Woehler – Researcher, Australasian Seabird Group (BirdLife Australia) and Institute for Marine and Antarctic Studies, University of Tasmania
Observer, IN2019_E01 (and potentially, future voyages)

Dr Eric Woehler has been researching Southern Ocean seabirds for almost 40 years; he has extensive seabirds and marine mammal survey experience on board the RV *Aurora Australis* between 1990 and 2006, and more recently on board the RV *Investigator* from 2016 - present. He has published more than 130 research papers, and is presently supervising higher degree students at the University of Tasmania.

Dr Millard Coffin – Professor, Institute for Marine and Antarctic Studies, University of Tasmania
Chief Scientist, IN2020_V01

An observational marine geoscientist, Coffin has participated in 32 seagoing expeditions averaging one to two months each in the Southern, Indian, Pacific, and Atlantic oceans. He has served as Chief or Co-Chief Scientist on 10 of these expeditions, including Ocean Drilling Program Leg 183, three Australian, three American, two Japanese, and one Schmidt Ocean Institute voyages. He has been a participating scientist on 22 expeditions, including two Ocean Drilling Program legs, nine American, five Australian, two French, one German, and three Japanese voyages. Two of these voyages (NO *Atalante* Geodynz-Sud in 1993, and RV *Rig Seismic* RS124 in 1994) have been to the Macquarie Ridge Complex, where Coffin and colleagues have focused attention on how subduction starts by investigating interactions between the Australian and Pacific plates south of New Zealand.

Mark Meekan – Senior Principal Research Scientist, Australian Institute of Marine Science
Chief Scientist, IN2021_V03

Meekan has 30 years of field experience in the ecology of coral reefs and a specialist interest in the early life history of tropical reef fishes. He has a track record of publications on the feeding, growth

and distributions of larval fishes and work published in high impact journals (Science, PNAS) on the impact of sound on young reef fishes. He is a Theme Leader of a major part of the North-West Shoals to Shore Research Program that examines the impacts of seismic surveys on pearl oyster and adult fishes on the North West Shelf of Western Australia.

Attachment 2: The equipment and methods used to comply with the EPBC Act Regulations

Commissioning of the air guns

During a transit voyage from Singapore to Cairns in July 2019 (IN2019_E01), we intend to commission the recently procured seismic system on board RV *Investigator*. The intended area of operation for the initial commissioning is in the Arafura Sea, between the following coordinates: 9° 5.76'S; 132° 43.02'E and 11° 11.40'S; 139° 22.08'E. This area of operation is shown in Figure 1.

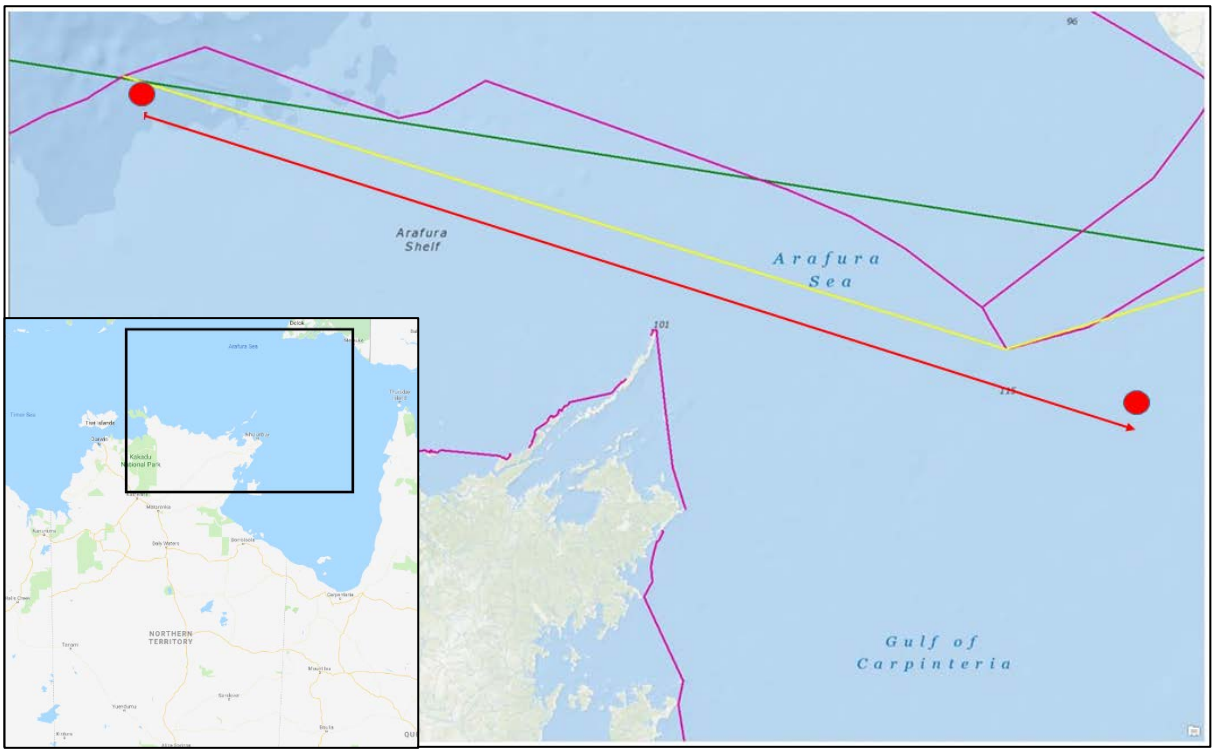

Figure 1: Intended area of operation for the commissioning of the seismic system during voyage IN2019_E01.

Over 3-4 days during daylight hours, we intend to trial the deployment, operation and retrieval of 2 GI guns and 1-2 lengths of active streamer (maximum length: 225 m), recently procured by the Marine National Facility (MNF) in order to conduct scientific research on board RV *Investigator*. These operations will be conducted by ASP deck crew and MNF Field Operations personnel, and are aimed at identifying safe working procedures for deployment and retrieval, as well as commissioning and validating the new seismic equipment. The GI guns will be operated periodically for some, but not all, of that time, observing all required precautions. The guns have previously been operated on RV *Investigator* during 2017, in a configuration identical to that proposed here, under Cetacean Permit C2016 - 0005.

Further commissioning and testing of the seismic system may occur during future trial and calibration voyages on board RV *Investigator* in different locations, and will be conducted using the same protocol and measures described here.

Seismic surveys

Planned seismic survey activities on board RV *Investigator* over the next five years (the period of time applied for in this permit application) are summarised below.

<u>IN2020_V01 (Coffin) – Development of William's Ridge, Kerguelen Plateau: tectonics, hotspot magmatism, microcontinents, and Australia's Extended Continental Shelf</u>

This expedition to the Indian Ocean in January-March 2020 will focus on William's Ridge, part of Earth's second largest submarine plateau, the Kerguelen Plateau, and on the once adjoining Broken Ridge. William's Ridge lies between 51°S-56°S and 77°E-85°E and Broken Ridge between 30°S-35°S and 93°E-103°E in the Indian Ocean (see Figure 2).

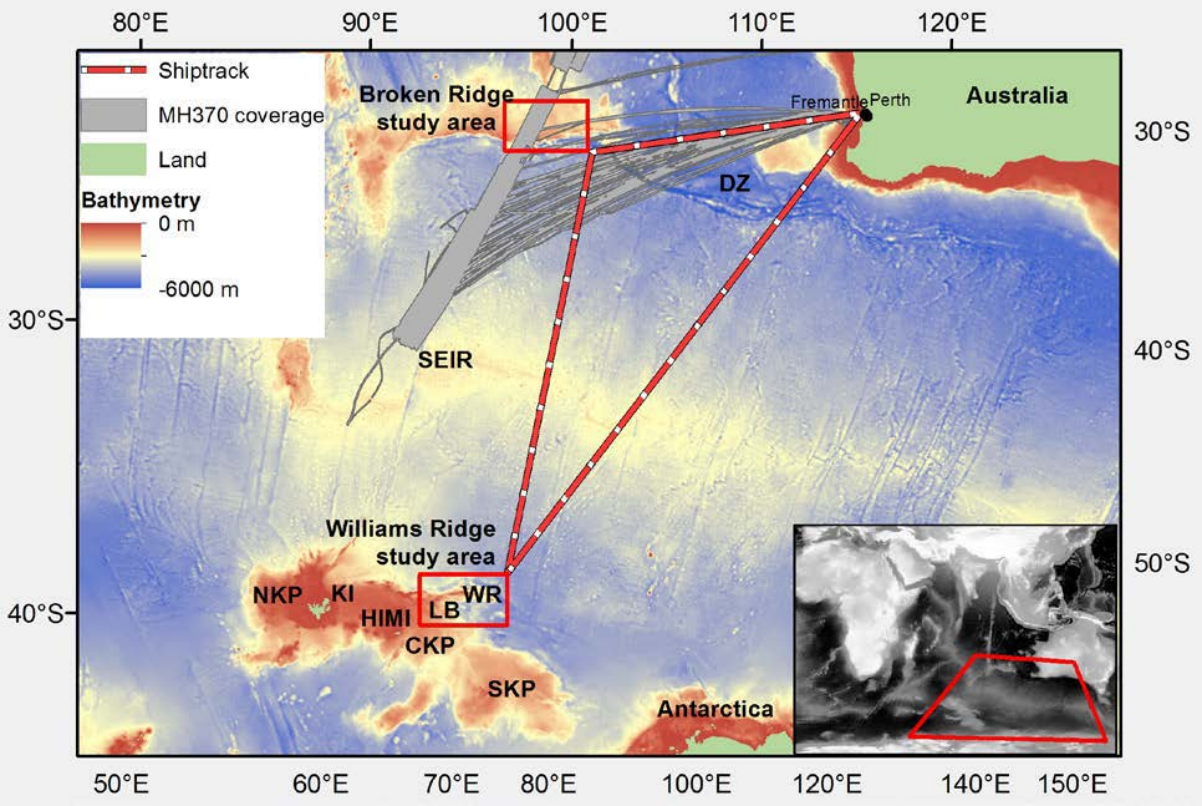

Figure 2: Intended area of operation for seismic surveys during voyage IN2020_V01.

Along with the collection of multibeam bathymetry, backscatter, gravity, water column echo sounding and sub-bottom profiling data, this voyage intends to collect seismic reflection data. This will be achieved by conducting four ~60 nautical mile long profiles perpendicular to the strike of William's Ridge, two ~60 nautical mile long profiles perpendicular to the strike of Broken Ridge, and one 200 nautical mile long profile along the strike of William's Ridge on its crest following multibeam and sub-bottom profile data acquisition that defines the feature's bathymetry and shallow sediment cover. Seismic reflection data acquisition will be undertaken at 5 kts, and transits between lines will be conducted at 10 kts, requiring a total of eight days. Seismic reflection data have not been acquired previously from William's Ridge, and are needed to address the structural, tectonic and ECS objectives of this project.

This project will require additional permitting issued under the Territory of Heard Island and McDonald Islands (HIMI) Environment Protection and Management Ordinance 1987 (the EPMO) to operate and conduct research within the Heard Island and McDonald Islands (HIMI) Marine Reserve.

IN2020_V07 (Jutzeler) – Sedimentation at its extreme: how powerful are submarine caldera-forming eruptions (Kermadec arc)?

This expedition in October-November 2020 will collect new information on volcanoes responsible for the largest types of volcanic eruptions, focusing on those located along the submarine Kermadec volcanic arc, northeast of New Zealand. The voyage will target three massive caldera volcanoes (Macauley, Havre and Healy), aiming to acquire their internal structure to infer eruption style and depositional processes. Seismic reflection profiles will be conducted to allow geometrical and volumetric characterisation of thick sub-seafloor volcanic sediment packages. The location of the three volcanoes which will form the areas of operation for the voyage are shown below and Figure 3:

- Macauley caldera volcano: 30°12S, 178°29W
- Havre caldera volcano: 31°06'S, 179°02'W
- Healy caldera volcano: 35°S, 179°E

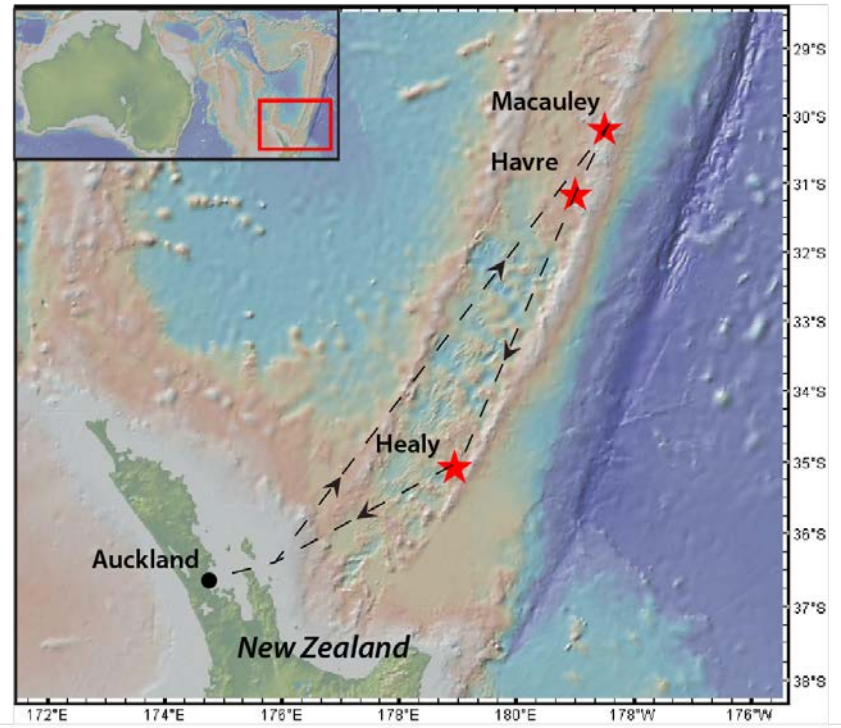

Figure 3: Intended areas of operation for IN2020_V07.

Seismic reflection data acquisition will be undertaken at 5 knots (120 miles/day), and transits between the lines will be conducted at 10 knots. Total seismic reflection survey will be 5.5 days (2.5 days at Macauley, 2.5 days at Havre, 0.5 day at Healy). Watches for marine mammals will be organised during seismic surveys, and operations will be immediately stopped in case of encounter. As this project is being conducted within a protected zone administered by New Zealand, additional permit applications will be made to the New Zealand Government, separate from this permit application.

IN2021_V03 (Meekan) – Evaluating the impact of seismic surveys on the zooplankton communities of the North West Shelf

This voyage, in May-June 2021, will address the question: do the high energy impulse signals generated during seismic surveys for oil and gas in marine systems significantly impact zooplankton populations? Specific aims are to:

- Determine if the distribution, abundance, behaviour, biology and mortality of zooplankton in an area off the north-west coast of Western Australia are significantly altered by marine seismic survey operations.
- Identify potential mechanisms for injury associated with any impacts generated by seismic survey operations.

This project will deploy a full-scale commercial seismic array on the RV *Investigator* and document the effect of seismic surveys on the plankton community on the shelf and offshore. The work will describe the distribution, abundance, behaviour and mortality of plankton using a variety of techniques including sonar surveys, plankton nets and pumps and light traps. Zooplankton exposed to surveys will be held in the laboratory on board to examine behaviour, growth and reproduction rates. Using a combination of gene expression, immunological and histology studies we will seek to understand the mechanisms underlying any documented impacts on the zooplankton community. This study will employ a before-after-control-impact (BACI) and dose-response (DR) sampling design to assess responses of zooplankton exposed to a seismic survey source that will be operated from the RV *Investigator*. One seismic line will be conducted each day, for eight days, alternating between lines with airguns operational and inactive, providing four experimental replicates in 'exposed' and 'vessel control' treatments, respectively. The area of study is proposed to be west of Broome as shown in Figure 4.

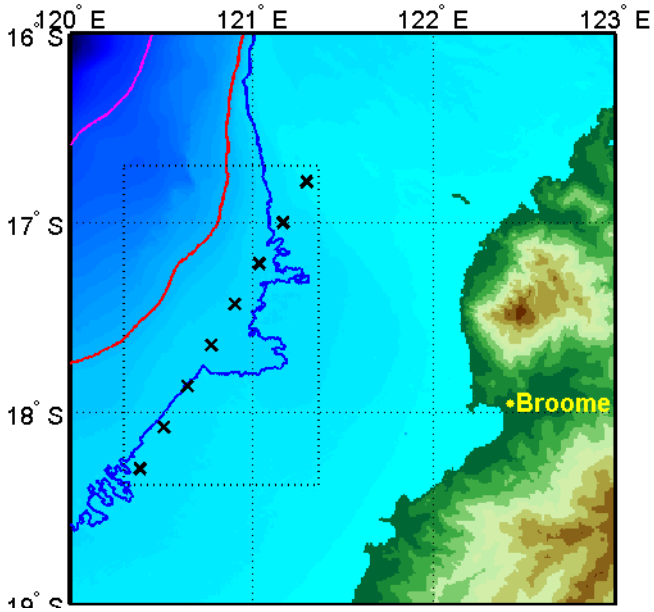

Figure 4: Locations of proposed study sites (black crosses) west of Broome. The 100 m (blue), 200 m (red) and 500 m (magenta) depth contours are shown.

Source characteristics and exposure thresholds
The seismic commissioning will use 2 Sercel Generator-Injector (GI) airguns with a combined capacity of 6.88 litres. This represents a volume of about 10% of a typical airgun array used in petroleum industry surveys. GI guns can be used in airgun mode where the entire volume is used to generate sound, or in GI gun mode where about 60% of the air is injected into the initial bubble to prevent bubble collapse and produce a cleaner signal. The airguns will be towed about 30 m behind the vessel during trials.

Breitzke et al. (2008) measured the source level of a single GI gun in airgun mode and found a source sound exposure level of 202 dB re 1 µPa2 s @ 1 m. They also measured a 3 GI gun array, finding a sound exposure level of 211 dB re 1 µPa2 s @ 1 m. In the absence of measurements for 2 GI guns, we have estimated the source level of 2 GI guns as double that of one i.e. 208 dB re 1 µPa2 s @ 1 m. This source level is below the threshold for injury for a single pulse suggested by Southall et al. (2007) and below the level for injury for multiple pulses within a few meters of the guns. It also means that the Department of Environment preferred threshold for Temporary Threshold Shift (TTS) in whale hearing of 160 dB re 1 µPa2 s @ 1 m is reached at 251 m from the source, assuming spherical spreading of the sound. This means that the TTS threshold will be reached in a circle much less than 1 km and that extends about 130 meters in front of the vessel. The 2 GI gun array has a source level comparable to some natural sound sources. For instance, icebergs produce source levels of 220-245 dB re 1 µPa-rms @ 1 m with similar frequency content to airguns (Matsumoto et al. 2014). Meanwhile, earthquakes and submarine volcanic eruptions have been shown to generate sound pressure levels in excess of 200 dB re 1 µPa (Miller et al. 2002). A single GI gun produces 216 dB re 1 µPa-rms @ 1 m and 3 GI guns produce 225 dB re 1 µPa-rms @ 1 m (Breitzke et al. 2008).

In summary, the seismic source for the proposed commissioning will produce sound pulses which will be within the range of natural sources and below TTS levels beyond 251 m from the airgun.

Area of operation
The maps in Attachment 2 indicate known areas of operation for seismic commissioning and surveying on board RV *Investigator* within the next five years. However, due to the variability in the location of these activities and the potential for additional seismic activities to occur during voyages in other areas, we are applying for a permit to cover all Commonwealth waters off the mainland and Tasmania, along with international waters (New Zealand). There are 46 species of cetacean listed as occurring in Australia's Commonwealth waters (see Attachment 5), along with a number of sea bird species.

The sea birds will not be affected by the survey because it involves no fishing activities, is well away from potential breeding sites and the vessel has best practise waste management plans that prevent discharges that may attract birds. The interaction with cetaceans will be minimised as set out below.

Cetaceans in the area of operation
Intended areas of operation shown for the proposed actions are flexible. As such, exact deployment sites are able to be modified in order to minimise potential interactions with cetaceans in the area.

It is difficult to assess the numbers of cetaceans likely to be encountered in any particular area off the Australian or New Zealand coastline, as the distribution of cetaceans is not uniform. The estimated number of cetaceans that will be affected by the proposed activities (shown in column 4 of the table in Part 1 of Supplementary Form A – Whales and Dolphins) have been significantly scaled up to account for the possibility of encountering a large pod of dolphins or whales and represent a large overestimation of the numbers that will likely be encountered based on data available in the Atlas of Living Australia and National Marine Mammal Database. The results of a

search of the Atlas of Living Australia for all cetacean records for Australia's Exclusive Economic Zone (EEZ) is shown in Figure 5 below.

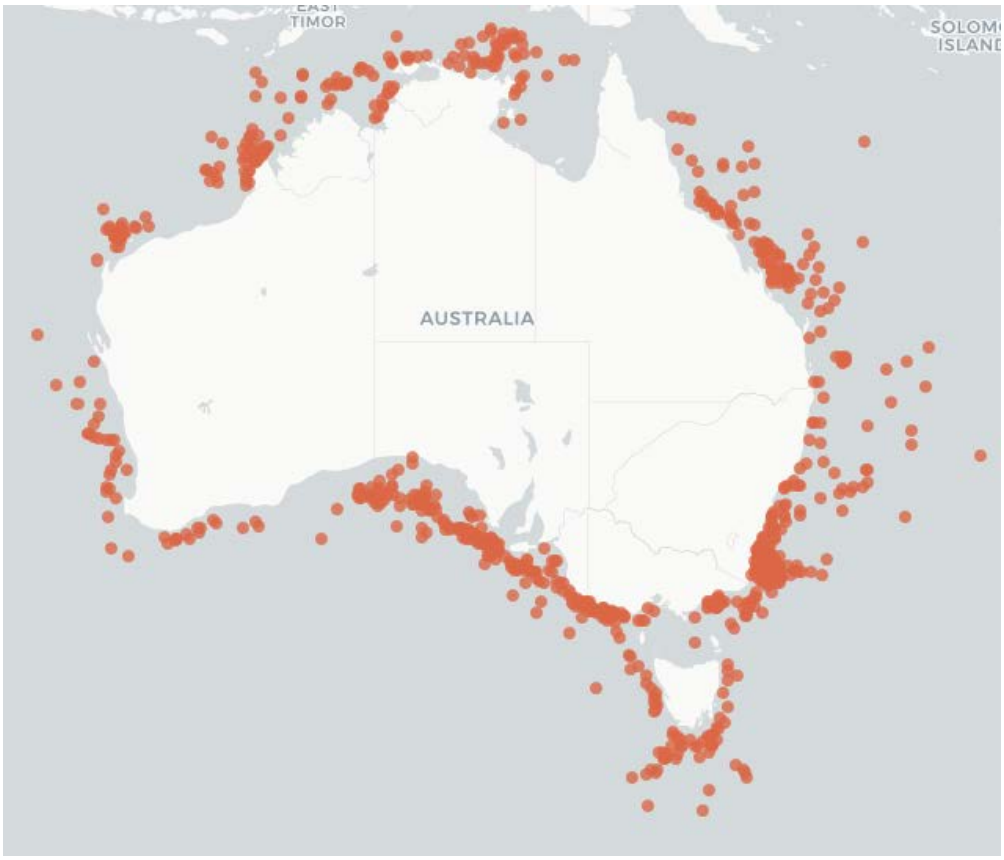

Figure 5: All cetacean occurrence records within the Atlas of Living Australia for Australia's Exclusive Economic Zone (EEZ).

The nature of encounters with the proposed action will be different to encounters by cetacean surveys. In dedicated cetacean surveys, an encounter is an observation within a visual radius from the observer ship. This observable radius is much larger than the TTS radius for the GI guns. The estimated encountered numbers means a small number of whales could be within audible range of the airgun. The survey will target a very small proportion of the total habitat used by cetaceans. The small source will be audible to a few whales that represent a small proportion of the total whale population using the waters of Australia's Commonwealth marine areas. Though audible, the source will not exceed TTS levels unless a whale is very close to the airgun (<251 m). This will be managed by standard mitigation strategies.

Mitigation methods

Personnel will include a dedicated observer who will be stationed on the vessel bridge during airgun operations, in accordance with the mitigation methods set out in EPBC Act Policy Statement 2.1 - Interaction between offshore seismic exploration and whales (Department of Environment, Water, Heritage and the Arts, September 2008). Airgun operations will be conducted under the other considerations of the EPBC Act Policy Statement 2.1., including pre start-up visual observations, soft start procedures, start-up delay procedures and stop work procedures. A soft start will be achieved using one airgun at the start.

When operating in areas with an increased likelihood of encountering cetaceans (i.e. within migration routes during known migrations seasons or within Biologically Important Areas), the following additional mitigation measures will be employed:

- Use of an additional observer.
- Target operations to daylight hours only, as much as practicable.

References

Atlas of Living Australia occurrence download at https://regions.ala.org.au/Other%20regions/Exclusive%2520Economic%2520Zone#group=Mammals&subgroup=Dolphins,+Porpoises,+Whales&guid=urn%3Alsid%3Abiodiversity.org.au%3Aafd.taxon%3A8d201546-a692-4bac-9513-eccd069050c4&from=1853&to=2019&tab=speciesTab&fq=taxon_concept_lsid%3A%22urn%3Alsid%3Abiodiversity.org.au%3Aafd.taxon%3A8d201546-a692-4bac-9513-eccd069050c4%22 accessed on Fri May 03 11:31:24 AEDT 2019.

Breitzke, M., Boebel, O., El Naggar, S., Jokat, W. and Werner, B., 2008. Broad-band calibration of marine seismic sources used by *R/V Polarstern* for academic research in polar regions. Geophysical Journal International, 174, 505-524.

Matsumoto, H. et al. 2014. Antarctic icebergs: A significant natural ocean sound source in the Southern Hemisphere. Geochemistry, Geophysics, Geosystems, 15, 3448-3458.

Miller, H., Gohl, K., Uenzelmann-Neben, G., Müller, C., and Jokat, W., 2002. Polarforschung, 72, 109-114.

National Marine Mammal Database search at https://data.marinemammals.gov.au/nmmdb accessed on Fri May 03, 2019.

Southall et al. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals, 33, 411-521.

South-east marine region profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region, Commonwealth of Australia 2015a.

National Conservation Values Atlas database search at http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf accessed Fri May 07, 2019. Commonwealth of Australia 2015b.

Attachment 3: What steps will be taken to minimise impacts on cetaceans

- The use of a two airgun source is consistent with the Scientific Committee for Antarctic Research (SCAR) recommendation to use the smallest source necessary to achieve survey objectives.
- During commissioning, the minimum level of operation required to sufficiently test the airguns will be conducted.
- During surveys, the minimum level of operation required to achieve the scientific objectives of the project will be conducted.
- Airgun operations will be conducted under considerations of the EPBC Act Policy Statement 2.1., including pre start-up visual observations, soft start procedures, start-up delay procedures and stop work procedures. A soft start will be achieved using one airgun at the start.
- Operations will be undertaken in a location which minimises impact to cetaceans.

- A dedicated observer will be stationed on the bridge during seismic operations.

When operating in areas with an increased likelihood of encountering cetaceans (i.e. within migration routes during known migration seasons or within Biologically Important Areas), the following additional mitigation measures will be employed:

- Use of an additional observer.
- Target operation to daylight hours only, as much as practicable.

Attachment 4: The objectives and purposes of the action

IN2019_E01 (Seismic Commissioning)

The objectives of the seismic commissioning are to test the deployment, operation and retrieval of components of a recently acquired seismic system, procured in order to conduct scientific research on board RV *Investigator*. These components are two GI airguns and 1-2 lengths of streamer (maximum length: 225 m). The purpose of the operation is to train staff in the deployment and retrieval of the equipment and to test its operation. This action does not involve a traditional seismic survey and the minimum data required to validate the system will be collected.

IN2020_V01 (Coffin)

The objectives of the voyage are to acquire and analyse rock samples and geophysical data from these ridges to understand how they formed and evolved. The research conducted during this voyage will resolve questions around the plate tectonics of the Indian Ocean, determine if William's Ridge is a continental sliver, help understand massive volcanism triggered by mantle hotspots, and potentially contribute to expanding Australia's sovereign undersea territory.

IN2020_V07 (Jutzeler)

The aim of this project is to link the behaviour of deep submarine eruptions with the morphology of their deposits. Modelling calculations of sediment mass fluxes will permit the first-ever hazard mapping scheme for submarine volcanoes globally (tsunami and sediment flows), and provide new ore vectoring strategies for exploration in Australia.

IN2021_V03 (Meekan)

Marine seismic surveys produce sound that penetrates the seafloor in order to identify oil and gas deposits. Recent studies suggest that this noise can harm zooplankton. This is important because these small animals form the base of the food chain for all other marine organisms, thus are vital for ocean health. We will examine the scale and significance of impacts of noise from a commercial seismic survey on zooplankton on the NW Shelf, off the coast of WA, using techniques including sonar, net tows and light traps to describe the distribution, abundance, behaviour and mortality of zooplankton.

Attachment 5: List of cetacean species in Commonwealth waters

Scientific name	Common name	Listing status
Balaenoptera acutorostrata	Minke Whale	Cetacean
Balaenoptera bonaerensis	Antarctic Minke Whale, Dark-shoulder Minke Whale	Cetacean; Migratory(Bonn)
Balaenoptera borealis	Sei Whale	Vulnerable; Cetacean; Migratory(Bonn)
Balaenoptera edeni	Bryde's Whale	Cetacean; Migratory(Bonn)
Balaenoptera musculus	Blue Whale	Endangered; Cetacean; Migratory(Bonn)
Balaenoptera physalus	Fin Whale	Vulnerable; Cetacean; Migratory(Bonn)
Berardius arnuxii	Arnoux's Beaked Whale	Cetacean
Caperea marginata	Pygmy Right Whale	Cetacean; Migratory(Bonn)
Eubalaena australis	Southern Right Whale	Endangered; Cetacean; Migratory(Bonn)
Feresa attenuata	Pygmy Killer Whale	Cetacean
Globicephala macrorhynchus	Short-finned Pilot Whale	Cetacean
Globicephala melas	Long-finned Pilot Whale	Cetacean
Hyperoodon planifrons	Southern Bottlenose Whale	Cetacean
Indopacetus pacificus	Longman's Beaked Whale	Cetacean
Kogia breviceps	Pygmy Sperm Whale	Cetacean
Kogia sima	Dwarf Sperm Whale	Cetacean
Lissodelphis peronii	Southern Right Whale Dolphin	Cetacean
Megaptera novaeangliae	Humpback Whale	Vulnerable; Cetacean; Migratory(Bonn)
Mesoplodon bowdoini	Andrew's Beaked Whale	Cetacean
Mesoplodon densirostris	Blainville's Beaked Whale, Dense-beaked Whale	Cetacean
Mesoplodon ginkgodens	Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale	Cetacean
Mesoplodon grayi	Gray's Beaked Whale, Scamperdown Whale	Cetacean
Mesoplodon hectori	Hector's Beaked Whale	Cetacean
Mesoplodon layardii	Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale	Cetacean
Mesoplodon mirus	True's Beaked Whale	Cetacean
Orcinus orca	Killer Whale, Orca	Cetacean; Migratory(Bonn)
Peponocephala electra	Melon-headed Whale	Cetacean

Physeter macrocephalus	Sperm Whale	Cetacean; Migratory(Bonn)
Pseudorca crassidens	False Killer Whale	Cetacean
Tasmacetus shepherdi	Shepherd's Beaked Whale, Tasman Beaked Whale	Cetacean
Ziphius cavirostris	Cuvier's Beaked Whale, Goose-beaked Whale	Cetacean
Delphinus delphis	Common Dophin, Short-beaked Common Dolphin	Cetacean
Grampus griseus	Risso's Dolphin, Grampus	Cetacean
Lagenodelphis hosei SE Asian population	Fraser's Dolphin, Sarawak Dolphin	Cetacean; Migratory(Bonn)
Lagenorhynchus cruciger	Hourglass Dolphin	Cetacean
Lagenorhynchus obscurus	Dusky Dolphin	Cetacean; Migratory(Bonn)
Lissodelphis peronii	Southern Right Whale Dolphin	Cetacean
Orcaella heinsohni	Australian Snubfin Dolphin	Cetacean; Migratory(Bonn)
Sousa sahulensis	Australian Humpback Dolphin, Indo-Pacific Humpback Dolphin	Cetacean; Migratory(Bonn)
Stenella attenuata incl E Tropical Pacific, SE Asian populations	Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean; Migratory(Bonn)
Stenella coeruleoalba	Striped Dolphin, Euphrosyne Dolphin	Cetacean
Stenella longirostris incl E Tropical Pacific, SE Asian populations	Long-snouted Spinner Dolphin	Cetacean; Migratory(Bonn)
Steno bredanensis	Rough-toothed Dolphin	Cetacean
Tursiops aduncus (incl Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Cetacean; Migratory(Bonn)
Tursiops truncatus s. str.	Bottlenose Dolphin	Cetacean
Phocoena dioptrica	Spectacled Porpoise	Cetacean; Migratory(Bonn)