ENVIRONMENTAL OFFSHORE SERVICES LIMITED

Schlumberger Seaco Inc.

East Coast and Pegasus Multiclient 2D Marine Seismic Survey

Marine Mammal Impact Assessment

28 March 2014

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List of Acronyms

ACE	Annual Catch Entitlement
AEI	Areas of Ecological Importance
ALARP	As Low as Reasonably Practicable
AOI	Area of Interest
BPA	Benthic Protected Area
CMA	Coastal Marine Area
Code of Conduct	2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations
COLREGS	International Regulations for the Prevention of Collisions at Sea 1972
dB	Decibels
DC	D'Urville Current
DOC	Department of Conservation
ECC	East Cape Currents
EEZ	Exclusive Economic Zone
EEZ Act	Exclusive Economic Zone and Continental Shelf Act 2012
EMP	Environmental Management Plan
EOS	Environmental Offshore Services Limited
EPA	Environmental Protection Authority
FMA	Fisheries Management Area
HSE	Health and Safety in Employment
IAPPC	International Air Pollution Prevention Certificate
IOPPC	International Oil Pollution Prevention Certificate
ISPPC	International Sewage Pollution Prevention Certificate
IUCN	International Union of Conservation of Nature
Km	Kilometre
MARPOL	International Convention for the Prevention of Pollution from Ships
MBIE	Ministry of Business, Innovation and Employment
MEC	Marine Environment Classification
MfE	Ministry for the Environment
MMIA	Marine Mammal Impact Assessment
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Mammal Observer
MMS	Marine Mammal Sanctuary
MPI	Ministry for Primary Industry
MSS	Marine Seismic Survey
NABIS	National Aquatic Biodiversity Information System

NIWA	National Institute of Water and Atmospheric Research
Nm	Nautical Mile
NZ	New Zealand
NZP&M	New Zealand Petroleum & Minerals
PAM	Passive Acoustic Monitoring
PEP	Petroleum Exploration Permit
PEPANZ	Petroleum Exploration & Production Association New Zealand
PNA	Protected Natural Area
QMS	Quota Management System
RMA	Resource Management Act 1991
SC	Southland Current
SEL	Sound Exposure Level
SOPEP	Shipboard Oil Pollution Emergency Plan
SRD	Self-Recovery Devices
STLM	Sound Transmission Loss Modelling
TACC	Total Allowable Commercial Catch
WAUC	West Auckland Current
WC	Westland Current

1 Introduction

1.1 Background

Schlumberger Seaco Inc (Schlumberger), a leading geophysical services company, is to undertake a 2D marine seismic survey (MSS) of approximately 5,000 lineal in the East Coast and Pegasus Basins (ECPB). The ECPB Survey Area will be located within the 51,800 km^2 Petroleum Prospecting Permit (PPP) 56061 and will be bound by the ECPB Operational Area; allowing for operation of line turns, acoustic source testing and soft start initiation (Figure 1). It is anticipated that the ECPB 2D MSS will take approximately 40-50 days to acquire, depending on weather constraints and marine mammal encounters. The actual commencement date of the ECPB 2D MSS is dependent on the seismic vessel *Aquila Explorer's* prior work commitments, however, with the current schedule is anticipated to commence early April 2014.

Under Section 23 of the Crown Minerals Act 1991, a PPP authorises the permit holder to prospect for petroleum deposits or occurrences. Schlumberger have been granted PPP 56061 as a speculative prospector under Section 90(7) of the Crown Mineral Act on a non-exclusive basis for a period of six months, allowing Schlumberger to undertake geological or geophysical surveying within PPP 56061. Further details in regards to the Crown Minerals Act is provided in Section 2.1.

The ECPB MSS will acquire data to provide a general understanding of the regional geological structure within the ECPB and to identify more prospective areas for further investigations. Further details of 2D and 3D MSS's are provided in Section 3.1.

The Exclusive Economic Zone (EEZ) and Continental Shelf (Environmental Effects – Permitted Activities) Act (EEZ Act) was promulgated and came into effect on 28 June 2013. The EEZ Act manages the previously unregulated potential for adverse environmental effects of activities in the EEZ and continental shelf. Under the EEZ Act, a MSS is classified as a permitted activity, providing the operator undertaking the MSS complies with the '2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations' (Code of Conduct) (DOC, 2013). The Code of Conduct is further explained in Section 2.3.

A few sections of the ECPB Operational Area is within the Coastal Marine Area (CMA) administered by Greater Wellington Regional Council (GWRC), Horizons Regional Council and Hawkes Bay Regional Council, however most of the proposed survey lines stay within the EEZ (Figure 1). The code of conduct is not mandatory within the CMA, however Schlumberger will adhere to the Code of Conduct requirements throughout the entire ECPB Operational Area.

The ECPB 2D Marine Mammal Impact Assessment (MMIA) has been prepared in accordance with the Code of Conduct (Appendix 1: Marine Mammal Impact Assessment) to assess the potential environmental effects from the ECPB 2D MSS, the sensitive environments and marine species in the surrounding areas and mitigation measures to avoid or minimise any potential effects to as low as reasonably practicable (ALARP).

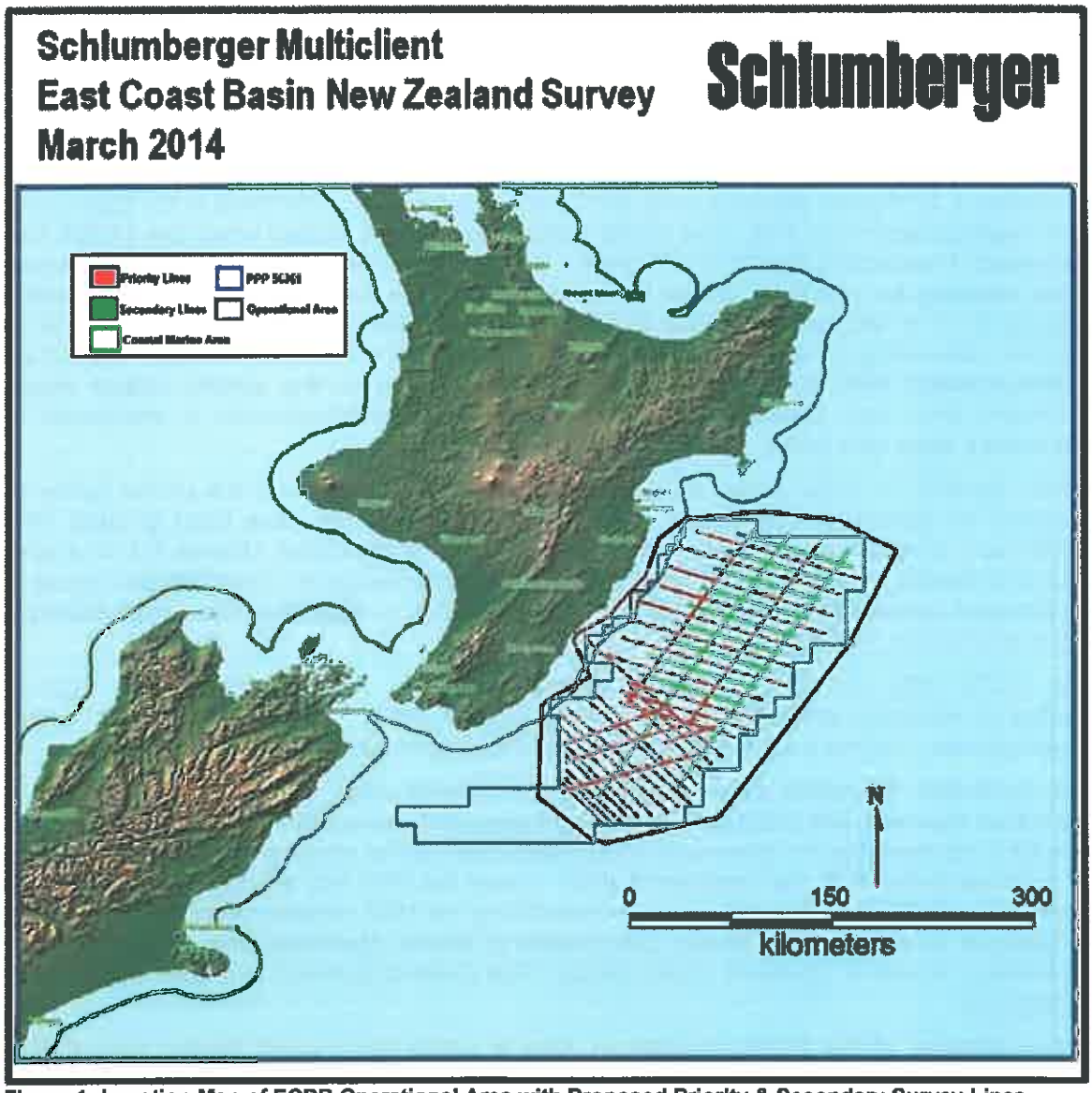

Figure 1: Location Map of ECPB Operational Area with Proposed Priority & Secondary Survey Lines

1.2 General Approach

As part of the preparation for the ECPB 2D MSS, the MMIA is an integral component to receive regulatory approval for Schlumberger to undertake the ECPB 2D MSS in adherence to the Code of Conduct. As well as the Code of Conduct, Schlumberger will operate in accordance to relevant NZ laws and regulations, international guidelines and procedures and their own internal environmental standards.

Within the Code of Conduct, the ECPB 2D MSS is classified as a 'Level 1 Survey' and Schlumberger will comply with these requirements and mitigation measures while carrying out the MSS. The requirements of a Level 1 survey under the Code of Conduct and mitigation measures that Schlumberger will implement is outlined in Section 2.3.1 and Section 5.3.1.

During the preparation of the ECPB 2D MMIA an extensive review of literature and existing data was used from both national and international sources. This information forms a considerable amount of the background information and descriptions of the existing environments surrounding the ECPB Operational Area. A full list of references can be found in Section 8.

1.3 Consultation

Schlumberger has undertaken consultation with key interested parties and stakeholders that were identified in relation to the seismic activities within the ECPB Operational Area and extended from Christchurch to the Hawkes Bay. This consultation process involved groups being consulted either in person, through an information sheet or contacted over the phone to describe the proposed ECPB MSS operations and the ECPB Operational Area. A copy of the information sheet sent out for the consultation process is attached in Appendix 1. The groups that were consulted with are defined below:

- Department of Conservation – National Office;
- Department of Conservation – Kaikoura Office;
- Department of Conservation – Napier Office;
- Department of Conservation – Nelson Office;
- Environmental Protection Authority;
- New Zealand Petroleum & Minerals;
- Ministry for Primary Industries;
- Petroleum Exploration & Production Associated New Zealand (PEPANZ);
- Te Runanga o Kaikoura;
- Kaikoura District Council;
- Port Nicholson Block Settlement Trust;
- Te Runanga o Ngai Tahu;
- Te Atiawa o Te Waka-a-Māui;
- Horizons Regional Council;
- Hawkes Bay Regional Council;
- Hawkes Bay Seafoods;
- Kahungunu ki Wairarapa;
- Ngati Kahungunu Iwi Incorporated;
- Rangitane o Wairarapa;
- Star Offshore Services Limited;
- Whale Watch Kaikoura;
- Dolphin Encounters;
- Deepwater Group;
- Sealord;
- Maruha NZ Ltd;
- Independent Fisheries;
- Talley's Group;
- Sanford Limited;
- Southern Inshore Fisheries Management Company Limited;
- Maritime New Zealand;
- Land Information New Zealand;
- Hawke's Bay Sport Fishing Club;
- Greater Wellington Regional Council;
- Marlborough Regional Council;
- Rangitane o Tamaki Nui a Rua;

- Fishing Vessel Management Services;
- Fisheries Inshore NZ;
- University of Auckland;
- University of Otago; and
- National Institute of Water & Atmosphere (NIWA).

A consultation register of Schlumberger's engagements is included in Appendix 2.

1.4 Research

Throughout the world where MSS's are undertaken, research is being undertaken to assess any potential effects from MSS operations on marine species and habitats. Within the Code of Conduct it is identified that research should be undertaken which is relevant to the local species, habitats and conditions (DOC, 2013), while not duplicating international efforts.

Under the Code of Conduct, within 60 days following the completion of the ECPB 2D MSS, a Marine Mammal Observer (MMO) report is to be submitted to DOC which is to include all the marine mammal observational data, where shut downs occurred due to marine mammals within the mitigation zones and GPS coordinates of each marine mammal sighting. This information will then add to the DOC marine mammal sighting database and can be used for research purposes by DOC, Universities or other institutions to keep developing the knowledge of marine mammals in regards to distribution and behaviour around an operating seismic vessel. There is presently very little information known about what marine mammals live in the ECPB region, so to have dedicated trained and experienced MMOs out there will add largely to DOC's knowledge on marine mammals for this area.

While conducting the ECPB 2D MSS; Schlumberger will have Massey University perform a necropsy on any marine mammals that may be found dead and cannot be attributed to shark attacks or vessel collisions, inshore of the ECPB Operational Area, along the Hawkes Bay, Wairarapa, Wellington, Marlborough, Kaikoura and north Canterbury coastline and bound by Mahia Peninsula, Tory Channel and Banks Peninsula during the ECPB 2D MSS and for a period two weeks after the ECPB 2D MSS is completed. If a necropsy is performed it will be to assess if the cause of death was from any auditory pressure related injuries. DOC will be responsible for all aspects of undertaking the necropsy and coordination with pathologists at Massey University; however Schlumberger will cover the associated costs.

2 Legislative Framework

The NZ Government's oil, gas, mineral and coal resources are administered by New Zealand Petroleum & Minerals (NZP&M) and are often regarded as the Crown Mineral Estate. NZP&M has the role of maximising the gains to NZ from the development of mineral resources, in line with the Government's objectives for energy and economic growth. NZP&M is a branch of the Ministry of Business, Innovation and Employment (MBIE) and they report to the Minister of Energy and Resources.

There is a wide range of legislation applicable to the offshore petroleum industry which regulates maritime activities, environmental protection, biosecurity and industrial safety. For the ECPB 2D MSS, Schlumberger are required to comply with the Crown Minerals Act 1991, EEZ Act – Permitted Activities and the Code of Conduct.

2.1 Crown Minerals Act 1991

The Crown Minerals Act 1991 sets the broad legislative framework for the issuing of permits for prospecting, exploration and mining of Crown-owned minerals in New Zealand, which includes those minerals found on land, offshore in the EEZ and extended continental shelf. This Act was amended on 24 May 2013.

The Crown Minerals Act regime comprises of the Crown Minerals Act 1991, two minerals programmes (one for petroleum and one of other Crown-owned minerals) and associated regulations, which together regulate the exploration and production of Crown-owned minerals (NZPAM, 2014a).

The petroleum minerals programme 2013 took effect on 24 May 2013 and now applies to all applications for permits for petroleum activities; where it sets out the policies and procedures followed for the allocation of mineral resources, while the requirements to be met by permit holders are defined in the regulations. The programme sets out specific requirements for consultation with iwi and hapu, including the matters that must be consulted on (such as all permit applications) and the consultation principles.

Schlumberger have applied for a 51,800 km^2 PPP, which under Section 23 of the Crown Minerals Act, allows for conducting reconnaissance and general investigations of an area, generally through acquisition of geological and geophysical data for the purpose of providing information for further petroleum exploration. The duration of a PPP is up to four years or an earlier specified date; Schlumberger have only applied for a PPP duration of six months. A PPP may not be extended beyond four years after the permit's commencement date, and there are no subsequent rights to the permit holder to obtain petroleum exploration or petroleum mining permits over all or part of the area of a PPP. PPP's are normally granted on a non-exclusive basis, however there may be exceptions where exclusive rights to applicants are granted but there are a number of requirements that have to be implemented for this to occur, and exclusive PPP's will generally have a maximum duration of two years.

Under the Crown Minerals Act different information protection and confidentiality provisions apply to information acquired and provided to NZP&M under a PPP depending on whether or not the PPP holder is a 'speculative prospector'. Section 90C of the Crown Minerals Act provides for a non-exclusive PPP applicant to be classified as a speculative prospector; this is defined as a non-exclusive PPP holder who carries out activities under the PPP solely for the purpose of on-selling the information obtained on a non-exclusive basis to petroleum explorers and producers. Schlumberger are considered as a speculative prospector.

Any information that a speculative prospector has provided to NZP&M will not be released to the public by NZP&M until 15 years after it has been obtained by the PPP holder. As a result this amendment to the Crown Minerals Act has now made it more inviting to potential prospectors for NZ petroleum resources who undertake multi-client MSS for the benefit of multiple operators. As a result, speculative prospectors now know they have the exclusive rights to seismic data they acquire in NZ for 15 years; allowing them to work with operators and the Crown to get subsequent blocks released over potential petroleum resources for further exploration activities; and is in keeping with the purpose of the Crown Minerals Act.

2.2 Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act

The purpose of the EEZ Act is to promote the sustainable management of the natural resources of the EEZ and Continental Shelf. Sustainable management involves managing the use, development and protection of natural resources in a way, or at a rate, that enables people to provide for their economic well-being while:

- Sustaining the potential of natural resources to meet the reasonably foreseeable needs of future generations; and
- Safeguarding the life-supporting capacity of the environment; and
- Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

The Minister for the Environment can classify activities within the EEZ and Continental Shelf as:

- **Permitted** – the activity can be undertaken provided the operator meets the conditions specified within the regulations. Marine seismic surveys are a permitted activity as long as the operator complies with the DOC Code of Conduct. DOC administers the Marine Mammals Protection Act (1978) with a mandate to administer and manage marine mammals, of which the Code of Conduct has been developed under that mandate. Therefore the Director-General of DOC must approve a MMIA before any MSS can commence. Seismic survey operators do not have to comply with the prior notification requirements in Schedule 1 of the Permitted Activity Regulations, or to supply reports of the activity to the EPA. If an operator chooses not to implement the Code of Conduct during the planning stage of a MSS, then the activity becomes a discretionary activity under the EEZ Act;
- **Non-notified discretionary** – activities can be undertaken if applicants obtain a marine consent from the EPA, who may grant or decline consent and place conditions on the consent. The consent application is not publically notified and has statutory timeframes adding up to 60 working days in which the Environmental Protection Authority (EPA) must assess the marine consent application. (Note: this classification is not yet in effect; it will come into effect when activities are first classified under it);
- **Discretionary** – activities can be undertaken if applicants obtain a marine consent from the EPA. The consent application will be publicly notified, submissions will be invited and hearings will be held if requested by any party, including submitters. The process has a statutory timeframe of 140 working days in which the EPA must assess the marine consent application; and
- **Prohibited** – the activity may not be undertaken.

The classification for each activity depends on a number of considerations outlined in Section 33 of the EEZ Act. These considerations include; the environmental effects of the activity, the importance of protecting rare and vulnerable ecosystems, and the economic benefit to NZ of an activity taking place.

The EPA will monitor for compliance with the permitted activity regulations for seismic surveys, which relates to the Code of Conduct, and may conduct audits. The EPA is the enforcement agency for compliance with the EEZ Act and has the authority to take enforcement action if any activities undertaken by an operator are non-compliant within the EEZ.

2.3 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations

The Code of Conduct was developed by DOC in consultation with a broad range of stakeholders involved with marine seismic survey operations in NZ and on 29 November 2013 replaced the 2012 Code of Conduct. The 2012 Code of Conduct was initially developed as a voluntary regime to manage the potential effects of MSS activities while teething issues were ironed out, of which the petroleum industry adopted while carrying out MSS operations in NZ waters. It was believed the initial 2012 Code of Conduct achieved world-leading environment protection, while providing for the sustainable economic development that is vital to NZ's future prosperity. However, when the EEZ Act came into effect on 28 June 2013, seismic surveys were classified as permitted activities (Section 2.2), requiring operators undertaking a MSS in the EEZ or Continental Shelf to operate in compliance with the Code of Conduct. This resulted in a review of the 2012 Code of Conduct to take into account a few operational difficulties that were identified during the first MSS season operating with the 2012 Code of Conduct and to make the Code of Conduct enforceable from a regulatory perspective.

The update to the 2013 Code of Conduct incorporated a number of amendments; including a reduced period of time that the NZ fur seal has to be beyond the 200 m mitigation zone before the pre-start observations can commence, operational procedures to implement if the PAM system malfunctions and a slight change to pre-start observations. The full mitigation requirements within the updated 2013 Code of Conduct are provided in Section 2.3.1.

The ECPB 2D MSS is classified as a Level 1 survey within the Code of Conduct; where the acoustic source has a total combined operational capacity that exceeds 427 cubic inches (in^3). Most MSS's for oil and gas exploration activities are classified as Level 1, which feature the most stringent requirements for marine mammal protection and is the main focus of the Code of Conduct.

Any operator undertaking a MSS (except those classified as Level 3) has to provide notification to the Director-General of DOC at the earliest opportunity but not less than three months prior to commencement. Notification was provided to the Director-General on 11 December 2013 in regards to Schlumberger's ECPB 2D MSS within PPP 56061.

The Code of Conduct requires a MMIA to be developed and submitted to the Director-General not less than one month prior to MSS acquisition to ensure that all potential environmental effects and sensitivities have been identified and measures to reduce those potential environmental effects are in place.

When MSS are conducted in Areas of Ecological Importance (AEI) as detailed in Schedule 1 of the Code of Conduct, and it is necessary and unavoidable; additional mitigation measures are to be put in place. The ECPB Operational Area is located within an AEI and the additional measures that Schlumberger will implement, following discussions with DOC are identified in Section 5.3.2.

As well as visual MMOs onboard the Survey Vessel, Passive Acoustic Monitoring (PAM) is required as a mitigation measure under a Level 1 MSS.

As well as visual MMO's onboard the Survey Vessel, Passive Acoustic Monitoring (PAM) is required as a mitigation measure under a Level 1 MSS. A Vanishing Point (VP) PAM system will be utilised for the ECPB 2D MSS, and further information relating to the PAM system was provided by the Sea Mammal Research Unit, St Andrews University following requests for further clarification by DOC relating to the PAM specifications.

It was stated that the ability to detect animals, including the maximum range at which they can be detected, is critically dependent on the levels of background noise. To achieve a workable balance between signals and noise (i.e., the signal to noise ratio or SNR) the VP system utilises two independent hydrophone chains. Analogue filtering is utilised to customise SNR. The low frequency elements are AQ4s, the manufacturers state a near flat +/- 1.5dB sensitivity from 1Hz to 10 kHz. The high frequency chains have better omni-directional high frequency sensitivity overlapping with the low frequency elements and are sensitive up to 250 kHz. The VP system is able to sample up to 500 kHz which is well in excess of the required 360 kHz within the Code of Conduct. Therefore the VP system used by Blue Planet Marine has arrays incorporating appropriate hydrophone elements (1 Hz to in excess of 180 kHz range) and data acquisition card technology for sampling relevant frequencies (to greater than 360 kHz) used by NZ cetacean species. It has also been confirmed that the VP PAM system has the capability to determine distance and bearing to 1.5km and has full system redundancy.

The DOC-endorsed senior PAM Operator that will be onboard the *Aquila Explorer* during the ECPB 2D MSS also confirmed that the PAM system planned to be used is suitable for detection of NZ endemic and vagrant marine mammal species.

Technical details of the PAM system to be used in the ECPB 2D MSS are included in Appendix 3. The Code of Conduct states that where additional mitigation measures are required a Marine Mammal Mitigation Plan (MMMP) is to be developed and circulated amongst the observers and crew to guide the offshore operations. The MMMP has been

compiled by the MMO and PAM system provider Blue Planet Marine and is attached in Appendix 4.

2.3.1 Level 1 Marine Seismic Survey

For compliance with the Code of Conduct, Schlumberger must submit a MMIA to the Director-General at least one month prior to commencement of the ECPB 2D MSS. The observer and operational requirements which Schlumberger will adhere to for the Level 1 MSS are listed in the following sections.

The Code of Conduct also requires that Sound Transmission Loss Modelling (STLM) is undertaken when operating a MSS in an AEI to validate the mitigation zones in the Code of Conduct. The STLM is based on the specific configuration of the ECPB 2D MSS acoustic array and the environmental conditions (i.e. bathymetry (which includes all the canyons and trenches within the modelled area), substrate, water temperature and underlying geology) within the ECPB Operational Area. The Code of Conduct states that if Sound Exposure Levels (SEL's) are predicted to exceed 171 dB re 1μPa^2.s (behaviour criteria) corresponding to the relevant mitigation zones for Species of Concern or 186 dB re 1μPa^2.s (injury criteria) at 200 m, consideration will be given to either extending the radius of the mitigation zones or limiting acoustic source power accordingly.

The STLM is discussed in more detail in Section 5.1.2.1 however the results are briefly summarised here as all the mitigation zones have been increased following the STLM. As a result the revised mitigation zones need to be incorporated into the operational procedures for the ECPB 2D MSS within this section.

STLM showed that 100% of SEL's greater than 186 dB re 1μPa^2.s were within 330 m of the acoustic source and 100% of SEL's were below 171 dB re 1μPa^2.s at 2.05 km from the acoustic source. Therefore, due to SEL's of 171 dB re 1μPa^2.s and 186 dB re 1μPa^2.s being greater than the standard mitigation zones stated in the Code of Conduct, the mitigation zones will be increased for the ECPB 2D MSS throughout the entire ECPB Operational Area.

The STLM was modelled at worst case, in the shallowest part of the ECPB Operational Area and the SEL's decrease as the depth increases further offshore (Section 5.1.2.1). The increased mitigation zones will be incorporated throughout the ECPB Operational Area, so as to take a conservative approach for the duration of the MSS, as most of the ECPB Operational Area have SEL's lower than the worst case scenario modelled and what the increased mitigation zones have been based on.

The mitigation zone for Species of Concern with and without calve present will be increased to 2.1 km following the STLM indicating this distance is compliant with the behaviour criteria requirements within the Code of Conduct. Whereas the mitigation zone for 'other marine mammals' will be increased to 350 m following the STLM results.

2.3.1.1 Observer Requirements

To undertake the ECPB 2D MSS in compliance with the Code of Conduct, the minimum qualified observer requirements are:

- At all times there will be at least two qualified MMOs onboard;
- At all times there will be at least two qualified PAM operators onboard;
- The observers role on the vessel during the ECPB 2D MSS is strictly for the detection and data collection of marine mammal sightings, and instructing crew on the Code of Conduct requirements, the crew requirements when a marine mammal is detected within the relevant mitigation zone (including pre-start, soft start and operating at full acquisition capacity requirements);

- At all times when the acoustic source is in the water, at least one qualified MMO (during daylight hours) and at least one qualified PAM operator will maintain watch for marine mammals; and
- The maximum on-duty shift for an observer must not exceed 12 hours per day.

DOC also encourage observations at all times where practical and possible to help build on the knowledge and distribution of marine mammals around the NZ coastline.

If during the ECPB 2D MSS the MMO's onboard the *Aquila Explorer* consider that there are higher numbers of marine mammals encountered than what is believed through the formation of this MMIA, the Director-General will be notified immediately. A decision on what adaptive management procedures will be implemented if this scenario arises will depend on the marine mammal species observed and the situation which is occurring at that time; this management decision will be made from discussions between DOC and Schlumberger, who shall then advise the MMO/PAM team of the correct approach.

Due to the limited detection range of current PAM technology for ultra-high frequency cetaceans, any such bioacoustics detections will require an immediate shutdown of an active survey or will delay the start of operations, regardless of signal strength or whether distance or bearing from the acoustic source has been determined. It is not necessary to determine whether the marine mammal is within a mitigation zone. Shutdown of an activated source will not be required if visual observations by a MMO confirm the acoustic detection was of a species falling into the category of 'Other Marine Mammals'.

If the PAM system onboard the *Aquila Explorer* malfunctions or becomes damaged, MSS operations may continue for 20 minutes without PAM while the PAM operator diagnoses the problem. If it is found that the PAM system needs to be repaired, MSS operations may continue for an additional two hours without PAM as long as the following conditions are met:

- It is during daylight hours and the sea state is less than or equal to Beaufort 4;
- No marine mammals were detected solely by PAM in the relevant mitigation zones in the previous two hours;
- Two MMOs maintain watch at all times during MSS operations when PAM is not operational;
- DOC is notified via email as soon as practicable, stating time and location in which MSS operations began without an active PAM system; and
- MSS operations with an active source, but without an active PAM system, do not exceed a cumulative total of four hours in any 24 hour period.

2.3.1.2 Operational and Reporting Requirements

Both visual MMO's and PAM operators are required to record and report all marine mammal sightings during MSS's conducted in adherence to the Code of Conduct. All raw datasheets must be submitted by the qualified observers directly to DOC at the earliest opportunity but no longer than 14 days after completion of each deployment. A written final trip report must also be submitted to DOC at the earliest opportunity but no longer than 60 days after completion of the ECPB 2D MSS.

MMO requirements include:

- Provide effective briefings to crew members, and establish clear lines of communication and procedures for onboard operations;
- Continually scan the water surface in all directions around the acoustic source for presence of marine mammals, using a combination of naked eye, and high-quality binoculars from optimum vantage points for unimpaired visual observations;

- Use GPS, sextant, reticle binoculars, compass, measuring sticks, angle boards or any other appropriate tools to accurately determine distances/bearings and plot positions of marine mammals whenever possible during sightings;
- Record and report all marine mammal sightings, including species, group size, behaviour/activity, presence of calves, distance and direction of travel (if discernible);
- Record sighting conditions (Beaufort sea state, swell height, visibility, fog/rain and glare) at the beginning and end of the observation period, and whenever the weather conditions change significantly;
- Record acoustic source power output while in operation, and any mitigation measures taken;
- Communicate with DOC to clarify any uncertainty or ambiguity in application of the Code of Conduct; and
- Record and report to DOC any instances of non-compliance with the Code of Conduct.

While PAM operator requirements include:

- Give effective briefings to crew member to establish clear lines of communication and procedures for onboard operations;
- Deploy, retrieve, test and optimise hydrophone arrays;
- When on duty, concentrate on continually listening to received signals and/or monitor PAM display screens in order to detect vocalising cetaceans, except for when required to attend to PAM equipment;
- Use appropriate sample analysis and filtering techniques;
- Record and report all cetacean detections, including, if discernable, identification of species or cetacean group, position, distance and bearing from vessel and acoustic source;
- Record type and nature of sound, time and duration heard;
- Record general environmental conditions;
- Record acoustic source power output while in operation, and any mitigation measures taken;
- Communicate with DOC to clarify any uncertainty or ambiguity in application of the Code of Conduct; and
- Record and report to DOC any instances of non-compliance with the Code of Conduct.

2.3.1.3 Pre-start Observations

Normal Requirements

The ECPB 2D MSS acoustic source can only be activated if it is within the ECPB Operational Area (Figure 1) and no marine mammals have been observed or detected in the relevant mitigation zones (Section 2.3.1.4) and has followed the procedures listed below in this section.

During daylight hours the ECPB 2D MSS acoustic source cannot be activated unless:

- At least one qualified MMO has made continuous visual observations around the source for the presence of marine mammals, from the bridge (or preferably even higher vantage point) using both binoculars and the naked eye, and no marine mammals have been observed in the respective mitigation zones for at least 30 minutes; and

- Passive acoustic monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation and no vocalising cetaceans have been detected in the respective mitigation zones.

During night-time hours or poor sighting conditions (daylight visibility of <1.5 km or a sea state greater than or equal to Beaufort 4), the acoustic source cannot be activated unless:

- Passive acoustic monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation; and
- The qualified observer has not detected any vocalising cetaceans in the relevant mitigation zones.

Soft Starts

The ECPB 2D MSS acoustic source will not be activated at any time except by soft start, unless the source is being reactivated after a single break in firing (not in response to a marine mammal observation within a mitigation zone) of less than 10 minutes immediately following normal operations at full power, and the qualified observers have not detected marine mammals in the relevant mitigation zones. No repetition of the less than 10 minute break period in the commencement of a soft start is allowed under the Code of Conduct.

A soft start 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 capacity defined in this MMIA (6300 in^3) is not to be exceeded during the soft start period.

Additional requirements for start-up in a new location in poor sighting conditions

In addition to the normal pre-start observation requirements above, when the *Aquila Explorer* arrives at the ECPB Operational Area for the first time, the initial acoustic source activation must not be undertaken at night or during poor sighting conditions unless either:

- MMOs have undertaken observations within 20 nautical miles (Nm) of the planned start up position for at least the last two hours of good sighting conditions preceding proposed MSS operations, and no marine mammals have been detected;
- Where there has been less than two hours of good sighting conditions preceding proposed operations (within 20 Nm of the planned start up position), the acoustic source may be activated if:
    - PAM monitoring has been conducted for two hours immediately preceding proposed MSS operations;
    - Two MMOs have conducted visual monitoring in the two hours immediately preceding proposed MSS operations;
    - No Species of Concern have been sighted during visual monitoring or detected by PAM in the relevant mitigation zones in the two hours immediately preceding proposed MSS operations;
    - No fur seals have been sighted during visual monitoring in the relevant mitigation zone in the 10 minutes immediately preceding proposed MSS operations; and
    - No other marine mammals have been sighted during visual monitoring or detected on the PAM system in the relevant mitigation zones in the 30 minutes immediately preceding proposed MSS operations.

2.3.1.4 Delayed Starts and Shutdowns

Species of Concern with calves within a mitigation zone of 2.1 km

If during pre-start observations or while the acoustic source is activated (which includes soft starts), a qualified observer detects at least one Species of Concern (DOC, 2013 – Schedule

2) with a calf within 2.1 km of the source, start-up will be delayed or the source will be shut down and not reactivated until:

- A qualified observer confirms the group has moved to a point that is more than 2.1 km from the source; or
- Despite continuous observation, 30 minutes has elapsed since the last detection of the group within 2.1 km of the source, and the mitigation zone remains clear.

Species of Concern within a mitigation zone of 2.1 km

If during pre-start observations or while the acoustic source is activated, a qualified observer detects a Species of Concern within 2.1 km of the source, start-up will be delayed or the source will be shut down and not reactivated until:

- A qualified observer confirms the Species of Concern has moved to a point that is more than 2.1 km from the source; or
- Despite continuous observation, 30 minutes has elapsed since the last detection of a Species of Concern within 2.1 km of the source, and the mitigation zone remains clear.

Other Marine Mammals within a mitigation zone of 350 m

If during pre-start observations prior to initiation of the ECPB 2D MSS acoustic source soft start procedures, a qualified observer detects a marine mammal within 350 m of the source; start-up will be delayed until:

- A qualified observer confirms the marine mammal has moved to a point that is more than 350 m from the source; or
- Despite continuous observation, 10 minutes has elapsed since the last detection of a NZ fur seal within 350 m of the source and 30 minutes has elapsed since the last detection of any other marine mammal within 350 m of the source, and the mitigation zone remains clear.

Once all marine mammals that were detected within the relevant mitigation zones have been observed to move beyond the respective mitigation zones, there will be no further delays to the initiation of soft start procedures.

2.4 Areas of Ecological Importance

MSS operations within an AEI require more comprehensive planning requirements and consideration, including additional mitigation measures to be developed and implemented through the MMIA process.

The locations and extent of the AEI in NZ continental waters were determined from DOC's database of marine mammal sightings and strandings, fisheries-related data maintained by Ministry for Primary Industries (MPI) and the National Aquatic Biodiversity Information System (NABIS). Where data was incomplete, technical experts have helped refine the AEI maps where data was absent or incomplete.

Within the Code of Conduct it states that under normal circumstances a MSS will not be planned in any sensitive ecologically important areas or during key biological periods where Species of Concern are likely to be feeding or migrating, calving, resting, feeding or migrating, or where risks are particularly evident such as in confined waters. The ECPB Operational Area is located within an AEI, as shown in Figure 29.

Schlumberger lodged a work commitment to the NZ Government as part of their PPP application that they can undertake a 2D MSS in the ECPB that will meet the requirements stipulated within the petroleum regulations and more specifically PPP 56061; this provides Schlumberger with non-exclusive rights of the PPP for a duration of six months. The timing of the ECPB 2D MSS is scheduled to coincide with vessel availability. Settled weather will help enable the ECPB 2D MSS to be undertaken in the shortest possible timeframe; this will help reduce any excess noise being emitted to the marine environment for a longer period due to weather delays. There is a considerable expense to mobilise a specialist seismic vessel like the *Aquila Explorer* to NZ waters; therefore Schlumberger have contracted the *Aquila Explorer* which is currently in NZ. It is also noted that information gathered from the MMO reports following the completion of the ECPB MSS will provide a greater awareness and knowledge of marine mammals to be present on the east coast of NZ, in which there have been no recorded marine mammal sightings on the DOC database (Figure 24).

2.5 Marine Mammal Sanctuaries

There are six gazetted Marine Mammal Sanctuaries (MMS) around NZ that were implemented to protect marine mammals from harmful human impacts, particularly in vulnerable areas such as breeding grounds or migratory routes. However, the most important aspect of a MMS is the presence of the general habitat of an endangered species, namely Hectors and Maui's dolphins. All MMS are administered and managed by DOC in accordance with the Marine Mammals Protection Act 1978, Marine Mammals Protection Regulations 1992 and in line with Conservation General Policy. A MMS does not exclude all fishing or seabed mining activities; however a MMS places restrictions on seismic surveys to prevent and minimise disturbance of marine mammals the MMS were gazetted to protect.

The closest MMS to the ECPB Operational Area is the Clifford and Cloudy Bay MMS which was gazetted in 2008. The Clifford and Cloudy Bay MMS extends from Cape Campbell eastwards to a point 12 Nm offshore and then in a direct line to West Head, Tory Channel entrance (Figure 27) protecting an approximate area of 142,716 hectares, covering 338 km of coastline. As stated above there are restrictions in place for seismic surveys within a MMS, however, they can still be undertaken as long as they are undertaken in accordance with the Marine Mammals Protection (Clifford and Cloudy Bay Sanctuary) Notice 2008. The Clifford and Cloudy Bay MMS was gazetted to protect Hector's dolphins, as the area supports the largest population of Hector's dolphins in the Nelson/Marlborough region. Humpback whales and southern right whales migrate through the area, while orca and bottlenose dolphins are occasional visitors. In the early-mid 1800s, Cloudy Bay was once the centre of whaling for southern right whales from the shore, as Cloudy Bay has historically been an important calving area.

The ECPB Operational Area is located 120 km to the east of the Clifford and Cloudy Bay MMS.

3 Project Description

3.1 Marine Seismic Surveys

The basic principle behind a MSS is that an energy source (i.e. acoustic source), instantaneously releases compressed air, releasing a directionally focused acoustic wave at low frequency that travels several kilometres through the earth. As the acoustic wave travels through the earth, portions are reflected by the underlying rock layers and the reflected energy is recorded by receivers (hydrophones) deployed in streamers. Depths and spatial extent of the strata can be calculated and mapped, based on the difference between the time of the energy being generated and subsequently recorded by the receivers.

The details of a specific MSS can vary enormously, however there are two principle categories of MSS; 2D and 3D and the complexity between the two varies greatly. A 2D MSS can be described as a fairly basic survey method which involves a single source and a single streamer towed behind the seismic vessel (Figure 2). However although the MSS is simplistic in its underlying assumptions, it has been and still is today used very effectively to discover oil and gas reservoir's. Using this method the reflections from the subsurface are assumed to lie directly below the sail line that the seismic vessel traverses. Sail lines are generally acquired several kilometres apart, on a broad grid over a large area. This methodology is generally used for frontier exploration areas to produce a general understanding of the regional geological structure and to identify more prospective areas which can be comprehensively examined through a 3D MSS.

Whereas a 3D MSS is a more complex method and involves a greater investment and much more sophisticated equipment compared to a 2D MSS. The purpose of a 3D MSS is to focus on a specific area over known geological targets considered likely to contain hydrocarbons, generally discovered by a previous 2D MSS. Extensive planning is undertaken to ensure the survey area is precisely defined and the direction of the survey lines are calculated to ensure the best results are obtained of the underlying geology in the received seismic images for interpretation. A sail line separation within the survey area for 3D surveys is normally 200 – 400 m apart, often with two acoustic sources and up to 10 streamers, typically 100 m apart, producing a three-dimensional image of the subsurface (Figure 2).

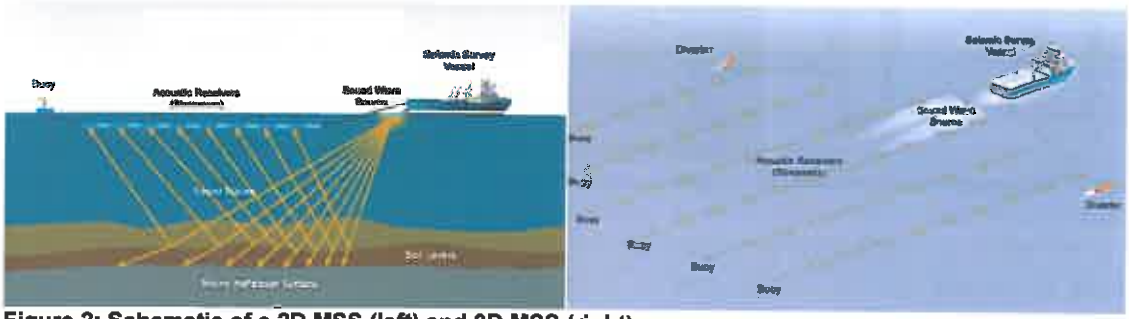

Figure 2: Schematic of a 2D MSS (left) and 3D MSS (right)

The acoustic source comprises of two high pressure chambers; an upper control chamber and a discharge chamber (Figure 3). High pressure air (~2,000 psi) from compressors onboard the seismic vessel is continuously fed to the acoustic sources towed behind the vessel via an air hose. This forces the piston downwards, and the chambers fill with high-pressure air while the piston remains in the closed position (Figure 3).

The acoustic source is activated by sending an electrical pulse to the solenoid valve which opens, and the piston is forced upwards, allowing the high pressure air in the lower chamber to discharge to the surrounding water through the airports. The air from these ports forms a bubble, which oscillates according to the operating pressure, the depth of operation, the temperature and the volume of air vented into the water. Following this release the piston is forced back down to its original position by the high-pressure air in the control chamber, so

that once the discharge chamber is fully charged with high-pressure air, the acoustic source can be released again. The compressors are capable of recharging the acoustic source rapidly and continuously which enables the acoustic source arrays to be fired every 10 – 11.5 seconds during seismic acquisition.

Acoustic source arrays are designed so that they direct most of the sound energy vertically downwards (Figure 3) although there is some residual energy which will dissipate horizontally into the water. The amplitude of sound waves generally declines with distance from the acoustic source, where the weakening of the signal with distance (attenuation), is frequency dependent, with stronger attenuation at higher frequencies. In practice, 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.

Typical source outputs used in MSS operations will emit ~220 – 250 dB when measured relative to a reference pressure of one micropascal (re 1µPa/m) (IAGC, 2002). However, this does depend on how many acoustic sources are fired together; generally they are activated alternatively. To place this in perspective, low level background noise in coastal regions with little wind and gentle wave action is ~ 60 dB re 1µPa/m, while in adverse weather conditions, the background noise increases to 90 dB re 1µPa/m (Bendell, 2011).

The sound frequencies emitted from the acoustic source are broad band, where most of the energy is concentrated in the 10 – 250 Hz with lower levels in the 200 – 1,000 Hz range although the largest amplitudes are usually generated in the 20 – 100 Hz frequency band.

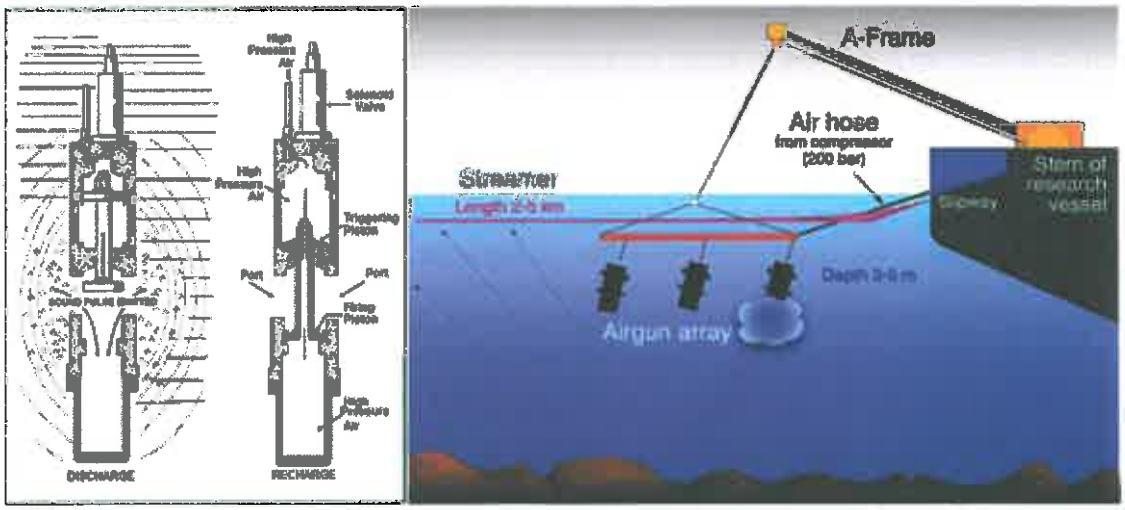

Figure 3: Schematic cross section of a typical acoustic source and a sub-surface multi acoustic source array

For a 2D MSS one streamer is towed behind the seismic vessel, whereas for a 3D MSS multiple streamers can be towed, and all streamers can be influenced by wind, tides and currents, causing feathering, or the streamers being towed in an arc offset from the nominal sail line. When the acoustic source is released the streamers detect the very low level of reflection energy that is reflected back up from the geological structures below the seabed using pressure sensitive devices called hydrophones. Hydrophones convert the reflected pressure signals into electrical energy that is digitised and transmitted along the streamer to the recording system onboard the seismic vessel.

Each streamer is divided into sections, 50 – 100 m in length to allow for modular replacement of damaged components. Solid streamers are more often used now, and are constructed of extruded foam to make them neutrally buoyant. The generation of solid streamers has many advantages over the older fluid filled streamers, where they are: more robust and resistant to damage (i.e. shark bites); are less sensitive to weather and wave noise (provides higher quality seismic images); require less frequent repairs; and the modern streamers are

steerable allowing greater control of the streamers, resulting in less infill lines, reducing the cumulative sound energy introduced into the marine environment.

Towing the streamers underwater removes the streamers from the surface weather and noise which limits the usability of the recorded data and other technical requirements. The deeper the tow depth, the quieter the streamer in regards to weather and surface noise, but this also results in a narrower bandwidth of the data. Typically the range of operating depths varies from 4 – 5 m for shallow high resolution surveys in relatively good weather to 8 – 12 m for deeper penetration and lower frequency targets in more open waters.

At the end of each streamer, a tail buoy is connected to provide both a hazard warning (lights and radar reflector) of the submerged towed streamer between the tail buoy and vessel, and to act as a platform for positional systems of each streamer (Figure 4). During the ECPB 2D MSS, the *Aquila Explorer* will be travelling at 4.5 kts so the streamer tail buoy will be travelling approximately one hour behind the vessel.

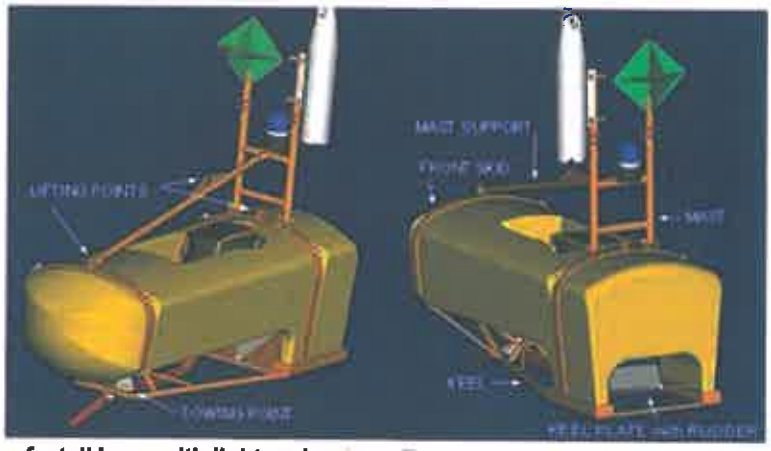

Figure 4: Example of a tail buoy with light and radar reflector

3.2 ECPB 2D Marine Seismic Survey

The ECPB 2D MSS will use the seismic vessel *Aquila Explorer* and will tow one solid streamer, 8 km in length which will be at a depth of 8 m at the front and slanted down to 30 m at the end of the streamer. The acoustic source will have an effective volume of 6,300 in^3 and will be comprised of four subarrays with 11 acoustic sources on the two outside subarrays and 9 acoustic sources on the inside two, located at a depth of 10 m below the sea surface and approximately 130 m behind the survey vessel. The depth of the subarrays will ensure the volume used enables the survey to be run effectively in regards to data acquisition, but also to minimise the potential environmental disturbance. In the case of dropouts during acquisition, the gun array may operate at a slightly lower capacity for a short period of time. STLM, as required when operating a MSS in an AEI, was conducted by Curtin University and was based on the specific acoustic source volume and operating pressure of the ECPB 2D MSS outlined within this MMIA. The STLM is further discussed in Section 5.1.2.1 and is attached in Appendix 5.

The acoustic source will have an operating pressure of 2,000 psi and fired at a sourcepoint interval of 25 m apart, where for a typical boat speed of 4.2 – 4.5 knots (kts), relates to a sourcepoint activation every 11 – 11.5 seconds.

The ECPB 2D Survey Area is located within PPP 56061, although the Operational Area does extend beyond this permit area (Figure 1). Schlumberger are planning to acquire the MSS in early April 2014 depending on vessel availability and is scheduled to take approximately 40-50 days. MSS operations will be conducted 24 hours per day, 7 days per week, subject to suitable weather conditions and marine mammal encounters within the mitigation zones.

The technical specifications of the *Aquila Explorer* are provided in Table 1. One support vessel (*Amaltal Mariner)*, Figure 6) will be contracted for the duration of the MSS and will be in close proximity to the *Aquila Explorer* at all times except when the support vessel has to go into port for supplies.

There are four main components involved with the acquisition of the ECPB 2D MSS:

- **Mobilisation of *Aquila Explorer* to ECPB Operational Area:** After the *Aquila Explorer* has completed its prior work commitments, it will mobilise to the ECPB Operational Area. The *Amaltal Mariner* will accompany the *Aquila Explorer* at all times during the passage to the ECPB Operational Area. During transit to the ECPB Operational Area, a MMO will be on the bridge to observe for any marine mammals that would add to the knowledge and distribution of marine mammals around NZ (Section 5.3.2.2);
- **Deployment of Streamer:** The *Aquila Explorer* will utilise the wind and currents present at the time for the successful deployment of the streamer and acoustic source and will take approximately 18 hours to deploy. Once all the seismic gear is deployed the MMO's will begin pre-start observations as required under the Code of Conduct when arriving at a new location (Section 2.3.1.2). Once these procedures have been followed and adhered to, a soft start can begin for commencement of the ECPB 2D MSS;
- **Data Acquisition:** The *Aquila Explorer* will follow predetermined survey lines which have been calculated to get the best images from the data and provide greater interpretation of the underlying geology. The four MMOs on board will monitor for marine mammals throughout the 24 hour period for the duration of the MSS to ensure compliance with a Level 1 survey under the Code of Conduct. Continuous acquisition through the line turns will be utilised for the ECPB 2D MSS. The seismic data acquired through the turns has proven to be valuable data from previous MSS's Schlumberger have undertaken. If the source is kept active during line turns, it will remove the requirement of pre-observations and soft starts before commencing each new survey line, reducing the duration of the ECPB MSS; and
- **Demobilisation:** Once the *Aquila Explorer* has completed the ECPB 2D MSS the seismic array will be retrieved and the vessel will mobilise to its next destination.

If the vessel has to go on standby during the MSS due to certain adverse weather conditions, it is likely that the acoustic source array would be retrieved to reduce any potential damage, while the streamer may be left deployed.

Figure 5: Seismic Survey Vessel – *Aquila Explorer*

Figure 6: Seismic Support Vessel – *Amaltal Mariner*

Table 1: *Aquila Explorer* Technical Specifications

Seismic Survey Vessel – General Specifications	
Vessel Name	*Aquila Explorer*
Vessel Owner	Aquila Explorer Inc.
Engine Details	2 x MAK 6M AK 1770 KW
Fuel Capacity	1,254 m^3
Seismic Survey Vessel – Dimensions and capacities	
Vessel Length	71 m
Vessel Beam	17.5 m
Max Draft	5.45 m
Gross Tonnage	3,057 t
Cruising Speed	11 knots

Table 2: ECPB 2D Seismic Specifications

Parameter	**Specifications**
Total array volume	6,300 in^3
Acoustic Source	Bolt 1900 LLXT
Number of sub-arrays	4
Number of acoustic sources per sub-array	11
Array length	14 m
Array width	30 m
Nominal operating pressure	2,000 psi
Source Frequency	2 - 250 Hz
Tow depth	10 m (+/- 1m)
Distance from the stern	130 m
Number of streamers	1
Streamer length	8 km
Streamer manufacturer/model	Sercel Seal
Towing depth	8 m slanted down to 30 m at end

3.3 Navigational Safety

During the ECPB 2D MSS, the *Aquila Explorer* will be towing one streamer of 8 km in length and in doing so will be 'restricted in its ability to manoeuvre'. At the operational speed while acquiring seismic data of ~4.5 kts the vessel cannot turn quickly so avoidance of collision relies on all vessels obeying the rules of the road at sea and the International Regulations for the Prevention of Collisions at Sea (COLREGS) 1972 which is implemented in NZ under the Maritime Transport Act regime. A Notice to Mariners will be issued and will be broadcast daily on maritime radio advising of the ECPB Operational Area and the presence of the *Aquila Explorer* and her restriction in ability to manoeuvre while towing the MSS array. The *Aquila Explorer* has Automatic Identification System (AIS) technology onboard that allows its

position to be monitored by other vessels as well as being able to receive the positions of other vessels in surrounding waters to help minimise any risk of collision.

The consultation process has identified all potential users of that area of ocean, while the presence of the support and chase vessels will be utilised to notify any boats that are unaware of the seismic operations or those vessels that cannot be reached via VHF radio. In accordance with International Maritime Law the *Aquila Explorer* will display the appropriate lights and day shapes while undertaking the survey; mainly being restricted in its ability to manoeuvre and towing an array of gear behind the boat. A tail buoy will mark the end of the streamer and has a light and radar reflector for detection both during the day and night.

3.4 Analysis of Alternatives

Most seismic surveys conducted throughout the world these days use acoustic sources, as they generate low frequency signal which can image the underlying geology several kilometres below the seafloor. Each component of the ECPB 2D MSS has the requirement to not only gather the best information of the underlying geology and hydrocarbon potential within the ECPB Survey Area but to also reduce any adverse effects on the marine environment to the fullest extent practicable.

Schlumberger will use a 'bolt acoustic source' for the ECPB 2D MSS, with the acoustic source consisting of four sub arrays. The energy source and acoustic source array configuration was selected so that it provides sufficient seismic energy to acquire the geological objective of the survey, whilst minimising the environmental disturbance through limiting excess noise to the environment.

As part of the ECPB 2D MSS design, Schlumberger performed modelling to identify the source size necessary to adequately record data from a pre-determined depth. A source volume of 6300 in^3 was identified as an optimum volume necessary given the water depths (Figure 12) and geology for the survey to achieve its objectives. The larger source volumes available onboard the *Aquila Explorer* (6,620 in^3 and 6,900 in^3) were therefore not selected in the interest of minimising unnecessary acoustic noise being released into the marine environment.

The acquisition period for the ECPB 2D MSS will utilise the end of the settled summer period and start of autumn to reduce weather-induced down-time to ensure that the survey duration is as short as possible. With the current MSS schedule the survey will be completed prior to the northwards migrating humpback whales through the Cook Strait, where the DOC Cook Strait monitoring project is undertaken in June-July to coincide with the peak of the migration to the South Pacific feeding grounds.

Schlumberger have a work programme commitment for PPP 56061 that has been agreed with NZP&M to provide a general understanding of the regional geological structure and to identify more prospective areas which can be more comprehensively examined and potential areas that can be released as part of the block offer process; of which 2D seismic data acquisition is required. As a result there is no 'do nothing' option in regards to a 2D seismic survey.

4 Environmental Description

4.1 Physical Environment

4.1.1 Meteorology

Anticyclones are a major feature of the weather in the Australian-NZ region and migrate eastwards every six to seven days across NZ, where the centres generally pass across the North Island; northerly paths are followed during spring and southerly paths during autumn and winter. These synoptic systems are capable of strong meridional (winds cross the latitude lines at a sharp angle) and zonal (winds are parallel to the lines of latitude) wind events along their peripheries (Dunn, 2010). Slow moving anticyclones to the east of NZ are most abundant during autumn and winter.

Troughs of low pressure are between the anticyclones with cold fronts associated, orientated northwest to southeast. As these cold fronts arrive from the west, northwesterly winds become stronger and cloud levels increase, followed by a period of rain for several hours as the front passes over. After the front has gone through there is a change to cold showery southwest winds.

The east coast region has a prevailing westerly wind which is sheltered by the high country to the west, with this stretch of coastline enjoying a dry, sunny climate with warm dry settled weather predominating over summer months. To the north of this region winter is mild, while in the south winter is often cooler. Typical winter daytime maximum air temperatures range from 10°C to 16°C, while typical summer daytime maximum temperatures range from 20°C to 28°C (NIWA, 2014).

Weather conditions from Wellington have been used as indicative for the ECPB Operational Area, with mean monthly weather parameters at Wellington shown in Table 3.

Table 3: Mean Monthly weather parameters at Wellington

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	23	16	23	32	40	39	28	33	23	47	34	25
Temp – avg. daytime (°C)	20	21	20	17	15	12	12	13	14	16	17	19
Temp – avg. night time (°C)	15	16	14	12	10	8	7	8	9	11	11	13
Avg. wind speed (kts)	15	13	13	13	13	14	13	13	14	15	15	15
Max. wind speed (kts)	51	47	45	50	46	47	43	48	42	50	43	48

(Source: Weather 2, 2014)

4.1.2 Coastal Storms

A regional database for the coastal storm activity along the eastern North Island between East Cape and Wellington between 1930 and 2005 has been compiled by utilising cyclone tracks, extreme winds and hindcast wave information for this stretch of coastline (Dunn, 2010). Coastal storms were identified by periods of wind ≥ 10.5 m/s (~20 kts) and any conditions that led to coastal shipping disruptions/delays, large waves along the coastline, coastal erosion and strong onshore wind periods. The damage potential of these storm events is primarily related to extreme wind speeds and then further compounded by the associated wind-driven oceanographic conditions of large waves, surge effects, and elevated tidal levels.

The two most dominant types of storm types along the east coast consisted of trough/ridges and east coast lows which involved weather systems from the Southern Ocean and large cyclones off the coast that were distantly generated (from Tasman Sea or subtropics) or locally generated around NZ from Southern Ocean troughs respectively. The most intense

storms are east coast lows which involve cyclones from the subtropics with blocking-type anticyclones east of the Chatham Islands which steer the cyclones south towards NZ and then block any eastward movements so that cyclones become slow-moving and increase the pressure gradients off the east coast (Dunn, 2010).

For a 44 year (1962-2005) period off the Wellington coastline there were 392 coastal storms with an annual average of 9 coastal storms with peak storm activity occurring in June and May-August. Of which 70% of these coastal storms persisted for up to two days duration and were predominantly from the south and southwest.

Whereas for the Gisborne/Hawke's Bay region 92 storms were recorded over a 30 year period (1962-1991) producing an annual average of 3 coastal storms with peak storm events during April-July, but the highest frequencies were in September (Dunn, 2010), however all storms had a duration of less than two days. Predominant wind direction was from the south and southeast (~80% of all storm events).

Strong cyclonic systems in the southwest Pacific cluster in the central Tasman Sea and east of the Chatham Islands in all seasons but are most frequent in winter. These storm events that occur during the winter months are the reason that most MSS's in NZ are planned and scheduled for the summer months when more settled weather is generally present.

4.1.3 Wind Climate

In Dunn (2010) a summary of hourly wind data (in percentages) per wind direction and speed was produced from wind readings recorded at the Wellington Airport (Table 4) and from Gisborne Airport (Table 5). These results show that the two prevalent wind directions are from the north and south and these directions also result in the strongest wind speed as well.

Table 4: Hourly wind data summary for Wellington Airport (1962-2005)

	Wind Direction							
Speed (m/s)	**SW**	**S**	**SE**	**E**	**NE**	**N**	**NW**	**W**
0.5 – 2.4	0.3	0.9	0.4	0.3	1.8	1.5	0.1	0.1
2.5 – 4.9	1.5	5.0	1.0	0.4	3.4	6.4	0.3	0.2
5 – 8.4	1.3	10.7	1.0	0.1	3.8	17.3	0.6	0.1
8.5 – 10.4	0.2	4.6	0.2	-	0.6	10.3	0.3	-
10.5 – 14.4	0.3	5.7	0.1	-	0.2	11.3	0.4	-
>14.5	0.5	3.3	-	-	-	3.1	0.1	-
Total	**4%**	**30%**	**3%**	**1%**	**10%**	**50%**	**2%**	**0%**

Table 5: Hourly wind data summary for Gisborne Airport (1962-1991)

	Wind Direction							
Speed (m/s)	**SW**	**S**	**SE**	**E**	**NE**	**N**	**NW**	**W**
0.5 – 2.4	0.8	0.9	1.1	1.2	0.7	6.5	6.5	1.9
2.5 – 4.9	2.6	2.9	4.2	2.3	1.4	8.2	16.7	3.1
5 – 8.4	2.7	5.2	4.5	2.0	1.2	5.1	11.0	1.5
8.5 – 10.4	0.5	1.5	0.4	0.2	0.1	0.6	2.7	0.4
10.5 – 14.4	0.1	0.7	0.1	0.1	-	0.2	1.0	0.2
>14.5	-	0.1	-	-	-	-	0.1	-
Total	**4%**	**30%**	**3%**	**1%**	**10%**	**50%**	**2%**	**0%**

Dunn (2010) classified a coastal storm as a weather event with a wind speed ≥10.5 m/s. A comparison was made between the Wellington and Gisborne wind readings (**Error! Reference source not found.** & **Error! Reference source not found.**) and showed that Wellington has wind speeds (across all sectors) ≥10.5 m/s for 25% of the time, whereas Gisborne winds only fulfil the same weather conditions for 3.5% of the time. Therefore a significantly higher magnitude of winds are present in Wellington (southern end of ECPB Operational Area compared to Gisborne (northern end of ECPB Operational Area).

MeteoGroup Offshore provided a modelling analysis for two geographic distinct locations within PPP 56061 (Figure 7). These two locations were modelled for wind, waves and currents.

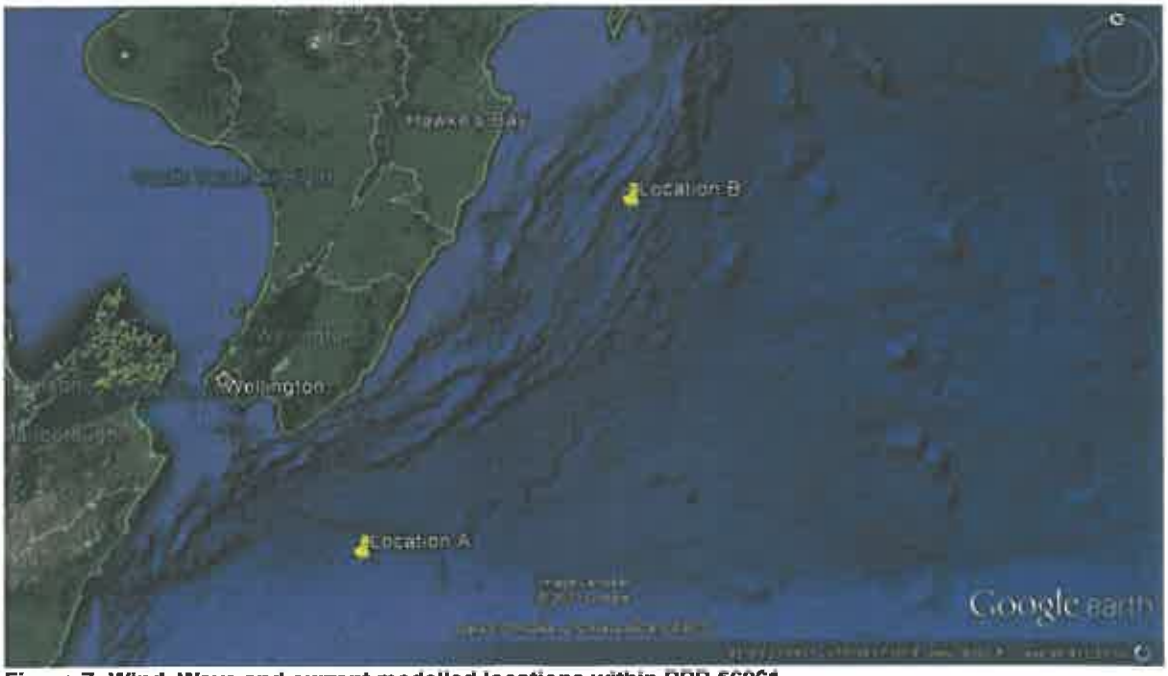

Figure 7: Wind, Wave and current modelled locations within PPP 56061

From the modelling results there are two different weather patterns over the length of PPP 56061. At the southern site (Location A) the predominant wind direction is from the northwest and the strongest wind is also from the northwest and to a lesser extent, southwest (Figure 8). This wind direction is due to the funnelling nature of Cook Strait where the winds seem to be drawn through between the North and South Island.

At the northern site (Location B) the predominant wind is from the north-northeast and the southwest quarter, while the strongest wind comes from the southwest quarter (Figure 9).

For both locations the windiest months are June-July.

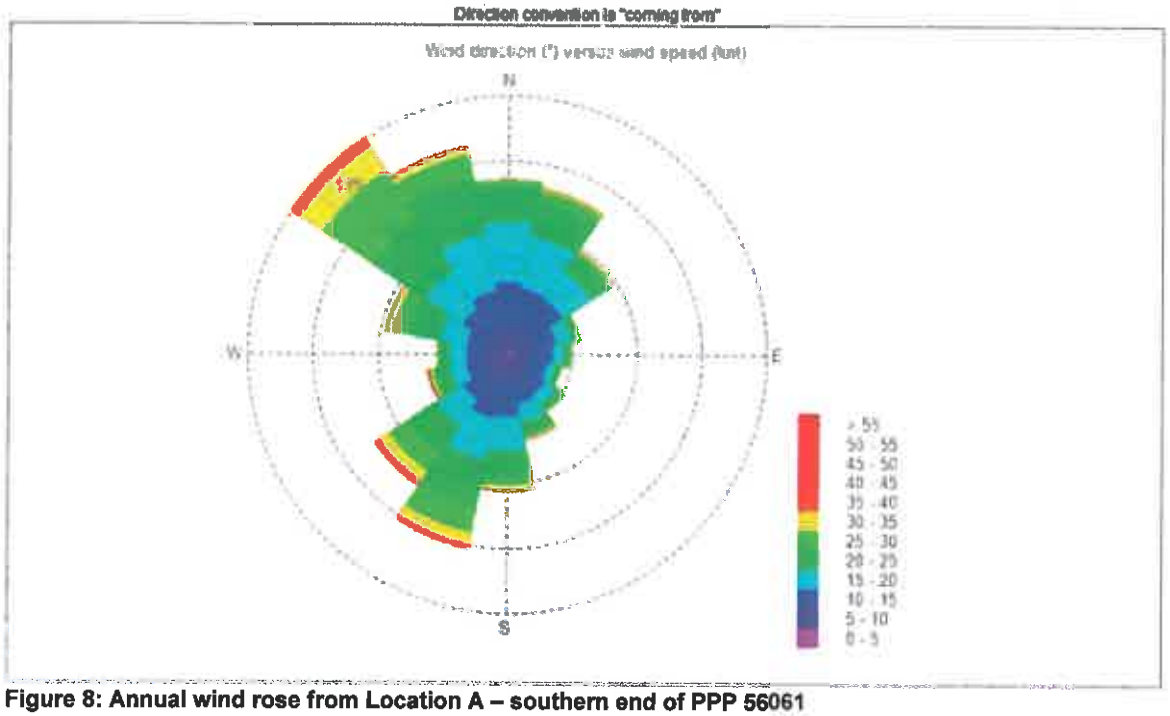

Figure 8: Annual wind rose from Location A – southern end of PPP 56061

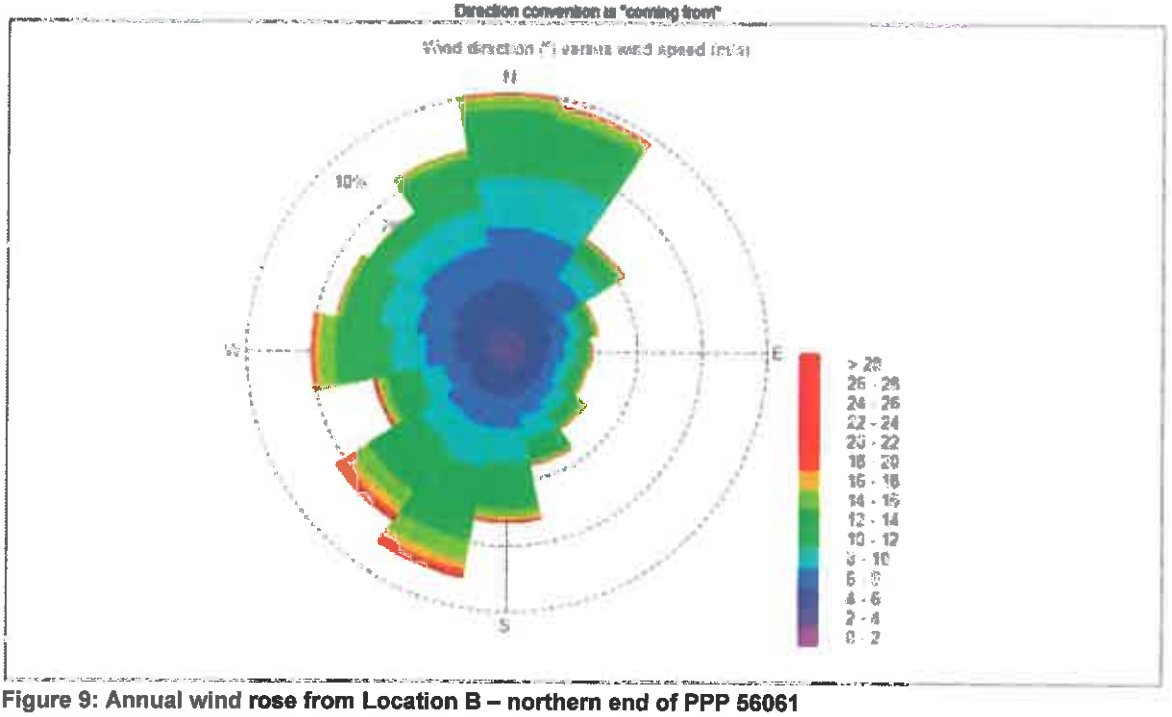

Figure 9: Annual wind rose from Location B – northern end of PPP 56061

4.1.4 Wave Climate

The deep-water wave climate off the eastern North Island is dominated by waves from the south (Dunn, 2010). Approximately 9-13 large wave events occur each year between East Cape and Wellington and most likely occur in the months May-July. The east coast between East Cape and Wellington is the most exposed with large deep-water waves (≥ 3 m) coming from the northeast through to the southwest (Dunn, 2010). However, waves from the south and southwest are the largest and most persistent and are derived from southern ocean troughs whereas the less frequent waves from the easterly quarter involve low pressure systems east or northeast of NZ.

The Hawkes Bay Regional Council monitor for coastal erosion along their coastline and part of this, monitoring data is recorded from a wave buoy situated approximately 2.3 Nm northeast of Port of Napier. Between January 2005-2011 the maximum wave height reached over 6 m on eight occasions, two of which were in August and November 2011, with the largest wave being recorded at 8.21 m (HBRC, 2011).

NIWA completed a number of numerical model simulations for larval dispersal around the Te Angiangi Marine Reserve (Figure 31) in the Hawkes Bay (Oldman *et al.*, 2006), and as part of this NIWA hindcasted the generation and propagation of deep-water waves over a 20 year period (1979-2008) using wind data from the European Centre for Medium Range Weather Forecasting. The modelled location is in the middle of the ECPB Operational Area offshore from Porangahau.

The model showed that the mean significant wave height was 1.9 m, with a mean wave approach direction from 170° and had a mean wave period of 6.9 seconds, with 70% of all waves approaching from east-southeast through to south-southwest (Oldman, *et al.*, 2006).

MeteoGroup Offshore provided an annual wave rose climate for Location A and B in the north and south of PPP 56061. The predominant wave direction is from the south-southwest quarter for both modelled locations. At the southern Location A, majority of the waves come from the south-southwest with 0.3% of the waves throughout the year being over 6 m (Figure 10). There is also a small peak of waves which arrive from the northwest quarter, which reflects the wind rose in (Figure 8) and the influence of the Cook Strait.

At the northern Location B the predominant wave direction is from the south which reflects the modelled location in reference to the NZ coastline (Figure 11). A smaller proportion of waves also arrive from the eastern quarter. For this modelled location it was shown that 0.3% of the waves throughout the year are larger than 6 m.

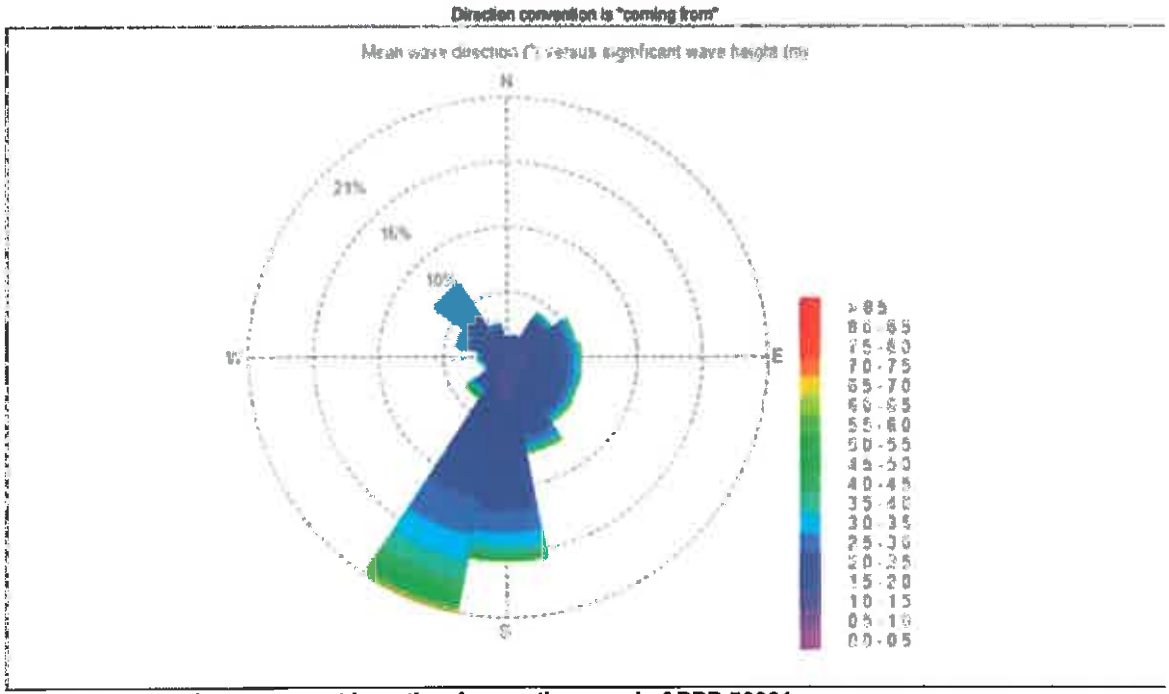

Figure 10: Annual wave rose at Location A – southern end of PPP 56061

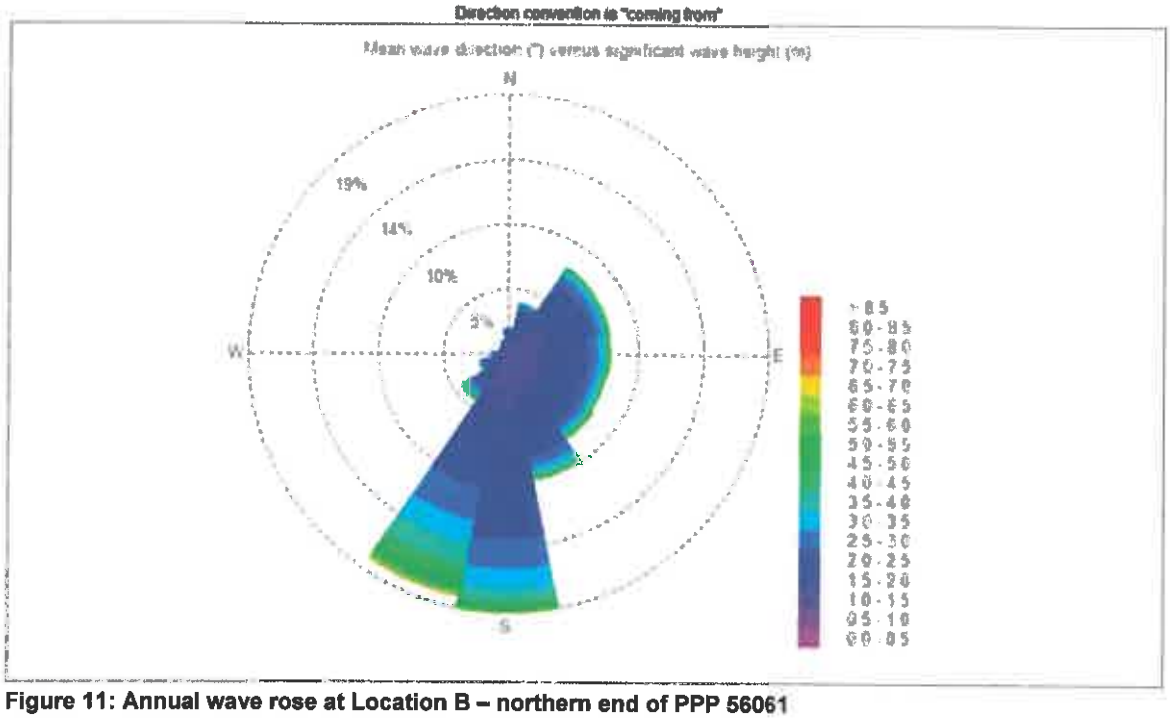

Figure 11: Annual wave rose at Location B – northern end of PPP 56061

4.1.5 Bathymetry

Each major land mass is surrounded by a flat, gently sloping zone known as the Continental Shelf which extends from the coast out to a water depth of approximately 100 – 200 m. Beyond the Continental Shelf, the slope of the seabed steepens and passes into the Continental Slope which descends relatively rapidly from the edge of the shelf down to depths greater than 4,000 m. At the foot of the Continental Slope, the seaward gradient flattens out into the Ocean Basin which is a wide undulating but relatively flat zone lying at the 4,000 to 5,000 m and covers most of the central parts of the major oceans (Te Ara, 2014a).

The surface of the Continental Shelf is predominantly flat although diversified by local banks and reefs, whereas the slope is more irregular, being cut in many areas by the large marine valleys known as submarine canyons. These tend to occur in slope areas of relatively steep gradient and generally run from the edge of the Continental Shelf to the foot of the Continental Slope.

The NZ coastline's Continental Shelf varies in width from one area to another; where the narrowest parts are found off the east coast of NZ between Kaikoura and Cape Kidnappers with a width that varies between 1 – 15 Nm. This section of coastline includes the inshore region of the ECPB Operational Area. Whereas other parts of NZ have a more extensive Continental Shelf that can be up to 40 Nm wide, with the western Cook Strait and south of Stewart Island having a Continental Shelf which extends to over 100 Nm (Te Ara, 2014a).

The gradient of the Continental Slope varies a lot around NZ, although there is a broad correlation between steepness of the Continental Slope and the narrowness of the Continental Shelf. Around NZ most of the Continental Slope is relatively gentle, however off the east coast between Kaikoura and East Cape the Continental Slope is relatively steep. Although in this stretch of Continental Slope there are a number of submarine ridges and basins which locally reverse the general gradient (Te Ara, 2014a).

Several submarine canyons cut the Continental Slope between Banks Peninsula and East Cape; the largest being Pegasus Canyon (north of Banks Peninsula), the Cook Strait Canyon and the Madden Canyon off Porangahau, Hawke's Bay. The Cook Strait canyon has an

unusual shape compared to most other submarine canyons around the world as it has numerous branches and other irregularities, while the Madden Canyon has a great headward expansion.

Between Kaikoura and East Cape, the Continental Slope flattens at 3,000 – 4,000 m into the Hikurangi Trench, a feature of low relief which is replaced by the much deeper Kermadec Trench to the northeast (Te Ara, 2014a).

The extensive bathymetry surrounding the ECPB Operational Area is shown in (Figure 12) with the inside portion of the ECPB generally running parallel with the top of the Continental Shelf. The Hikurangi trough and the resulting Hikurangi channel extend over the length of the ECPB Operational Area, while the Madden Canyon is in the northwest section of the ECPB Operational Area, offshore from Dannevirke.

Water depths within the ECPB Operational Area range from approximately 100 – 150 m on top of the Continental Shelf, while the deepest parts are in the order of 3,000 m (Figure 12).

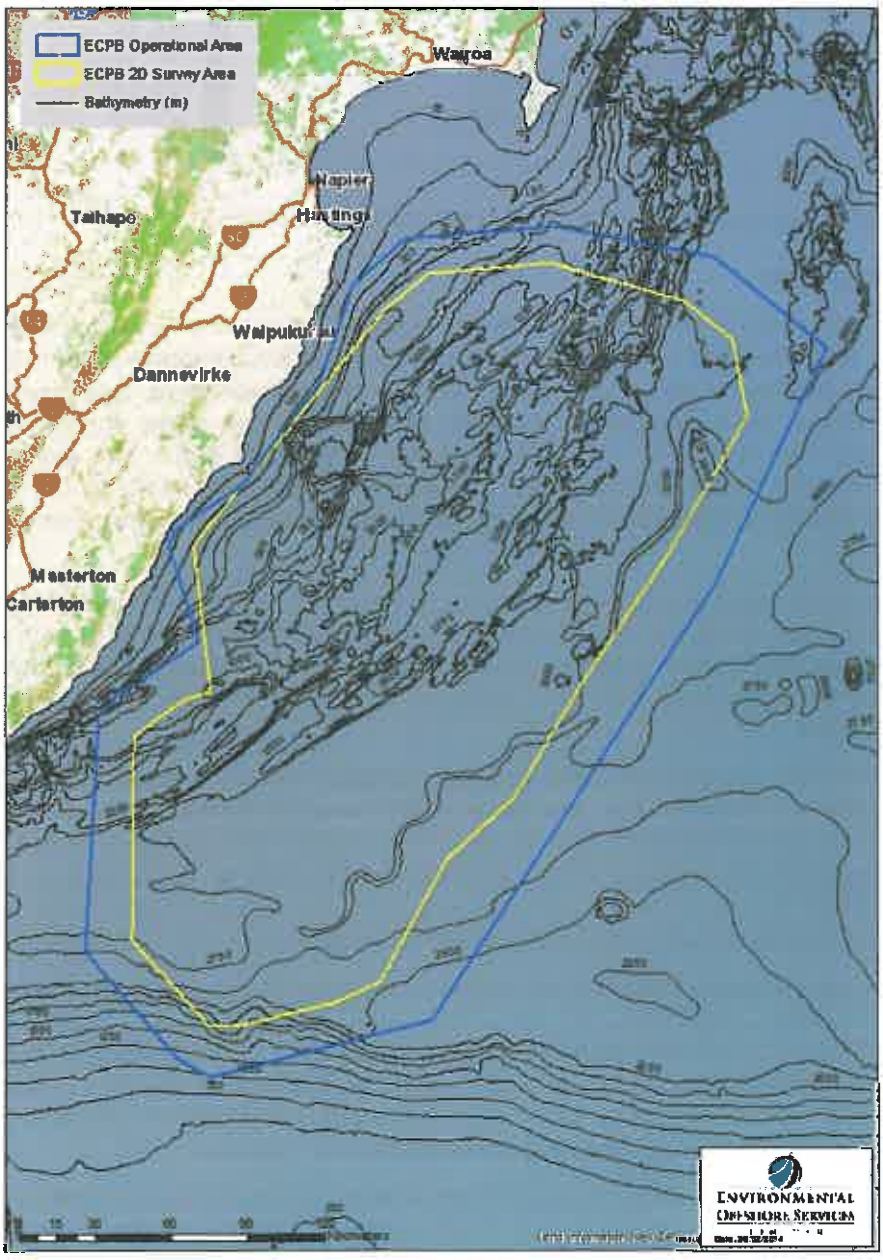

Figure 12: Bathymetry of the ECPB Operational Area

4.1.6 Current Regime

New Zealand lies in the path of eastward-flowing currents, which are driven by winds that blow across the South Pacific Ocean. This results in NZ being exposed to the southern branch of the South Pacific subtropical gyre, driven by the southeast trade winds to the north and the Roaring Forties westerly winds to the south (Gorman *et al.*, 2005). The anti-clockwise circulation of the gyre is initiated by the winds but is then further modified by the spin of the earth (Coriolis Effect).

Around the NZ coastline the current regime is dominated by three different components; wind-driven flows, low-frequency flows and tidal currents. The net current flow is a combination of all three of these components and is often further influenced by the bathymetry relative to the location.

The East Auckland Current (EAUC) has a tropical origin and flows southeast along the northeast coast of the North Island and can travel at up to speeds of 50 cm/s (0.97 kts) (Figure 13). Typical surface temperatures at the EAUC northern reaches is 20 - 22°C in summer and 15 - 16°C in winter (Te Ara, 2014b). Part of the EAUC continues south where it forms the East Cape Current (ECC) and continues south until it encounters the Chatham Rise, where it is forced to flow offshore and eastwards along the rise (Figure 13).

Warm, low-nutrient D'Urville Current (DC) water flows west to east through Cook Strait and mixes with the Southland Current (SC) and upwelling water to form the Wairarapa Counter Current. Inshore of the EAUC, the Wairarapa Coastal Current flows northeast along the Wairarapa coast, bringing relatively cool water to the region. As this current moves north, part of it gets entrained into the ECC, resulting in the Wairarapa Coastal Current unlikely to extend north of Mahia Peninsula. Water temperatures in the Wairarapa Coastal Current are 1 - 2°C lower than in the Marlborough Sounds region and ECC (Chiswell, 2000; Davidson *et al.*, 2011; Te Ara, 2014b).

The ECPB Operational Area is to the east of Cook Strait, which has some of the strongest tidal currents in the world. This is a result of the main lunar tide is out of phase on either side of NZ. High tide arrives on the Pacific Ocean side of the strait five hours before it arrives at the Tasman Sea side – when it is high tide on one side it is nearly low tide on the other. This difference in water level drives very fast tidal currents of up to 1.4 m/s (3 knots) through the Cook Strait and into the Marlborough Sounds (Te Ara, 2014b).

Off the east coast of the North Island residual currents under tides alone are small (<5 cm/s) and are generally to the south along most of the coast (Oldman *et al.*, 2006). Combined forcing by waves, tides, oceanic intrusion and bathymetry result in complex patterns of current flows off the east coast both in the near shore zone as well as in the deeper waters offshore.

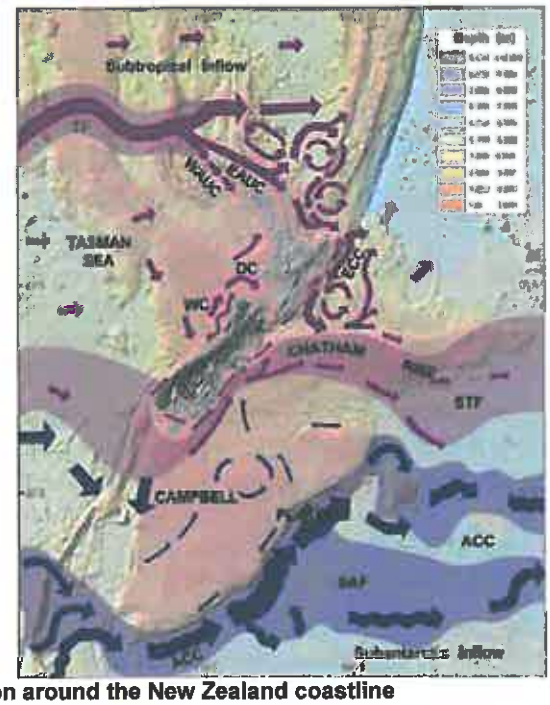

Figure 13: Ocean Circulation around the New Zealand coastline
(Source: http://www.teara.govt.nz/en/map/5912/ocean-currents-around-new-zealand)

MeteoGroup produced current rose climate plots for the two modelled locations in the north and south of PPP 56061, however the modelled current and speeds does not include tide effects. For the modelled Location A in the south of PPP 56061 it can be seen than majority of the currents arrive from the northwest, reflecting the DC moving through the Cook Strait (Figure 14).

In the north of PPP 56061 the predominant current arrives from the northeast quarter which is the ECC moving south (Figure 15).

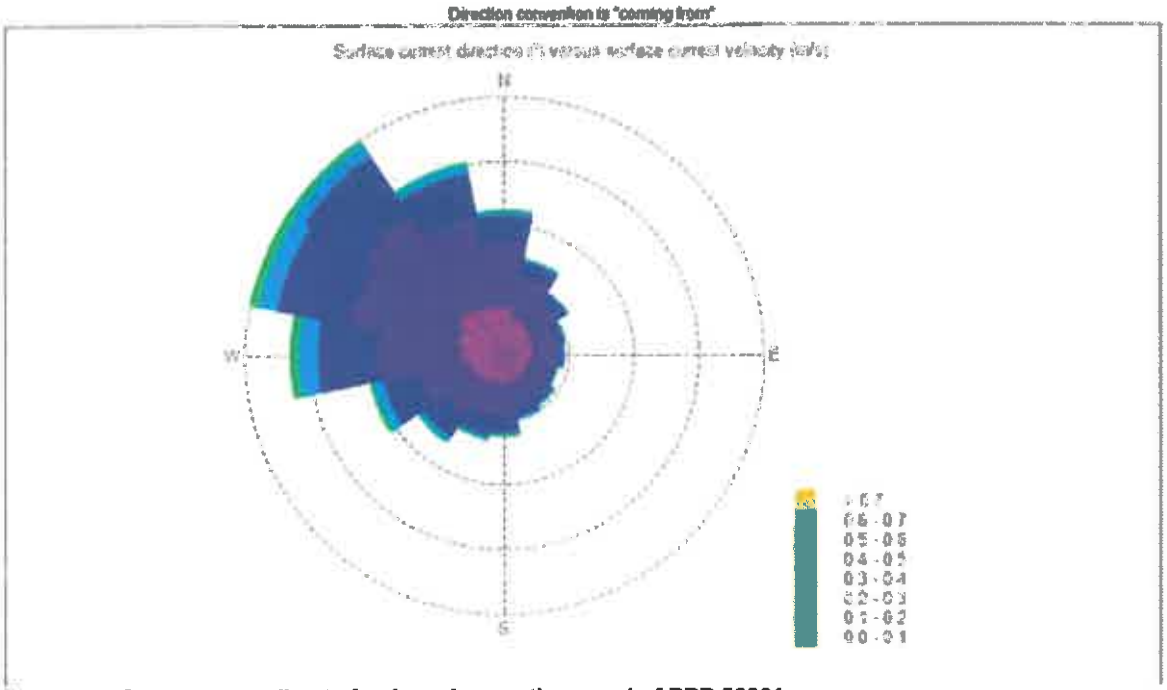

Figure 14: Current rose climate for Area A – southern end of PPP 56061

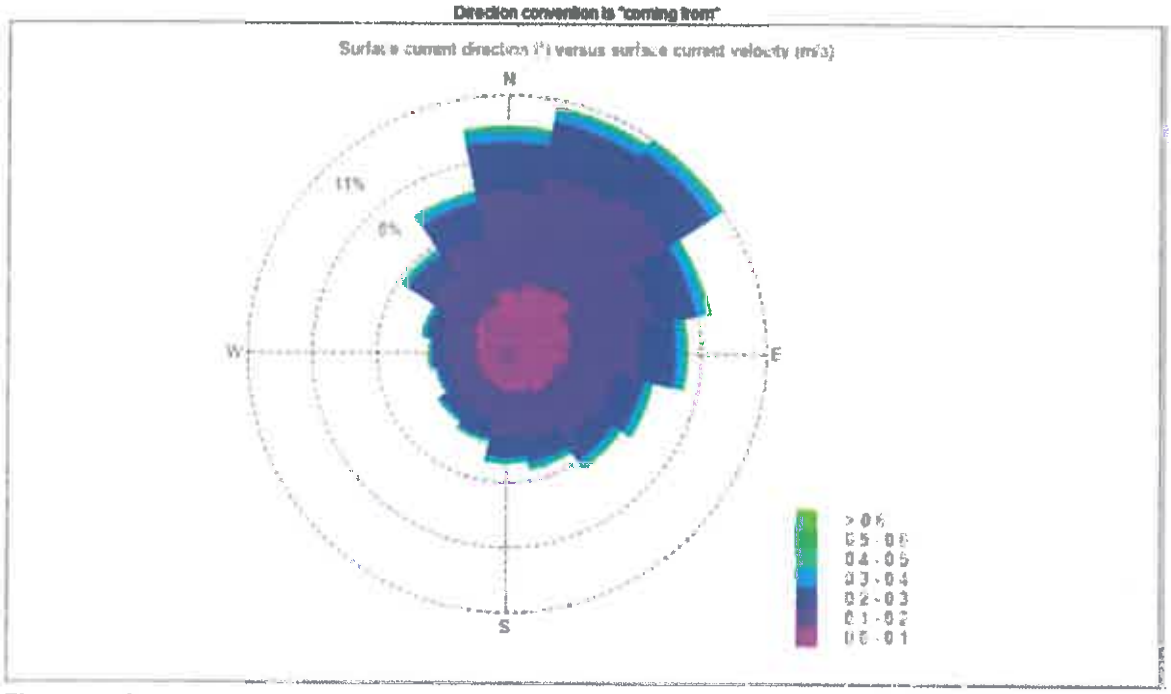

Figure 15: Current rose climate for Area B – northern end of PPP 56061

4.1.7 Thermoclines and Sea Surface Temperature

During spring and summer thermal stratification of the water column becomes evident as a result of solar heating of the upper water column (i.e. 40 – 50 m below the sea surface). The range and form of the stratification varies with weather conditions, with storm conditions causing significant vertical mixing and breakdown of thermal structure. Likewise the local environmental conditions can also play a part in formation of thermoclines such as tides and currents. As a result a well-defined thermocline is not always present.

Thermoclines can be observed through processed seismic data, where a thermocline can be characterised by a negative sound speed gradient, so the thermocline reflects an acoustic signal off this layer in the ocean. This is a result from a discontinuity in the acoustic impedance of water created by the sudden change in density which is derived from temperature differences. As water temperature decreases with depth, the speed of sound decreases, where a change in temperature of 1°C can result in a change of speed by 3 ms^{-1} (Simmonds *et al.*, 2004).

There is a large range of water temperatures across the ECPB Operational Area throughout the year due to the geographic extent of the ECPB 2D MSS. Annual water temperatures off the Kaikoura coastline range from 8.5°C to 19°C (Marsden, 2007). Annual water temperatures off the coast of Wellington range from 11.1°C to 18.4°C. While off the coast of Napier seawater temperatures peak in February (18 – 20°C) and are at their coldest in August (12 - 14°C).

In the STLM undertaken by Curtin University (Appendix 5) a representative sound velocity profile for the autumn months of the southern hemisphere was used to obtain the best estimate of the environmental conditions at the time of the proposed survey, including the presence of a thermocline. A sound velocity profile was obtained from the nearest grid point of the World Ocean Atlas and the profile clearly shows a mixed layer of almost constant sound speed down to a depth of about 30 m, and below this depth there is a reduction of sound speed with increasing depth which continues to a depth of about 150 m. The profile for deep water contains a duct between 500 m and 2,500 m (Koessler & Duncan, 2014). The sound velocity profile in Koessler & Duncan (2014) includes a mixed layer approximately 50 m thick in which the sound speed increases with depth, under which there is a steep

thermocline in which the sound speed decreases with depth. The mixed layer will tend to trap sound near the surface by refraction and lead to higher levels at long range than would otherwise be the case. Any sound entering the thermocline will be refracted downwards towards the seabed. These effects are included in both the short and long range modelling (Section 5.1.2.1), however refraction is only significant at ranges of more than a few kilometres and would have a negligible effect on the short range modelling results.

4.1.8 Geological Setting

A sedimentary basin is formed by a depression in the earth's crust into which sediments have been deposited over millions of years. Within NZ, the sedimentary basins that are likely to contain oil and gas are young (<80 million years) and most have many faults that offset the rock layers.

NZ's key sedimentary basins started forming after the breakup of Gondwana (~85 million years ago) and the opening of the sea floor in the Tasman Sea. Erosion of land by rivers transported sediments containing organic material into these basins. This resulted in shoreline sands being deposited, followed by marine silts and mud several kilometres thick, which were compacted by the weight of the overlying sediment. Due to being both porous and permeable, they made ideal reservoir rocks, while the impermeable overlying silts, mud and carbonates formed the seals.

There are eight sedimentary basins around NZ (Figure 16); both onshore and underlying the continental shelf, with known or potential hydrocarbons present; however, commercial quantities of oil and gas have only been produced from the Taranaki Basin. In addition there are also several deep-water basins offshore (Figure 16).

The NZ sedimentary basins can be subdivided into 'Petroleum Basins' and 'Frontier Basins', where the petroleum basins are based on modern, industry-standard seismic surveys over at least a part of each basin or from well logs. As a result, all or part of each petroleum basin has been licenced for exploration.

Basin boundaries are mainly determined by major geological structures or seafloor physiography, i.e. regions with stratigraphic continuity and a common geological history are included within a single basin.

Figure 16: NZ Sedimentary Basins.
(Source: GNS)

Schlumberger's PPP 56061 is across two sedimentary basins; East Coast Basin and Pegasus Basin and details of the respective basins are discussed below. The east coast province is geologically complex, sitting in-between a modern subduction zone (and plate boundary) and the uplifted axial ranges of Mesozoic meta-sedimentary rocks.

The Alpine Fault is the longest active fault in NZ and runs for 650 km along the main northeast/southwest axis of the South Island, where the Pacific and Australian plates collide and scrape past each other (Figure 17).

The Kaikoura Canyon is an active canyon that merges into a deep ocean channel system and is an outlier of the Hikurangi trench to the north, where the Pacific Plate is subducting under the Australian Plate. It is believed that the Kaikoura Canyon is the main sediment source of the 1,500 km long Hikurangi Channel, which supplies turbidites (geologic deposit of a turbidity current) to the Hikurangi Trough (Figure 18) as well as to low parts of the oceanic Hikurangi Plateau and to the edge of the southwest Pacific Basin. It is also believed to be the sink for the coastal sediment transport system that carries large amounts of erosional debris northwards up the coast from the rivers draining the tectonically active mountains of the South Island.

The Kaikoura Canyon is responsible for the interruption of the north-flowing Southland current and the coincidence of the Subtropical Convergence Zone with the Chatham Rise which leads to the local upwelling of plankton which attracts marine life such as whales, dolphins and seals the abundant supply of food within the canyon.

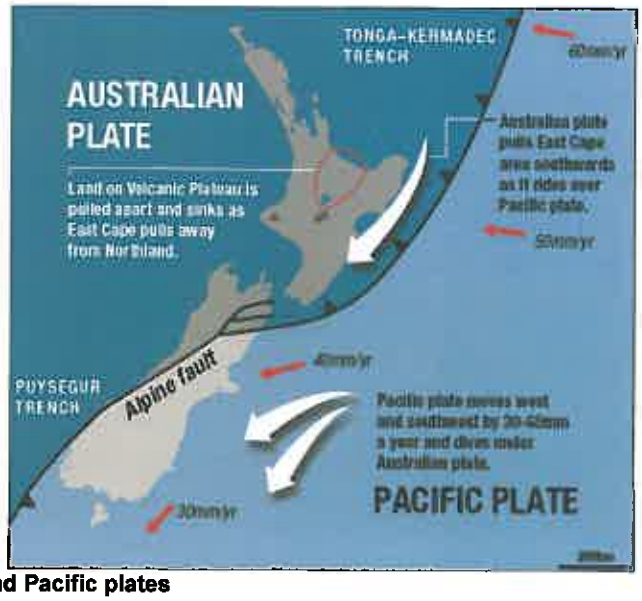

Figure 17: Australian and Pacific plates

4.1.8.1 East Coast Basin

The East Coast Basin (ECB) is a geologically complex region, with numerous depocentres located on the Australian plate along the eastern side of the North Island and in the Marlborough region of the South Island (Figure 18). In the north the ECB is separated from the Raukumara Basin by the East Cape Ridge and in the south it is bounded by the active dextral strike-slip faults of Marlborough, while the Pegasus Basin to the southeast rests on the Pacific plate (NZP&M, 2014b). The ECB has undergone several phases of faulting in the Neogene as part of a convergent margin, which has caused significant structural complexity.

The ECB covers an area of approximately 130,000 km^2 and it is thought to include a large thickness of potential Cretaceous and Paleogene source rocks at depth. Reservoirs are believed to be primarily Neogene turbidite sandstones with fine-grained mudstones and marls providing the seals.

There have been three wells drilled offshore in the East Coast Basin. Hawke Bay-1 was the first to be drilled in 1976 and encountered gas shows in Middle Miocene marly limestone and thin sandstone. In 1994 the Titihaoa-1 well was drilled and encountered gas shows in the Miocene turbidite sandstones. Even though gas shows were recorded throughout the well, the lack of well-developed reservoir sands meant it was deemed non-commercial. However, a post-drill analysis estimated that the Titihaoa structure may hold up to 400 billion cubic feet of recoverable gas. The most recent well was drilled in 2004, Tawatawa-1 which found high-pressure gas shows but there was no effective reservoir.

There is however a moderate level of exploration activity onshore within the ECB, with more than 300 oil and gas seeps known, indicating an active petroleum system or systems (NZP&M, 2014b).

The proposed ECPB 2D MSS will help gather more subsurface information to build onto the existing knowledge of the ECB and underlying strata and potentially identify areas that require more investigation.

Figure 18: East Coast Basin
(Source: http://www.nzpam.govt.nz/cms/petroleum/petroleum-basins/east-coast-basin-1)

4.1.8.2 Pegasus Basin

The Pegasus Basin lies east of Wairarapa, Cook Strait and Marlborough and is named after Pegasus Bay (Figure 19). It is adjacent to the transition zone between the highly compressive East Coast ocean-to-continent subduction margin and the continent-to-continent strike-slip margin of Marlborough and central South Island. The southern boundary of Pegasus Basin is the ancient Gondwana subduction flank of the Chatham Rise and covers an unexplored area up to 50,000 km^2 in waters depths ranging from 200 m to 3,000 m.

It is believed that the basin is rich in gas, gas hydrates and also oil. In 2009-2010 NZP&M acquired 3,200 km of marine 2D seismic data within the Pegasus Basin and it is believed there are oil reserves present within the basin but the seismic data acquired to date is

insufficient to provide a meaningful indication. However, no wells have yet been drilled in the Pegasus Basin so the petroleum system currently remains untested. The first PEP for the Pegasus Basin was awarded in late 2012.

The basin's source rocks are thought to comprise of early Cretaceous marine shales; Cretaceous and Paleocene Whangai Formation marine mudstone and Late Paleocene Waipawa Formation marine black shale. While the reservoir rocks are believed to be Cretaceous, Paleogene and Neogene transgressive and turbidite sandstones and fractured Late Cretaceous to Paleocene shales (NZP&M, 2011). Seismic evidence from Pegasus Basin clearly shows a fossilised subduction margin and an associated thrust and fold belt underlying much of the north slope of the Chatham Rise (NZP&M, 2014c). Several large incised channels along the Chatham Rise margin have been identified as potentially containing good quality reservoir sands. Oil seeps are present in the Cretaceous and Tertiary succession of Marlborough suggesting a nearby active petroleum system.

The Pegasus Basin is much less deformed than the ECB due to ECB being located entirely east of the modern subduction thrust. Pegasus Basin was a depression into which sediments were deposited from the south and west, mainly as turbidite flows, with turbidite sandstones having reservoir potential. It is believed that there are more than 6 km of Neogene sediments estimated to fill the axis of the Pegasus Basin (NZP&M, 2014c). The central part of the Pegasus Basin also contains several large anticlines created by blind thrusts rooted to the subduction/stick-slip plate interface.

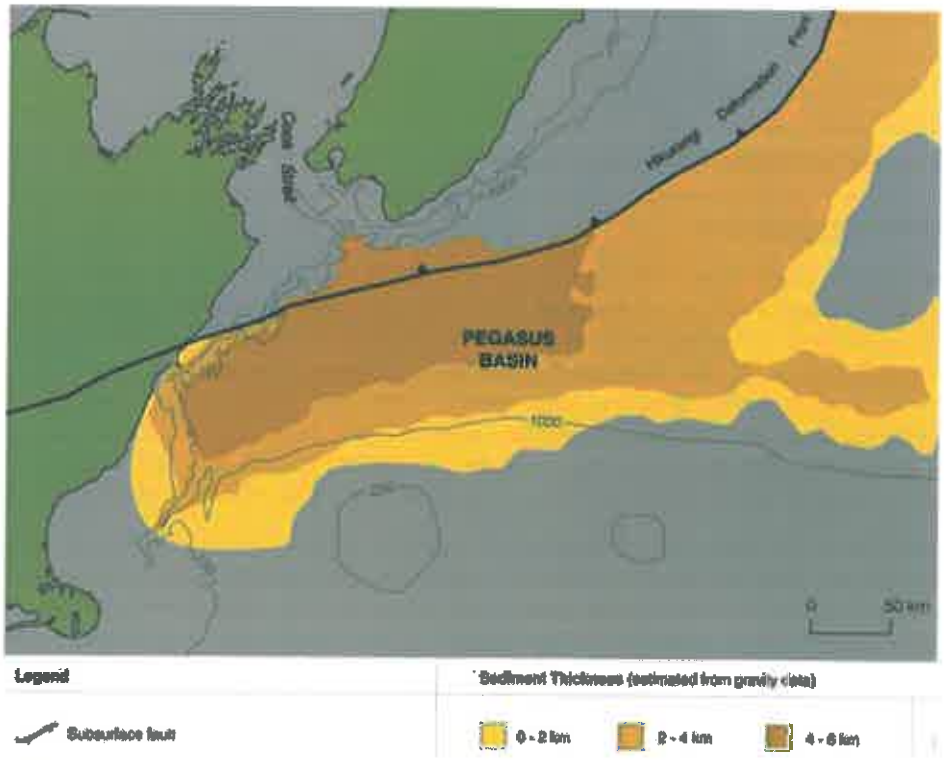

Figure 19: Pegasus Basin
(Source: http://www.nzpam.govt.nz/cms/pdf-library/petroleum-basins/Pegasus%20Basin%20Fact%20File.pdf/view?searchterm=pegasus basin)

4.2 Biological Environment

4.2.1 Regional Coastal Environment

The ECPB Operational Area extends over a large section of NZ's east coast which is the responsibility of Marlborough District Council (MDC), GWRC, Horizons Regional Council (Manawatu and Wanganui) and Hawkes Bay Regional Council (Figure 20). Each Council

has within their jurisdiction a range of different habitats and areas of significance that are unique to that region. The following section provides an overview of the regional environments inshore of the ECPB Operational Area.

Figure 20: Regional and District Council Boundaries

4.2.1.1 Kaikoura Coastline

Kaikoura is the northern most district in the Canterbury region and as a result, Environment Canterbury are responsible for managing the Kaikoura coastline and Coastal Marine Area (CMA). The Kaikoura coastline comprises of rich and diverse habitats that include intertidal reefs, rocky platforms within intervening shingle, gravel and cobble beaches, irregular bedrock reefs and boulder shores, kelp beds, with cliff and rock headlands including Kaikoura Peninsula as a distinctive feature. The nutrient rich water is very productive and supports a great diversity of marine life; including a variety of fish species, dolphins, whales, fur seals and seabirds and is believed to be one of NZ's richest marine environments.

The Kaikoura coast defines the northernmost position of the Southland Front which is the convergence of the offshore cool low salinity water and the inshore warm high salinity water. The Southland Current travels up the east coast of the South Island to Kaikoura and brings relatively cool water which diverges in the vicinity of Kaikoura; one part moving north along the coast to Cook Strait and the Wairarapa coast and the remainder meanders eastwards meeting the warmer southward flowing ECC that continues along the Chatham Rise (Marsden, 2007).

The Kaikoura Canyon extends northeast from Goose Bay for approximately 60 km, where depths of over 1,000 m deep are found within 2 km of the shore. The canyon is known to trap and divert sediment that travels up the coast where it is then carried offshore and northwards. The walls of the Kaikoura Canyon are mostly muddy, although there is some emergent bedrock where the canyon edge is too steep to hold fine sediment (Te Korowai o Te Tai o Marokura, 2008).

Kaikoura has become a popular tourist destination, mainly for whale watching and swimming with or near dolphins. A large NZ fur seal breeding colony is present at Ohau Point, north of Kaikoura Peninsula, where several hundred pups are born there each year. Seabirds are another attraction of this coastal region as it provides one of the best reasonably accessible

places in the world to see open ocean seabirds such as albatrosses, petrels and shearwaters.

In 2005 Te Korowai o Te Tai o Marokura (Kaikoura Coastal Marine Guardians) was formally established, a group made up of commercial and recreational fishers, representatives from Te Runanga o Kaikoura, DOC, Kaikoura District Council, local businesses and Forest & Bird have been working on a marine protection strategy for the area and to share in the role of kaitiaki (guardians) of the natural environment.

In March 2014 the NZ Government released a number of proposals around the Kaikoura coastline which include a new marine reserve, whale and NZ fur seal sanctuary and five customary fishing areas. This proposal will also be in combination with new recreational fishing regulations that will see reduced bag limits for some shellfish and finfish with an increase of 3 cm to the legal size limit for blue cod. Kaikoura is regarded as a unique biodiversity hotspot with a tourism industry, largely derived around marine mammals worth around $134 million a year.

The protection measures have been led by Te Korowai o Te Tai o Marokura which consist of iwi, recreational and commercial fishers and conservation groups. These measures have been developed by Te Korowai o Te Tai o Marokura over the last nine years before the marine reserve bill was introduced into parliament on 17 March 2014. Limits will be placed on commercial fishing and seismic surveys and is expected to result in a $1.1 million a year decrease for the fishing industry due to the restrictions in place.

The proposed 'Hikurangi Marine Reserve' will cover a total of 10,416 ha which extends offshore for 23.4 km and along the shore for 2 km just north of Goose Bay, Kaikoura. The reserve is larger and deeper than any existing marine reserve on NZ's three main islands and focuses on the very deep waters of the Kaikoura canyon.

The 'Kaikoura Whale Sanctuary' will cover 4,686 km^2, extending 45 km north and south of Kaikoura Peninsula and 56 km offshore.

The 'Ohau Point NZ fur seal Sanctuary' extends 700 m along the coastal side of State Highway 1 out about 50 m to the low water spring mark and covers approximately 4 ha. This area is the most significant breeding colony of NZ fur seals on NZ's main islands.

These proposed areas are approximately 180 km southwest of the ECPB Operational Area.

4.2.1.2 Marlborough Coastline

Marlborough's coastal environment is made up of two quite distinct geographic areas: the Marlborough Sounds and the east Marlborough coast which is the closest area to the ECPB Operational Area. The Sounds are essentially large drowned river valleys lying between mountain ranges, extending from Cape Soucis in the west to Port Underwood in the east.

The southeastern coastline from Cape Jackson in the north to Rarangi in the south is exposed to large southerly swells with strong tidal currents and cold nutrient rich waters. High cliffs, sand and gravel beaches, and rocky headlands dominate this section of coastline which combined with the Marlborough Sounds contains about 1,800 km of coastline; approximately 18% of NZ's total coastline (Davidson *et al.*, 2011). South of Rarangi is Cloudy Bay, Clifford Bay and Cape Campbell which have a coastline comprised of mixed sand and sand/gravel beaches, cobbles with cliffs and large mudstone shore platforms at Cape Campbell. Water clarity around Cloudy Bay and Clifford Bay is generally pretty poor due to flooding of the Wairau and Awatere Rivers, softer rock types such as limestone and siltstone along the coast and sediment run off.

The Marlborough coastal environment has diverse use and values which includes: recreation; as a means of transport and travel; commercial and recreational fishing; a source of kaimoana and for cultural significance; marine farming; boating; swimming and diving;

jetties; mooring and boatsheds and enjoyment of landscape and wilderness in this unique area of NZ.

There are a number of significant sites within the Marlborough region due to the habitat they provide for important species, feeding and breeding areas of marine species or migratory routes. The closest significant site to the ECPB Operational area is ~150 km away. A full description and an assessment of their ecological significance can be found in Davidson *et al.*, 2011).

4.2.1.3 Wellington Coastline

Greater Wellington Regional Council has the responsibility to manage and monitor the Wellington region's near-shore CMA which extends out to 12 Nm. This area contains significant habitats for a wide variety of plants and animals as well as providing for a diverse range of human activities and values.

The coastline of the Wellington region is almost 500 km long and stretches from north of Otaki on the west coast, south through Cook Strait and north along the eastern Wairarapa coast to north of Castlepoint (Figure 20). The regions coastline is a high energy environment dominated by strong tidal flows of the Cook Strait which deliver nutrient-rich deep-ocean waters to the continental shelf.

The near-shore coastal environment supports several coastal habitat types, including harbours, estuaries, extensive sandy beaches, dunes and rocky shores, all of which sustain valuable ecosystems for recreation, tourism, food gathering, fish and bird nurseries and hotspots for biodiversity.

The south coast of the Wellington region is predominantly high rocky cliffs and narrow steep pebble and boulder beaches and has the highest tidal currents in the region (<13 km/h) and the greatest water depths which can reach to over 1,000 m within a few kilometres of the shore (Oliver & Milne, 2012). The NZ fur seal haulout area at Sinclair Head is of regional importance and the coast also supports breeding colonies of variable oyster catcher, southern black-billed gull and the black shag.

On the southeast coast is Wellington Harbour and the hub of the regions urban activity and development. The harbour is a vital shipping port within NZ and is also well utilised for boating, windsurfing, swimming, fishing, scientific research, and diving. Palliser Bay lies southeast of Wellington Harbour and forms a large embayment of steep coarse sand and pebble beaches backed by low mudstone cliffs. The bay is exposed to heavy southerly swells and is too dynamic for most intertidal organisms (Oliver & Milne, 2012). Lake Onoke is in the centre of Palliser Bay and is a brackish intermittently open/closed coastal lake estuary fed by the Ruamahanga River and is listed as an area of significant conservation value due to its indigenous fish, plant and animal communities in the Greater Wellington's Regional Coastal Plan (GWRC, 2000).

The Wairarapa coastline has rugged, isolated, natural beauty and iconic landscapes with special geological features. Integral to the character of the Wairarapa coast are the large tracts of undeveloped land between settlements and the high level of natural character.

From Cape Palliser north to the Wellington regional boundary at Mataikona, just north of Castlepoint, it is characterised by soft rock platforms or gently sloping sandy beaches dotted with estuaries and reef systems (Oliver & Milne, 2012). NZ fur seals haulout on the Kahau Rocks, south of Riversdale and the surrounding beaches in winter.

4.2.1.4 Manawatu Coastline

Horizons Regional Council administer both the Manawatu and Wanganui region which includes parts of both the west coast and east coast of the North Island (Figure 20). The east coast only covers approximately 40 km from Cape Turnagain south to Owahanga River mouth and is characterised by rocky platforms backed by cobbled or sandy beaches dotted

with boulders (Horizons, 2014). The landward coastal flats are narrow, backed by hills and there is an area of sedimentary cliffs at Cape Turnagain.

The river mouths are dynamic and contribute large quantities of sand, gravel and silt to the seabed. The estuaries and tidal flats support a wide range of bird and fish life while the rocky coast provides good habitats that allows commercial fishing of paua, crayfish and kina as well as a substantial finfish resource offshore.

4.2.1.5 Hawkes Bay Coastline

The Hawkes Bay coastline stretches 353 km from Mahia Peninsula in the north to slightly south of Porangahau beach and is valued for recreation, swimming, boating, surfing and fishing (Figure 20). This coastline supports a diverse range of habitats underpinned by the unique geological history of the area; with large undulating coastal cliffs, sandy beaches, extensive dune systems and rock platforms characterising the coastline between Cape Kidnappers and Cape Turnagain (HBRCEP, 2012). The region is dominated by Hawke Bay itself, which is 94 km across at its widest point and contains a mix of sandy and gravel beaches, with a series of reefs, an offshore island and several large rivers draining into the coast. The Hawkes Bay Regional Council administer the CMA within this section of coastline.

Offshore reef systems, a continental shelf, marine trenches, siltstone stacks, intertidal platforms, sand spits and varying sediment deposits are all integral parts of the coastal environment and provide a variety of ecosystems and niche habitats to coastal flora and fauna. Lagoons, estuaries, salt marshes, tidal mudflats and backwaters connecting the rivers to the sea are also part of this coastal environment.

4.2.2 Planktonic Communities

Within NZ, the productivity of the ocean is a result of many factors; namely ocean currents, climate and bathymetry which causes upwelling creating nutrient rich waters – ideal conditions for plankton growth and the animals that feed on them (MPI, 2014a).

Plankton are a drifting organism (animals, plants or bacteria) that occupy the pelagic zone of oceans and seas around the world. Plankton are the primary producers of the ocean, they travel with the ocean currents although some plankton species can move vertically within the water column. Nutrient concentrations and the physical state of the water column (i.e. settled or well-mixed) influence the abundance of plankton. There are three broad functional groups for plankton:

- Bacterioplankton – play an important role in nutrient cycles within the water column;
- Phytoplankton – microscopic plants which capture energy from the sun and take in nutrients from the water column via photosynthesis. They create organic compounds from CO_2 dissolved in the ocean and help sustain the life of the ocean; and
- Zooplankton – consists of small protists, metazoans (i.e. crustaceans), larval stages of fish and crustaceans and feed on the phytoplankton and bacterioplankton. Although zooplankton are primarily transported by ocean currents, many are able to move, generally to either avoid predators or to increase prey encounter rates. Zooplankton primarily live in the surface waters where food resources are abundant.

Studies of the pelagic biota along the Canterbury and Marlborough coastlines have shown that there is generally low phytoplankton production with a pronounced spring phytoplankton bloom from September to early December (Marsden, 2007). Bradford (1972) found that *Euphausia lucens*, *Nyctiphanes australis* and the larvae of *Munida* spp. were found to be the most frequently occurring species off the Kaikoura coastline, which often form swarms that attract fish such as kahawai and also seagulls. Many of the plankton species showed characteristic depth distributions with grazing species (copepods, larval fish and juvenile

amphipods) occurring at the surface and predatory species with maximal concentrations often below 100 m.

In October 2009, a NASA satellite recorded a large bloom to the east of Cook Strait, which through sampling by NIWA was identified as two different species of coccolithophores which are coated with calcium-carbonate scales that are very reflective. Coccolithophores are phytoplankton and are a vital food source at the base of the marine food web. This observation was one of the largest coccolithophore blooms in NZ waters which was most likely a result of a number of different factors present such as favourable light, temperature and nutrients. The satellite image is shown in Figure 21.

Figure 21: NASA satellite image showing Coccolithophore bloom, 25 October 2009
(Source: http://www.niwa.co.nz/news/spectacular-oceanic-bloom-identified - credit NASA).

If large aggregations of plankton are present in the East Coast or Pegasus Basin coinciding with the ECPB 2D MSS, studies have shown that mortality of these communities can occur within 5 m of the acoustic source (DIR, 2007). However, given the large planktonic populations and their high natural mortality rate from stochastic events; any mortality imposed on these communities within close proximity to the acoustic source would be considered negligible.

4.2.3 New Zealand Marine Environmental Classification

MfE, MPI and DOC commissioned NIWA to develop an environmental classification called the NZ Marine Environment Classification (MEC). The MEC covers NZ's Territorial Sea and EEZ to provide a spatial framework for structured and systematic management, where geographic domains are divided into units that have similar environmental and biological characters (NZMEC, 2005).

Physical and biological factors (depth, solar radiation, sea surface temperatures (SST), waves, tidal current, sediment type, seabed slope and curvature) were used to classify and map marine environments around NZ.

The ECPB Operational Area falls within MEC groups 22, 47, 55, 60 and 63 representing the moderately shallow waters on the continental shelf out to deep water (Figure 22), and are described below:

- **Class 22:** is extensive in moderately deep waters (mean = 1,879 m) and is typified by cooler winter SST. Chlorophyll-*a* only reaches low average concentrations, with characteristic fish species being orange roughy, Baxter's lantern dogfish, Johnson's cod and hoki.
- **Class 47:** occurs extensively in deep waters (mean = 2,998 m). Average chlorophyll-*a* concentrations are moderately low, with characteristic fish species including smooth oreo, Baxter's lantern dogfish, the rattail, Johnson's cod and orange roughy.
- **Class 55:** is of restricted extent, occurring at moderately shallow depths (mean = 224 m) around northern NZ and has high annual solar radiation and moderately high winter SST. Average chlorophyll-*a* concentrations are moderate. Characteristic fish species include sea perch, red gurnard, snapper and ling, while arrow squid are also common. The most commonly represented benthic invertebrate families are Dentallidae, Nuculanidae, Pectinidae, Carditidae, Laganidae and Cardiidae.
- **Class 60**: occupies moderately shallow waters (mean = 112 m) on the continental shelf. It experiences moderate annular solar radiation and wintertime SST and has moderately high average chlorophyll-*a* concentrations. Some of the most commonly occurring fish species are barracouta, red gurnard, john dory, spiny dogfish, snapper and sea perch, while arrow squid are also frequently caught in trawls. The most commonly represented benthic invertebrate families are Dentaliidae, Cardiidae, Carditidae, Nuculanidae, Amphiuridae, Pectinidae and Veneridae.
- **Class 63**: is extensive on the continental shelf including much of the Challenger Plateau and the Chatham Rise. Waters are of moderate depth (mean = 754 m) and have moderate annual radiation and wintertime SST. Average chlorophyll-*a* concentrations are also moderate. Characteristic fish species include orange roughy, Johnson's cod, Baxter's lantern dogfish, hoki, smooth oreo and javelin fish. The most commonly represented benthic invertebrate familes are Carditidae, Pectinidae, Dentaliidae, Veneridae, Cardiidae, Serpulidae and Limidae.

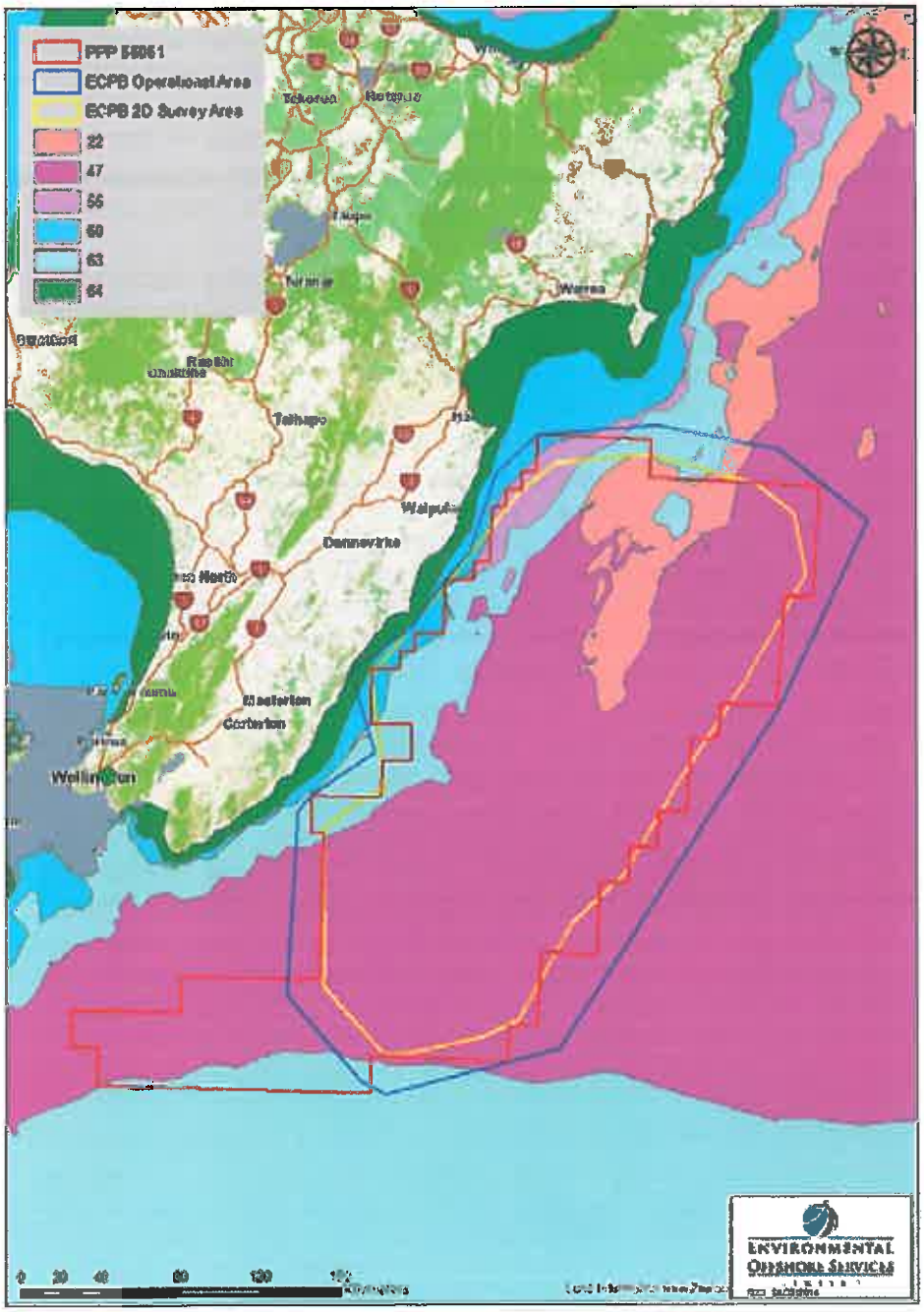

Figure 22: The NZMEC at the 20-class level

4.2.4 Fish Species

In the East Coast and Pegasus basins fish populations comprise of various demersal and pelagic species, which have a wide distribution across NZ – from shallow to deep water. General distribution of fish species throughout these basins is listed in Table 6.

MPI prepared a fisheries assessment for Schlumberger's PPP 56061. This assessment identified orange roughy and alfonsino are the two most commonly caught commercial fish species within this area (Section 4.4.2). In the 2012-2013 fishing year there was 373 tonnes of orange roughy caught and 329 tonnes of alfonsino caught, utilising the bottom trawl method of fishing. The bottom trawling within the ECPB Operational Area over the last five years has shown a trend of fishing activity which peaks during October-March. With the

proposed commencement data of the ECPB 2D MSS at the start of April, it is likely that there is very little trawling activity targeting orange roughy and alfonsino.

Through consultation with the fishing industry (Appendix 2) no issues were raised as a result of the proposed ECPB 2D MSS in relation to any potential impact on fish stocks.

Table 6: Distribution of fish species around the ECPB 2D Operational Area

Water column	Likely fish species
Shallow to mid-shelf (<200 m)	Snapper, trevally, kahawai, gurnard, butter fish, blue warehou, blue cod, blue nose, john dory, hapuku, rig, school shark, spiny dogfish, blue mackerel, blue moki, jack mackerel, elephant fish, flatfish, leather jacket, red cod, arrow squid, sea perch, tarakihi and kingfish.
Coastal shelf region (<500 m)	Elephant fish, school shark, blue nose, giant stargazer, arrow squid, tarakihi, red cod, frost fish, silver dory, gem fish, barracouta, hapuku, ling, spiny dogfish, cardinal fish, rays and skates, rig and jack mackerel.
Waters < 800 m	Bass, hake, ling, blue nose, spiny dogfish, orange roughy, alfonsino, Baxter's lantern dogfish, cardinal fish, smooth oreo, javelin fish, lantern fish, silver warehou, white warehou, gem fish and hapuku.
Deep water > 800 m	Ling, hoki, orange roughy, alfonsino, cardinal fish, Baxter's lantern dogfish, Johnson's cod, smooth oreo, rattail

4.2.5 Threatened Marine Species

Under the NZ threat classification list, NZ has 368 threatened marine species. This includes 4.5% of the seaweeds, 2.4% of the invertebrates, 4.2% of the fish and 62.3% of NZ's 122 species of seabirds (excluding waders and shorebirds) (Hitchmough *et al.*, 2005). Eight of NZ's 50 species of marine mammals are also threatened (Hitchmough *et al.*, 2005; Baker *et al.*, 2010).

Great white sharks occur throughout NZ waters and are at risk of extinction and are classified as being in gradual decline under the NZ Threat Classification System and as vulnerable by the International Union of Conservation of Nature (IUCN) Red List of Threatened Species. They are fully protected in NZ waters under the Wildlife Act 1953 and are further protected on the high seas under the Fisheries Act, prohibiting NZ flagged vessels taking great white sharks beyond the EEZ. Satellite tagging of NZ great white sharks has shown that they migrate seasonally from March to September, between aggregation sites at Stewart Island and the Chatham Islands to the tropical and subtropical Pacific (i.e. northern New South Wales and Queensland, Norfolk Island, New Caledonia, Vanuatu, Fiji and Tonga) (DOC, 2014a), they don't however appear to cross the equator. NIWA have played a key role in the satellite shark tagging, where 35 great white sharks have been tagged since 2005 and from NIWA maps that show the movements of the tagged sharks, no great white sharks appear to go near the ECPB Operational Area. Stewart Island great white sharks tend to head northwest of NZ, while those great white sharks tagged at the Chatham Islands head north to warmer waters. Within NZ waters other protected marine species include: basking sharks, whale shark, oceanic whitetip shark, deepwater nurse shark, manta ray and spiny-tailed devil ray.

4.2.6 Marine Mammals

There is a diverse community of marine mammals in NZ waters; over half of the world's whale and dolphin species can be found here. Forty one cetaceans (whales and dolphins) and nine species of pinnipeds (seals) have been recorded in NZ waters (Suisted & Neale,

2004). Whales are further divided into two main types: toothed whales and baleen whales. Baleen whales are often large and generally solitary animals; they don't have teeth, they have a fringe of stiff hair-like material, or baleen hanging from their upper jaw which they use to filter small animals out of the seawater (DOC, 2007). However, most of the whale species are toothed whales and generally spend their life in social groups, feeding, navigating and communicating with each other using underwater vocalisations or sound.

For the preparation of this MMIA, the National Aquatic Biodiversity Information System (NABIS) database was accessed as well as the DOC sighting database, DOC stranding database and the available literature to identify potential marine mammal species which could potentially be encountered throughout the ECPB Operational Area (MPI, 2014b). The NABIS database has collated records and data from marine mammal sightings, strandings and DOC to identify the locations where each marine mammal species could occupy. The marine mammal species identified that could be present, transitory or have been found stranded in the vicinity of the ECPB Operational Area from the above sources are listed in Table 7 with a basic ecological summary of some of the more common and likely marine mammal species to be present in the area summarised below.

Table 7: Marine mammals likely to be present in or around the ECPB Operational Area

Whales	Dolphin Family	Pinnipeds
Humpback whale (*Megaptera novaeangliae*)	Common dolphin (*Delphinus delphis*)	NZ fur seal (*Arctocephalus forsteri*)
Blue whale (*Balaenoptera musculus*)	Killer whale (*Orcinus orca*)	Leopard seal (*Hydrurga leptonyx*)
Fin whale (*Balaenoptera physalus*)	Bottlenose dolphin (*Tursiops truncates*)	
Minke whale (*Balaenoptera acutorostrata* & *B. bonaerensis*)	Long-finned pilot whale (*Globicephala macrorhynchus*)	
Sei whale (*Balaenoptera borealis*)	Hector's dolphin (*Cephalorhynchus hectori*)	
Southern right whale (*Eubalaena australis*)	Dusky dolphin (*Lagenorhynchus obscurus*)	
Bryde's whale (*Balaenoptera edeni*)	Risso's dolphin (*Grampus griseus*)	
	False killer whale (*Pseudorca crassidens*)	
	Hourglass dolphin (*Lagenorhynchus cruciger*)	
	Rough toothed dolphin (*Steno bredanensis*)	
Toothed Whales		
Beaked whales (11 species)		
Sperm whale (*Physeter macrocephalus*)		
Pygmy sperm whale (*Kogia breviceps*)		

As discussed in Section 4.2.5, eight species of marine mammal have been included in the NZ threat classification list; either as nationally critical, nationally endangered or range

restricted (Table 8) (Baker *et al.*, 2010). Four species have been identified that could be present within the ECPB Operational Area during the ECPB 2D MSS (Bryde's whale, killer whale, southern right whale and bottlenose dolphin).

During spring most of the large whales living in the Southern Hemisphere migrate from the Pacific Islands down to the Antarctic Ocean to feed. They return back to the Pacific Islands during Autumn-winter for the breeding season (May-July) (DOC, 2007). The distribution and migration paths around NZ for humpback, sperm, Bryde's and southern right whales are shown in (Figure 23). The northern migration routes back up to the Pacific Islands are relatively well known, however the southwards routes are not. The ECPB 2D MSS is currently expected to start at the beginning of April 2014, and with the approximate 40-50 day MSS acquisition period, it is believed the survey will be complete prior to the northward migrations of whales, especially through the Cook Strait. The Code of Conduct and mitigation measures proposed in the MMIA will be followed for the duration of the ECPB 2D MSS, and if there are believed to be large numbers of migratory whales within the ECPB Operational Area, DOC would be notified and any additional mitigation measures would be discussed between DOC and Schlumberger. As discussed there is very little knowledge of marine mammal migration paths up the east coast of the North Island so the MMO's onboard the *Aquila Explorer* will be made aware of this, especially towards the latter part of the ECPB 2D MSS and particular attention will be paid to any likely migratory marine mammals present.

Figure 23: Whale distribution and migration pathways in NZ waters
(Source: http://www.teara.govt.nz/en/map/7052/whales-in-new-zealand-waters)

The DOC sighting database, current up until the end of 2013 had the geographical positions of 2,600 sightings of marine mammals, of which MSS around the Taranaki coastline have contributed significantly to this database. The database was plotted on GIS mapping software to see distributions of marine mammals around NZ, however care has to be taken with sighting data, as the lack of sightings does not mean the marine mammals do not reside

there, only the fact that there is either little boating activity in that particular area, no observations have occurred during dedicated observational surveys, are beyond easily accessible areas of coastline/harbours or that sighting information has not been submitted to DOC.

The DOC stranding database has also been accessed up until the end of 2013 and plotted on GIS mapping software which has been used as part of the assessment for potential marine mammal species within the ECPB Operational Area. A summary of the DOC stranding database was undertaken by Brabyn (1991), where at that time of writing 88% of the 1,140 whale strandings in NZ comprised of three species; pilot whales, false killer whales and sperm whales.

Sperm whales and pygmy sperm whales have one of the highest incidence of strandings in NZ, where Opoutama Beach at Mahia Peninsula to the north of the ECPB Operational area is the only hotspot for pygmy sperm whale herd strandings with single stranding hotspots are Opoutama, Napier, Wellington and Christchurch (Brabyn, 1991).

Opoutama Beach is steeped in Maori history with whaling activities occurring in this area, as the isthmus protrudes into the migration path of the whales, which is also believed to be part of the reason for the whale strandings. By the 1880's it was estimated that 300 Maori were making their living entirely by whaling.

Pilot whales are the most frequent herd stranders of all cetaceans with the largest single stranding recorded in NZ was 450 whales at Kawa Bay, Great Barrier Island in 1985 (Brabyn, 1991). Farewell Spit has a number of strandings each year which although is unexplained is believed to be a result of the shallow extensive sandy beaches.

The DOC database of marine mammal strandings and observations are plotted below in Figure 24.

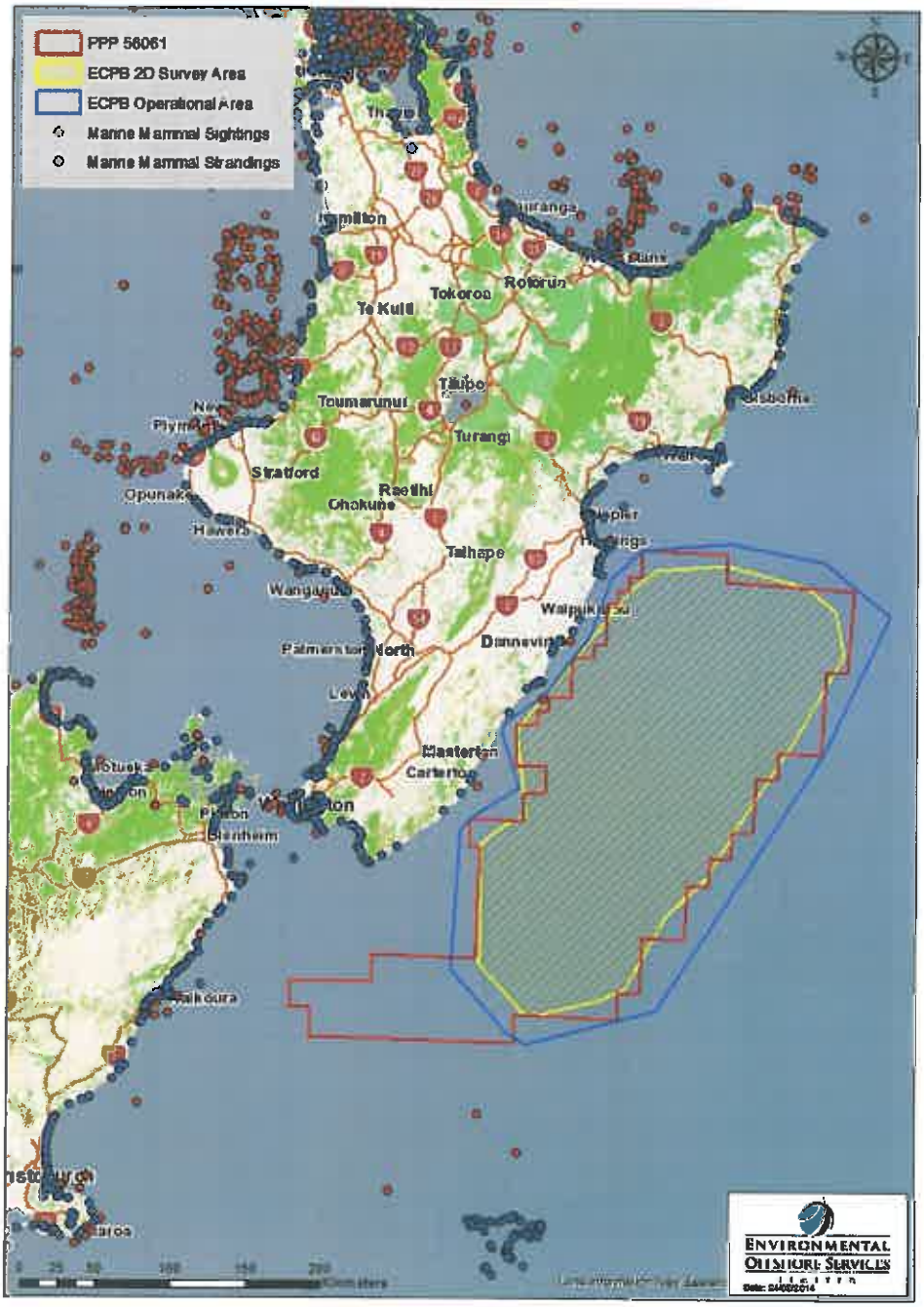

Figure 24: DOC records of marine mammal strandings and sightings

Table 8: Marine mammals on NZ threat classification list (DOC, 2007; Baker *et al.*, 2010)

Marine Mammal Species	NZ Threat Classification	IUCN Classification	Summary	Distribution	Likely to be in Survey Area
Bryde's whale *(Balaenoptera edeni)*	Nationally critical	Data deficient	Generally a coastal species but does live in the open ocean. Bryde's whales prefer temperate waters and are observed off the NZ coast generally north of the Bay of Plenty. This species of whale is believed to rarely venture beyond 40 degrees south.	Have a preference for warmer waters. A stranding has occurred at the tip of Mahia Peninsula, 40 km to the north of ECPB Operational Area. Has the potential to be observed in the northern part of the ECPB Operational Area	✓
Killer whale *(Orcinus orca)*	Nationally critical	Data deficient	Feeds on a variety of animals which include other marine mammals and fish species. They are believed to breed throughout the year and appear to migrate based on the availability of prey.	Largely unknown but tend to travel according to the availability of food. Killer whales are widely found in all oceans of the world although more dominant in cooler waters. Likely to occur in the ECPB Operational Area.	✓
Maui's dolphin *(Cephalorhynchus hectori maui)*	Nationally critical	Critically endangered	World's smallest dolphin and found in inshore waters on the west coast of the North Island. Considered a subspecies of Hector's dolphin	Generally live close to shore (within 4 nautical miles) although the 100 m depth contour has been indicated as being their offshore distribution given current scientific understanding. Only found on west coast of the North Island. Unlikely to occur in the ECPB Operational Area.	x
Southern elephant seal *(Mirounga leonina)*	Nationally critical	Least concern	They are the largest species of seal and feed on squid, cuttlefish and large fish. Generally only comes ashore in spring/summer on offshore islands and some mainland areas to breed and moult; otherwise lives mostly at sea. They have an inflatable proboscis (snout) which is most present in adult males which is meant to increase the bull elephant seals roar.	Primary range includes the Antipodes, Campbell, Auckland, Snares Islands and the surrounding Southern Ocean. Occasionally they are found on the mainland from Stewart Island to the Bay of Islands. Unlikely to occur in the ECPB Operational Area.	x
Southern right whale *(Eubalaena australis)*	Nationally endangered	Least concern	Present both offshore and inshore and their diet consist of krill, particularly copepods. Mate and calve during winter months in sheltered sub Antarctic harbours such as Auckland Islands and Campbell Island. Are baleen feeders and often travel well out to sea during feeding season; but they give birth in coastal areas (American Cetacean Society, 2010).	Likely to occur as a transient species in the ECPB Operational Area.	✓
Hector's dolphin *(Cephalorhynchus hectori)*	Nationally endangered	Decreasing	One of the smallest dolphin species (less than 1.5m long). Generally live inshore although have been sighted up to 20 Nm from the coast. Little known about migratory, reproductive, or feeding habits.	Patchily distributed around the South Island coast. On east coast live between Banks Peninsula and Te Waewae Bay and Porpoise Bay in the south. There is also populations around Kaikoura and Cloudy Bay/Marlborough Sounds. Not likely to occur in the ECPB Operational Area.	x
NZ sea lion *(Phocarctos hookeri)*	Nationally critical	Decreasing	Feeds on fish, invertebrates, and occasionally birds or other seals. Breeding occurs in summer months with pupping occurring in December/January with the pups being weaned in July/August.	Known to forage along continental shelf breaks with primary range including the Auckland, Campbell, and Snares Islands. Unlikely to be encountered in the ECPB Operational Area.	x
Bottlenose dolphin *(Tursiops truncatus)*	Nationally endangered	Least concern	Are found worldwide in temperate and tropical waters, generally north of 45 degrees south. Population density appears to be higher near shore. Resident bottlenose dolphins are found off the east coast of the North Island, the northern tip of the South Island, and in Doubtful Sound.	Possibly observed in the ECPB Operational Area.	✓

4.2.6.1 Humpback Whale

Humpback whales are a baleen whale belonging to the rorqual family; the head is broad and rounded but slim in profile, a round body shape and unusually long pectoral fins. The top of the humpback's head and lower jaw have rounded bump-like knobs which have at least one stiff hair, believed to help detect movement in nearby waters. During summer humpback's feed in polar waters for up to 80 – 100 days and can consume up to two tonnes of krill per day; then in winter migrate north to tropical or sub-tropical waters (i.e. Tonga) for mating and calving. During the summer months the humpback whales fast and live off their fat reserves built up from the polar region. Humpback whales can dive for up to 30 minutes but usually only last for up to 15 minutes and can dive down to depths of about 150 - 210 m (Sea Sheperd, 2014) Whaling in the southern hemisphere reduced the population from ~120,000 animals to 15,000 but the population is now currently recovering (Suisted & Neale, 2004).

The migration route of humpback's sees them travel from their summer feeding grounds in the Antarctic up the east coast of the South Island, through the Cook Strait and up the west coast of the North Island on the way to the tropics and their winter breeding grounds (Shirihai, 2002). DOC undertake whale monitoring in the Cook Strait each year during June – July to coincide with the northern migration of the humpback whales to the South Pacific Breeding grounds. Throughout the world, humpback whales follow a regular migration route and generally migrate at speeds of 4.8 – 14 km/hr (Sea Sheperd, 2014). During this migration period, the humpback whales have incredible endurance, where they can travel over 5,000 km during each migration season with almost no rest along the way (Sea Sheperd, 2014) and given they are not feeding are travelling at the surface which allows them to be monitored during the DOC Cook Strait monitoring programme. This northern migration will occur after the ECPB MSS is acquired, where the scheduled commencement date in early April 2014 and a 40-50 day programme will see it completed prior to most of the humpback whales making their way north. All efforts will be made to acquire the southern part of the ECPB Operational Area first so that at the end of the ECPB 2D MSS the acoustic source will be in the order of > 300 km away from Cook Strait.

Both male and female humpback whales vocalise, but only males produce the long, loud, complex 'songs' which consist of several sounds in a low register, varying in amplitude and frequency and typically lasting from 10 to 20 minutes (ACS, 2014).

The southern migration back to the feeding grounds is along the west coast of the South Island and is led by the lactating females and yearlings who are followed by the immature whales, and lastly the mature males and females. The pregnant females are last to migrate south in late spring (Gibbs & Childerhouse, 2000).

From the DOC stranding database there are records of humpback whales stranding along the coast north of Kaikoura and on the south coast of Wellington. These strandings have most likely coincided with the humpback whales on their northern migration.

4.2.6.2 Blue Whale

Blue whales are the largest animals to ever live; adults can reach up to 33 m long and weigh up to 150 tonnes (Croll *et al.*, 2005). They are long-lived, slow reproducing animals and it is estimated that fewer than 2,000 blue whales can be found in the southern hemisphere. There are only four blue whale foraging areas documented in the Southern Hemisphere outside Antarctic waters (Torres, 2013). During summer they travel to their feeding grounds in the Antarctic while in winter they spend their time in equatorial waters.

Despite blue whales being such large animals, they are fairly elusive and little is known about their distribution or habitat use patterns. A paper has recently being published on a previously unrecognised blue whale foraging ground in the South Taranaki Bight (Torres, 2013) as a number of blue whales have now been observed in the South Taranaki Bight during MSS programmes over recent years. Blue whales have the highest prey demands of

any predator and can consume up to two tonnes per day (Rice, 1978; DOC, 2007), therefore large aggregations of food in upwelling areas is important to these whales.

Blue whales can feed at depths of more than 100 m during the day and surface feed at night due to the distribution of krill which they feed on (Wikipedia, 2014a). Dive times are typically ten minutes when feeding, although dives of up to 20 minutes are common. Blue whales feed by lunging forward at aggregations of krill, taking the krill and a large quantity of water into its mouth. Excess water is squeezed out through the baleen plates by pressure from the ventral pouch and tongue. Once the mouth is clear of water, the remaining krill, unable to pass through the plates, are swallowed.

In the Southern Hemisphere there are two subspecies of blue whales; Antarctic (or true) blue whales and pygmy blue whales but are difficult to distinguish at sea so is not surprising that all sightings have been recorded as blue whales. Four pygmy blue whales are recorded on the DOC stranding database from the coasts of Taranaki, Wellington, Tasman Bay and Auckland. The most recent pygmy blue whale stranding was of a 20 m specimen at Himatangi Beach near Wellington in October 2013.

Antarctic blue whales are generally found south of 55 °S during the Austral summer, while pygmy whales are believed to remain north of 54 °S (Branch *et al.*, 2007). It has been assumed that Antarctic blue whales migrate to temperate waters for mating and calving during the winter and return to the Antarctic in the summer months for feeding (Torres, 2012). However, there is recent evidence around the world from a number of locations (including NZ) that some Antarctic blue whales do not migrate south every winter (Branch *et al.*, 2007). The distribution of pygmy blue whales has been documented to show that they do migrate to Antarctic waters during summer.

The IUCN red list of threatened species currently lists the Antarctic blue whale as *Critically Endangered* and the pygmy blue whale as *Data Deficient*. However under the NZ threat classification system blue whales are currently classified as a 'migrant' and therefore does not designate a threat status (Torres, 2013) but are listed as a Species of Concern under the Code of Conduct. However, DOC have stated that the NZ threat classification for blue whales may change if further research demonstrates blue whales are resident or breeding in NZ waters.

Blue whales vocalise at a low frequency (0.01 – 0.04 kHz); resulting in their vocalisations being able to travel a very long distance through the water. This distance, which can be up to a couple of hundred kilometres, is a result of efficient propagation of a low-frequency sound emitted in water and is the reason that MSS's emit low frequency acoustic signals to penetrate down through the seabed. The communication calls of blue whales partially overlap with the acoustic energy emitted from MSS's (Table 12). Blue whale vocalisations are also very loud, where their calls can reach levels of up to 188 dB (WDCS, 2013; WWF, 2014). It has been shown that blue whales will increase their calls (emitted during social encounters and feeding) when a MSS is operational within the area (Section 5.1.2.5). It is believed that the blue whale increases its calling when a MSS is operational to increase the probability that its communication signals will be successfully received by conspecifics and compensate for the masking of communications by noise (Di Iorio & Clark, 2009).

4.2.6.3 Bryde's Whale

Around the NZ coastline Bryde's whales are the most common baleen whales. Given they prefer warmer waters (above 20°C) they are generally found in northern NZ (Suisted & Neale, 2004). Bryde's whales are the second smallest baleen whale within NZ waters; they can grow up to 12 – 15 m in length and weigh up to 16 – 20 tonnes. Bryde's whales are distinct to other baleen whales in the polar regions; as they will also feed on fish (pilchards, mackerel and mullet). On the east coast of the lower north island, there have been no sightings, but two strandings have occurred at Mahia Peninsula and Gisborne, indicating that

they do use this stretch of coastline. Therefore the chance of observing them during the ECPB 2D MSS is likely to be low but is possible.

4.2.6.4 Minke Whale

There are three species of minke whales: the northern minke (*Balaenoptera acutorostrata*) (confined to northern hemisphere), the Antarctic or southern minke (*Balaenoptera bonaerensis*) and a sub-species, the dwarf minke which is present in NZ waters. The southern minke is confined to the southern hemisphere, including NZ, and is most commonly observed south of NZ feeding in Antarctic waters. There have been numerous strandings of the northern minke along the stretch of coastline inshore of the ECPB Operational Area. As a result there is the potential that a minke whale could be encountered during the ECPB 2D MSS.

4.2.6.5 Sei Whale

Sei whales are a medium sized baleen whale with an average length of 15 – 18 m and weigh 20 – 25 tonnes. Sei whales are among the fastest swimming cetaceans; swimming at speeds of 50 km/hr and have travelled up to 4,320 km in ten days. During February-March, Sei whales migrate south to Antarctica where there is an abundance of food then return to the waters between the South Island and Chatham Islands to calve. No Sei whales have been recorded on the DOC stranding database, however there is the potential that they could be encountered during the ECPB 2D MSS.

4.2.6.6 Southern Right Whale

Southern right whales are a large baleen whale that can grow up to 15 – 18 m in length and with a lack of a dorsal fin allows for easy identification. The upper jaw and facial area of the southern right whale has callosities (hardened patches of skin) that are often white due to infestations from whale lice, parasitic worms and barnacles making them more distinguishable. They are a slow moving whale, often swimming at speeds less than 9 km/hr, making them vulnerable to ship-strikes.

Southern right whales are the only baleen whale to breed in NZ waters; during winter months calving occurs in coastal waters whereas in summer they migrate to the Southern Ocean (sub-Antarctic and Campbell Islands) to feed. Their northern migration sees them go through the Cook Strait between May-October, although sighting observations have been recorded outside of this period.

The population was heavily reduced by whaling, where numbers dropped from ~17,000 to ~1,000 (Suisted & Neale, 2004; Carroll *et al.*, 2011a) and is a priority for DOC to collect sighting data and genetic samples. Within NZ southern right whales are regarded as nationally endangered but it appears they are making a recovery. Genetic evidence suggests that southern right whales seen around mainland NZ and the NZ subantarctic represent one stock, as there is no differentiation between the two regions based on the analysis of mitochondrial or nuclear loci (Carroll *et al.*, 2011b). It is now thought that there is currently one NZ population of southern right whales with a range that includes two wintering grounds: the primary wintering ground in the NZ subantarctic and secondary wintering ground of mainland NZ (Carroll *et al.*, 201b). Rayment & Childerhouse (2011) estimated the population of southern right whales in the subantarctic using annual photo-ID surveys from 2006-2011. The survey resulted in 511 individuals being identified and through modelling estimated that the whales associated with the survey area during the course of the study was estimated to be 1,286 (689-2,402) in 2011.

Southern right whales have been observed inshore of the ECPB Operational Area along the east coast region with all of these sightings being very coastal. These sightings have shown a seasonal trend which most likely depicts the migration cycle of southern right whales, with the winter sightings most likely reflecting animals on breeding or calving grounds (Torres,

2012). This is typical of the southern right whales with a habitat use pattern at this life history stage to be in protected coastal waters with the least threat of predation from predators such as killer whales and sharks (Torres, 2012). There has been one stranding event along the Wairarapa coastline of a southern right whale. It is believed unlikely that a southern right whale would be observed during the ECPB 2D MSS, scheduled to commence early April 2014 as these whales appear to be down in the Antarctic waters to feed during the summer months.

4.2.6.7 Beaked Whale

Due to the limited sightings at sea, very little is known about the distribution of beaked whales around the NZ coastline. Eleven species of beaked whales are present in NZ, however it is difficult to identify specific habitat types and behaviour for each individual species, as most of the information comes from stranded whales, and in some cases provides the only knowledge that they exist within NZ waters. Beaked whales are mostly found in small groups in cool, temperate waters with a preference for deep ocean waters or continental slope habitats at depths down to 300 m.

Along the coastline inshore of the ECPB Operational Area nine species of beaked whales have been recorded from the DOC stranding database and include: Andrew's; Blainville's; Gray's; Hector's; Layard's/strap-toothed; Shepherd's; Cuvier's; Arnoux's and pygmy. A lot of the strandings have occurred over the summer months, however across all of the species the strandings have also occurred throughout the year, so it is assumed they are present all year round. Therefore these beaked whales mentioned here as determined from DOC's stranding database, could be observed during the ECPB 2D MSS but they will likely to be difficult to observe at sea.

4.2.6.8 Sperm Whale

Sperm whales are globally distributed and are the largest of the toothed whales. Males can reach 18 m in length and weigh up to 51 tonnes; whereas females are usually half the weight and two-thirds the length. They are an intelligent animal, with a brain weighing on average 8 kg it is heavier than any other animal (Te Ara, 2014c; Wikipedia, 2014b). Squid is their most common food but they are also known to eat demersal fish (Torres, 2012).

Sperm whales prefer the open ocean environment of shelf breaks and deep canyons at depths down to 1,000 m where dives can last for over an hour, so they rely heavily on acoustic senses for navigation and communication (Torres, 2012).

Sperm whales use clicking sounds to communicate and using this echolocation to not only hunt for prey but to identity the other whales in its group, which can often allow the groups to coordinate foraging activities (Andre & Kamminga, 2000). It is believed that sperm whales can most likely determine the size, direction and distance of prey when they are hunting in the deep water where there is no light (ORG, 2014). This echolocation will allow any sperm whales in the proximity to the ECPB Operational Area to be heard on the PAM system onboard the *Aquila Explorer*. Whale watch Kaikoura use the sperm whales echolocation from deployed hydrophones over the side of their vessels to see where they are and how far away from the surface they are due to the many years of observing these species they are aware and have a great understanding of these large whales behaviour (K Ngapora pers. comm.). As such if there was to be any influence on the sperm whales behaviour from the ECPB MSS, Whale Watch Kaikoura would be able to observe this and will discuss any issues with Schlumberger (Section 5.3.2.6).

Within NZ, the main population of sperm whales resides in Kaikoura and includes both resident and transient individuals. The sperm whales are attracted to Kaikoura due to its rich food resources such as squid and the deep water fish. Kaikoura is one of the few places in the world where sperm whales can be seen year round and close to shore. They congregate here due to the Kaikoura Canyon which is 3 km deep runs right up against the coast creating

a unique environment that sustains a rich and diverse marine food chain. In Kaikoura the whales are almost exclusively young males, 12 – 16 m in length, while the females are larger bulls rarely visit Kaikoura (Te Korowai o Te Tai o Marokura, 2008). Under the IUCN sperm whales are currently listed as vulnerable and under the NZ threat classification system sperm whales are currently classified as non-threatened. The economy of Kaikoura is driven on marine mammal tourism which is worth $134 million a year to the region, of which the resident sperm whales contribute greatly as they ensure that most whale watching tours observe these large whales.

All whales have significant cultural importance, with sperm whales being especially regarded as chiefly figures of the ocean realm and are commonly recognised as taonga (treasure) to all Maori.

During summer month's sperm whales migrate to the poles, males more so than females and juveniles. There have been a large number of strandings of sperm whales along the coastline inshore of the ECPB Operational Area with only one recorded sighting on the DOC database on the southeast coast of the North Island. It is therefore regarded that sperm whales could be observed within the ECPB Operational Area however during seismic acquisition of the ECPB 2D MSS it is likely they are in Antarctica feeding.

4.2.6.9 Pygmy Sperm Whale

Pygmy sperm whales (*Kogia breviceps*) are slightly larger than dolphins, they can grow up to 3.5 m in length and weigh 400 kg. Pygmy sperm whales have no teeth in their upper jaw, only sockets, which the 10 – 16 pairs of teeth in the lower jaw fit into.

They have a very timid behaviour, lack a visible blow, and with their low profile/appearance in the water are often difficult to observe at sea unless weather conditions are calm with little or no swell. As a result most of the knowledge on these whales is derived from stranded whales. A large number of stranded pygmy whales have been recorded inshore of the ECPB Operational Area, especially in the Hawke's Bay where there has been a very large number of strandings recorded on the DOC database.

It is assumed that pygmy sperm whales may be present in the ECPB Operational Area, but could be difficult to observe in most sea conditions.

4.2.6.10 Dwarf Sperm Whale

Dwarf sperm whales (*Kogia sima*) are rare in NZ waters (Te Ara, 2014c) and are not often sighted at sea, so most of the known information comes from stranded whales. The dwarf sperm whales are the smallest species commonly known as a whale, where they can grow up to 2.7 m in length and weigh up to 250 kg, often smaller than some of the larger dolphins. These whales make slow, deliberate movements with little splash or blow and usually lies motionless when they are at the sea surface, making them hard to be observed in anything but very calm seas.

The dwarf sperm whale is very similar in appearance to the pygmy sperm whale, making identification difficult at sea, however, the dwarf is slightly smaller and has a larger dorsal fin.

4.2.6.11 Hector's Dolphin

Hector's dolphins are only found in NZ waters and at 1.2 – 1.5 m in length they are one of the smallest cetaceans in the world. Over the last 40 years their numbers have declined significantly and are classified as 'nationally endangered' by the NZ threat classification list and as 'endangered' on the IUCN list as they are among the most rare of the world's 32 marine dolphin species. Hector's dolphins have a patchy distribution, generally living in three geographically distinct groups around the South Island. The most frequently sighted Hector's dolphins are found on the west coast between Jackson Bay and Kahurangi Point, on the east coast between Marlborough Sounds and Otago Peninsula and on the south coast between

Toetoes Bay and Porpoise Bay as well as in Te Waewae Bay (MPI, 2013). Smaller population densities are also found in Fiordland, Golden Bay and south Otago coast. There is significant genetic differentiation among the west, east and south coast populations, with little or no gene flow connecting them (Hamner *et al.*, 2012).

MPI funded survey programmes were conducted to assess abundance and distribution of the south coast South Island and east coast South Island populations of Hector's dolphin (Clement *et al.*, 2011; MacKenzie *et al.*, 2012; MacKenzie & Clement, 2013). The survey programme involved aerial surveys during summer and winter months with the number of Hector's dolphins recorded along transect lines. The sighting data was analysed using mark-recapture distance sampling and density surface modelling techniques to yield estimates of density and total abundance. It was estimated that the south coast South Island population was estimated to be 628 dolphins (95% CI = 301-1,311).

For the east coast South Island surveys a total of 354 dolphin groups were sighted in summer and 328 dolphin groups were sighted in winter. After the results were analysed using the modelling techniques above to yield estimates of density and total abundance, an estimate of 9,130 (95% CI = 6,342-13,144) was determined for summer and 7,465 (95% CI = 5,224-10,641) was estimated for summer. Hector's dolphin numbers are believed to have increased within the Banks Peninsula MMS and are now routinely reported around the Marlborough Sounds (Hamner *et al.*, 2012). The South Island west coast population is estimated at about 5,400 (MPI, 2014c).

It is believed set nets used are responsible for ~75% of the known Hector's dolphin's deaths but many more may go unreported (MPI, 2014c; Project Jonah, 2014). Hector's dolphins are often observed close to shore as they prefer shallow, turbid coastal waters with most sightings in water depths of less than 100 m. However, occasional sightings have occurred beyond the 100 m isobaths at distances out to 20 Nm off Banks Peninsula (MacKenzie & Clement, 2013) and a sighting of a Hector's dolphin from the Māui platform in the South Taranaki Bight supports they can be found further offshore.

The DOC stranding database shows a number of Hector's dolphins have stranded along the Kaikoura and Marlborough coastlines, however there have been no recorded strandings along the east coast of the lower North Island. Therefore, given the water depth of the ECPB Operational Area, it is unlikely that a Hector's dolphin would be present.

4.2.6.12 Common Dolphin

The common dolphin has a distinctive colouring of purplish-black to dark grey on top to white and creamy tan on the underside. They can grow to 1.7 – 2.4 m in length, weigh 70 – 110 kg and feed on a variety of prey (fish (anchovies), small mid-water fish (jack mackerel) and squid) (Meynier *et al.*, 2008). The maximum ages of the common dolphin is up to 29 years old which scientists calculated from a fresh carcass, the oldest on record for this species, with sexual maturity at 7 – 12 years for males and 6 – 7 years for females.

Common dolphins are distributed around the entire NZ coastline, generally remaining within a few kilometres of the coast and can often form groups of several thousand individuals. In the Bay of Islands the mean water depth of sightings is 80 m, but range from 6 – 141 m (Constantine & Baker, 1997). The principal predators of common dolphins are killer whales.

This species of dolphin is common around the NZ coastline and has been observed inshore of the ECPB and even though common dolphins generally prefer coastal waters, they are likely to be observed in the ECPB Operational Area.

4.2.6.13 Bottlenose Dolphin

Bottlenose dolphins are among the largest of dolphin species, ranging from 2.4 – 4 m in length and 250 - 650 kg in weight. Throughout the world, bottlenose dolphins are widely

distributed in cold temperate and tropical seas, with NZ being the southernmost point of their range.

Within NZ there are three main coastal populations of bottlenose dolphins; approximately 450 live along the northeast coast of Northland, 60 live in Fiordland and there is a population living in the Marlborough Sounds to Westport region. The three populations each have differences within their DNA indicating little or no gene flow between the populations (Baker *et al.*, 2010). A sub-population of offshore bottlenose dolphins also exists that travels more widely and often in larger groups.

Bottlenose dolphins are now listed as 'Nationally Endangered' on the NZ threat classification list, largely due to their low abundance and concerns over potential decline in populations.

Bottlenose dolphins have been observed inshore of the ECPB Operational Area and around the south Wellington coastline, however it is likely that if any are observed during the ECPB 2D MSS they would likely be the offshore bottlenose dolphins.

4.2.6.14 Dusky Dolphin

Dusky dolphins are slightly smaller than common dolphins; growing up to 2 m in length, 50 – 90 kg in weight and are characterised by having virtually no beak. They prefer cool inshore waters but have can be found as far offshore as the continental shelf. In NZ waters they mainly live south of East Cape and are the second largest population of dolphin species around NZ. The population of dusky dolphins within NZ is believed to be 12,000 – 20,000 individuals and are not regarded as threatened (Markowitz *et al.*, 2004). Large populations of dusky dolphins are found around Kaikoura and form an important component of Kaikoura's marine tourism industry either through dolphin watching or swimming with the dusky dolphins. No defined seasonal migrations exist but they are known to make offshore seasonal and diurnal movements. During late spring and summer, dusky dolphins spend the mornings inshore resting and socialising then late afternoon move 6 – 15 km offshore. In winter dusky dolphins generally spend more time in deeper water.

Dusky dolphins consume a variety of fish (e.g. anchovies) and squid species as part of their diet, often forming large feeding groups. No dusky dolphins have been observed or any strandings recorded in close proximity to the ECPB Operational Area however from their known distribution they could potentially be observed during the ECPB 2D MSS.

4.2.6.15 Killer Whale

Killer whales are the largest member of the dolphin family; males can grow to 6 – 8 m and weigh in excess of six tonnes. They have the second heaviest brains among all mammals and are very intelligent. It is believed two populations exist within NZ waters; one inshore and one offshore although this is still not verified. During the summer NZ fur seal breeding season, killer whales are often found inshore.

The resident NZ killer whale population is small (mean = 119 ± 24 SE) with broad distribution patterns around both North and South Islands (Visser, 2000). Within the NZ threat classification list killer whales are classified as 'nationally critical' (Suisted & Neale, 2004). On 12 February 2014 nine killer whales stranded at Blue Cliffs Beach, near Tuatapere (South Coast of NZ) which was a tragic stranding, being NZ's third largest stranding of killer whales and possibly one of the 10 largest internationally. As part of this stranding, Visser was quoted as saying there are fewer than 200 killer whales now living off the NZ coast.

Killer whales have been sighted and reported from Napier, Wellington and Kaikoura, all in close proximity to the coastline and stranding events have occurred at Porangahau and the Kaikoura to Marlborough coastlines. However it is important to note that there are limitations within sighting databases and collecting data on marine mammals that have low numbers with wide temporal and spatial distributions. It is believed there is the possibility that killer

whales could be observed when the *Aquila Explorer* is mobilising to and from the ECPB Operational Area.

4.2.6.16 Pilot Whale

Pilot whales are also a member of the dolphin family; males are larger than females and can grow up to 6 m long and weigh three tonnes. There are two species of pilot whales; long-finned and short-finned, of which the long-finned is more likely to be found in NZ waters. Long finned pilot whales are a migratory species; they prefer cold temperate coastal waters and along shelf breaks, where they feed on fish and squid in deeper water.

Pilot whales are notorious for stranding along the NZ coastline, which generally peaks in spring and summer (O'Callaghan, 2001), with Farewell Spit renown for a number of whale strandings each year.

They are a very social whale and can often travel in groups of over 100; it was originally thought the family relationships among the pilot whales was the cause of strandings as a result of their 'care-giving' behaviour. Where if one or a few whales stranded due to sickness or disorientation, a chain reaction is triggered which draws the healthy whales into the shallows to support their family members (Oremus *et al.*, 2013). However from genetic data gathered from stranded whales in NZ and Tasmania, it was proven that stranded groups are not necessarily members of one extended family and many stranded calves were found with no mother present (Oremus *et al.*, 2013).

Pilot whales are abundant around the coast of NZ, with the DOC stranding and sighting database both indicating their presence around the entire ECPB Operational Area. As a result it is highly likely that pilot whales will be observed in the ECPB Operational Area.

4.2.7 Pinnipeds

Within NZ waters the NZ fur seal is the most common of the pinnipeds. They are distributed around NZ, with a population estimate of 50,000 – 60,000 but this is likely to be significantly underestimated. NZ fur seals forage for food along continental shelf breaks up to 200 km offshore but are generally distributed inshore, in water depths of less than 100 m.

NZ fur seals can hold their breath for 10 – 12 minutes, enabling very deep dives (~ 200 m) to feed on fish (small mid water fish, conger eels, barracouta, jack mackerel and hoki), squid and octopus; which is further aided by being able to slow their heart rate down to help conserve oxygen.

NZ fur seals are present around the entire NZ coast with sighting information covering the extent of NZ. It is noted that a large proportion of the sighting observations have arisen from previous MSS around NZ where dedicated MMO's have been onboard. As a result it is highly likely that NZ fur seals will be observed within the ECPB Operational Area.

4.2.8 Marine Reptiles

Off the coast of NZ, seven marine reptile species are known to live: the loggerhead turtle (*Caretta caretta)*, green turtle (*Chelonia mydas)*, hawksbill turtle (*Eretmochelys imbricate)*, olive Ridley turtle (*Lepidochelys olivacea)*, leatherback turtle (*Dermochelys coriacea*) yellow-bellied sea snake (*Pelamis platurus)*, and the banded sea snake (*Laticauda colubrine)*. Most of the marine reptiles are generally found in warm temperate waters, and within NZ this mainly occurs off the northeast coast of the North Island.

Within the waters inshore of the ECPB Operational area the following marine reptiles have been observed: green sea turtle; hawksbill turtle; loggerhead sea turtle; leatherback turtle; banded sea snake and the yellow-bellied sea snake (DOC, 2014b). These are rare visitors to waters within which the ECPB Operational Area is situated, but if any reptiles are recorded during the MSS they would be recorded and further increase the knowledge of NZ's marine reptiles. A study which exposed captive sea turtles to an approaching acoustic source

indicated that turtles displayed a general alarm response at ~2 km from the acoustic source with avoidance behaviour estimated to occur at 1 km (McCauley *et al.*, 2000).

4.2.9 Seabirds

There are 86 species of seabirds in NZ waters which include albatross, cormorants, shags, fulmars, petrels, prions, shearwaters, terns, gulls, penguins and skuas (DOC, 2014c). NZ is often considered to be the seabird capital of the world and important breeding grounds, with NZ having the greatest variety of albatrosses and petrels. Most of the seabirds identified in this MMIA breed on coastal headlands and offshore islands although some use the ECPB Operational Area as foraging habitat.

A number of sources (DOC, NABIS, and available literature) have been used to identify the likely seabirds that could be present within and around the ECPB Operational Area and includes:

- **Albatross** – wandering, southern royal, northern royal, light-mantled sooty, antipodean, Campbell, Gibson's, grey headed, Chatham, pacific and white capped;
- **Mollymawks** – Salvins, black-browed and Buller's;
- **Shearwaters** – short tailed, little, Buller's, flesh-footed, sooty, Hutton's, common-diving and fluttering;
- **Petrels** – black, common diving, grey, grey-faced, Kermadec, Kermadec white-faced storm, northern giant, Westland, NZ storm, Giant (Nelly), Cape, Mottled and white chinned;
- **Terns** – Caspian, white, black-fronted and white-fronted;
- **Penguins** – northern little blue, blue, yellow-eyed, white-flippered and eastern rockhopper; and
- South polar skua, black-backed gull, red-billed gull, black-billed gull, cape pigeon, fairy prion and Australasian gannet.

Sea birds that feed by plunge diving (i.e. Australasian Gannet) or that rest on the sea surface and dive for food (i.e. sooty shearwater) have the potential to be affected by underwater noise from MSS's. However it is believed that acoustic damage to birds could only be experienced if a bird was diving in close proximity to the acoustic source array (i.e. within 5 m of the array) (Bendell, 2011).

Diving seabirds are all highly mobile and are likely to flee from approaching sound sources. The potential for physiological effects from MSS noise on diving bird species is considered to be of high intensity but would only be in close proximity to the acoustic source and limited to the MSS duration. Likewise, any avoidance behaviour of birds from the ECPB Operational Area, if indeed it does occur, would only last for the MSS duration.

It is highly likely that the Australasian Gannet will be in the ECPB Operational Area during the proposed MSS period; given these birds often follow the sub-tropical water that moves south carrying an abundance of food for the gannets, where gannets can be observed along both coasts of the North Island and throughout the top of the South Island. These birds feed on pelagic baitfish (i.e. pilchards, saurie, anchovies) that are present in this sub-tropical water, and it is likely that if these baitfish move away from the ECPB Operational Area due to the sound levels emitted during the ECPB 2D MSS, the likelihood of any seabirds diving in close proximity to the acoustic source is considered remote. Gannets have very good eyesight and only enter the water when they can view these baitfish, often travelling many kilometres until they find food.

4.2.9.1 Breeding Colonies

Surrounding the ECPB Operational Area, ten bird species are known to have breeding colonies (MPI, 2014b). These birds, listed below along with their listing in the NZ threatened species classification, have their breeding colonies plotted in Figure 25.

- Sooty shearwater – declining;
- Caspian tern – nationally vulnerable;
- King shag – vulnerable;
- Grey-faced petrel – declining;
- Flesh-footed shearwater – declining;
- Hutton's shearwater – nationally endangered;
- Yellow-eyed penguin - threatened;
- Black-fronted tern - threatened;
- Black-billed gull - Threatened; and
- White-flippered penguin – acutely threatened.

Figure 25: Breeding colonies of seabirds surrounding the ECPB Operational Area

4.2.10 Invertebrate Communities

Worldwide, invertebrates consist of approximately 34 major groups, 10 major phyla and 23 minor phyla, and from the one million animal species described, the majority comprise of Arthropoda, followed by the Mollusca, Protista, Nematoda, Platyhelminthes, Cnidaria, Annelida, Echinodermata, Porifera and Bryozoa (Marsden & Schiel, 2007).

NZ has a large diversity of marine invertebrates which is attributable to the variable seafloor relief and NZ's ancient geological history. Certain groups dominate rocky intertidal shores (i.e. molluscs), while mobile invertebrates often dominate soft shores. On hard shores sessile invertebrate species (i.e. sponges, ascidians, bryozoans, and hydroids) are conspicuous and form stable communities. Some of the more well-known taxonomic groups, not already mentioned above include starfishes, crustaceans, corals, jellyfish, and cephalopods (squid and octopus). A large proportion of the marine invertebrates around NZ live a sessile benthic lifestyle which often have a planktonic larvae or pelagic juvenile stages. Research has shown that the influence of larval dispersal of propagules from coastal sites can be strongly directional, and connectivity between adjacent sites and populations of many benthic species is likely to be limited, with populations at some sties most likely dependent upon local reproduction and self-recruitment (Lavery *et al.*, 2007).

Cephalopods are a member of the molluscan class Cephalopoda and are characterised by a bilateral body symmetry, a prominent head, and a set of arms or tentacles, modified from the primitive molluscan foot. Cephalopods are found in all of the oceans around the world, of which there are around 800 species; in NZ the most well-known are the squid, octopus and cuttlefish. It is believed that cephalopods are the most intelligent of the invertebrates and have well developed senses and large brains as well as the most complex nervous system. Cephalopods have a balance sensory receptor which is called a statocyst which consists of a sac-like structure containing a mineralised mass (statolith) and numerous innervated sensory hairs. Cephalopods generally live short lives (~ one to two years) but have rapid growth rates, where most of the energy extracted from their food is utilised for growing. Squid are important to NZ, they not only have a commercial value with the southern fishery but they are a food source to a number of marine fish and mammals, especially the sperm whale which predate on squid (including giant squid) and other deep water fish around the Kaikoura canyon.

Along the intertidal zone inshore of the ECPB Operational Area, intertidal invertebrates are dominated by certain groups and are dependent on habitat. Molluscs are most abundant on rocky shores and mobile crustaceans are the most abundant organisms on particulate shores (Marsden & Schiel, 2007). Invertebrate species diversity increases with habitat complexity, where there have been 120 invertebrate species identified within the intertidal zone at Kaikoura Peninsula alone (Te Korowai o Te Tai o Marokura, 2008). The most common invertebrate species in the intertidal and shallow subtidal consist of chitons, limpets, gastropods, topshells, whelks, paua, crabs, barnacles, tube worms, sea anemones, echinoderms (sea urchins, brittle stars, sea cucumbers and starfish), bivalves (mussels, scallops), periwinkles, surf clams, and ascidians. Along the Kaikoura coastline to the south of the ECPB Operational Area most of the invertebrates are shellfish, with more than 30 mollusc species present comprising of various grazers, filter feeders, scavengers and carnivores (Te Korowai o Te Tai o Marokura, 2008).

Subtidally there are many invertebrate species that live on both the hard and soft substrates and include starfish, various sponges (*Ancorina alata*, *Aplysilla sulphurea*, *Polymastia fusca*, *Stelleta conulosa*, orange cup sponge, *Tethya ingalli*, *Aaptos aaptos*), wandering anemone, jewel anemone, noble chiton, octopus, black sea slug, paua, mussels, Cook's turban, spotted topshell, tiger topshell, opal topshell, urchins, whelks, crayfish, snake star, sea cucumber, byrozoans, brachiopods and ascidians. The deeper water tends to be dominated by a diverse range of sponges, corals and other encrusting invertebrates.

Corals are also marine invertebrates and belong to the class Anthozoa of the phylum Cnidaria, and typically live in compact colonies of many identical individual polyps. NZ has a rich and diverse range of corals that are present from the intertidal zone down to 5,000 m (Consalvey *et al.*, 2006). Corals can live for up to hundreds of years and exist either as individuals or colonies. Deep-sea corals are fragile, sessile, slow growing, long-lived, have a low natural mortality rate, can have limited larval dispersal and are restricted to certain habitats.

Black corals or antipatharians are distinguished by their erect and often bushy growth forms and hard proteinaceous skeleton that bears tiny polyps. They have a wide distribution by both depth and latitude around NZ, however it is noted that the knowledge of deep-sea coral fauna around the world, including the NZ region remains poor, largely due to the difficulties inherent in observing them alive (Consalvey *et al.*, 2006). There are 58 black corals species known in NZ waters and are protected within NZ's EEZ under the Wildlife Act 1953. The definition of deep-water corals in NZ has been given to those corals generally living in depths greater than 200 m and are also known as cold-water corals (MPI, 2014b). Research has shown that these deep-water corals are fuelled by surface primary productivity.

NIWA have developed a database of black coral distribution around NZ which provide some general distribution trends within the NZ region. The presence of black coral increases to the north and east (Chatham Rise), although this may be due to sampling effort as a lot of knowledge about the black coral distribution comes from the commercial fishers (Figure 26).

From this distribution map (Figure 26) it is clear that there have been no records of black coral within the ECPB Operational Area.

The potential effects of acoustic noise on corals is not well publicised due to a lack of literature. It has been suggested that sound emission from acoustic sources could either remove or damage polyps on the coral calcium carbonate skeleton but has not been reported so far.

In 2006 Woodside Energy Ltd applied to the regulator in Australia (Environmental Protection Authority) to undertake the 340 km^2 Maxima 3D MSS around Scott Reef in Western Australia. Prior to the survey an extensive marine scientific field validation survey costing over $10 million was conducted to assess the effects of a seismic survey on coral reef fish and coral species. The experiment involved 123 people from a variety of scientific organisations, including the Australian Institute of Marine Science who conducted pre, during and post seismic survey field experiments. The Maxima MSS Area water depths ranged from 20 – 1,100 m with the scientific study taking place within the southern lagoonal waters of Scott Reef. The study involved the exposure of faunal communities to acoustic source emissions using the actual survey vessel and acoustic array (2,905 in^3) to be used in the Maxima MSS. The monitoring work consisted of shallow water fish diversity and abundance, coral monitoring, deep-water fish diversity and abundance, collection of fish samples for pathology studies, physiological studies. Sub-surface equipment was also deployed including sound loggers, remote underwater video and fish exposure cages with captured reef fish.

The key outcomes of the study were that after the MSS had completed, there was no hearing impacts (temporary or permanent) found in fish after exposure to the acoustic source, there was no evidence of coral damage or fish mortality caused by the acoustic source emissions, the observed impacts were less than initially modelled and predicted within the EIA, there was no long term impacts on fish populations (Woodside, 2007; Colman *et al.*, 2008).

After the survey vessel and acoustic source had passed over an area of reef, the Australian Institute of Marine Science followed behind the source with underwater video recording all of the observations. There were no signs of effect on any coral species immediately after the seismic survey, where the scientists were looking for any sign of lethal or sub-lethal effects.

This study is the world's first scientific study of this kin and demonstrated that MSS's can be undertaken in sensitive coral reef environments with no detrimental impact (Colman *et al.*, 2008).

So when these results are applied to the deep waters within the ECPB Operational Area, given there is no scientific studies or literature available for deep water corals, it is also assumed that there would be no detectable effects on any of the coral species from the ECPB 2D MSS acoustic source. Given the water depth at which black corals grow within NZ (> 200 m) it would make it very difficult to undertake any scientific research, and the exact distribution is not well known, most of the distribution location information comes from specimens recovered during deepwater trawls.

Most of the studies undertaken on coral reproduction and recruitment have been carried out in tropical reefs and little is known about the reproduction/recruitment of deep-sea corals. Miller (1996) undertook a study on the shallow black coral *Antipathes fiordensis* found in Fiordland and determined them to be gonochoristic and only reproduce once a year (most likely towards the end of summer). It was further reported that *A. fiordensis* have a restricted larval dispersal with larvae being negatively buoyant, weak swimming and short lived (Parker *et al.*, 1997). These shallow water corals in Fiordland are easier to study, however there applicability to deep-sea corals may be limited and more work is still required to investigate the reproduction of deep-sea black corals. Studies undertaken on different coral species that have a planktonic or pelagic phase to their lifecycle has shown that mortality can result if the planktonic phase of the coral are within close range (< 5 m) to the acoustic source (DIR, 2007). However, in general for corals that have a pelagic planktonic phase they generally high fecundity rates for pelagic larval dispersal to offset high natural mortality rates from stochastic events, so any effects on the planktonic coral larvae in close proximity to the acoustic source would be considered negligible. It appears that black coral have low fecundity and recruitment (Consalvey *et al.*, 2006) where the larval stage does not disperse very far from the mature coral, and given the larvae are negatively buoyant and the depths that the black coral live in (>200 m – apart from Fiordland) the larval stages will not come in close proximity to the acoustic source used within the ECPB 2D MSS.

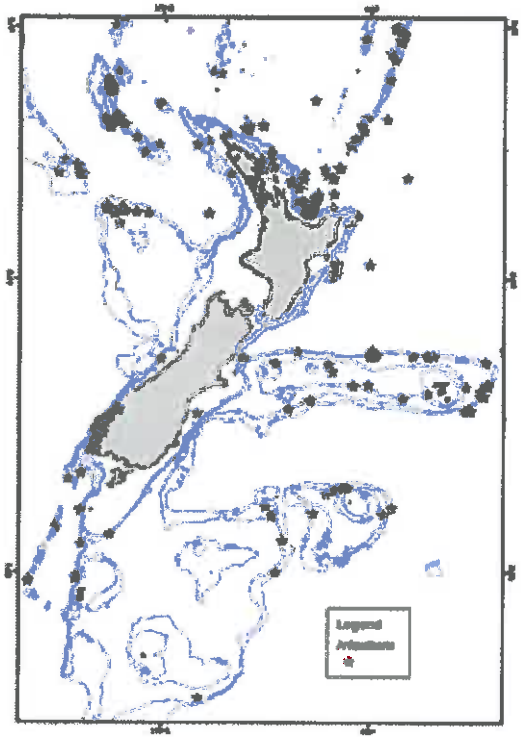

Figure 26: Known localities of all black coral records within NZ region (Source: Consalvey *et al.*, 2006)

4.2.11 Protected Natural Areas

Protected Natural Area's (PNA) are put in place for biodiversity conservation and receive protection as a result of their recognised natural ecological values. There are a number of PNA's inshore and surrounding the ECPB Operational Area; the closest being Te Angiangi Marine Reserve and Te Tapuwae O Rongokako Marine Reserve (Figure 27).

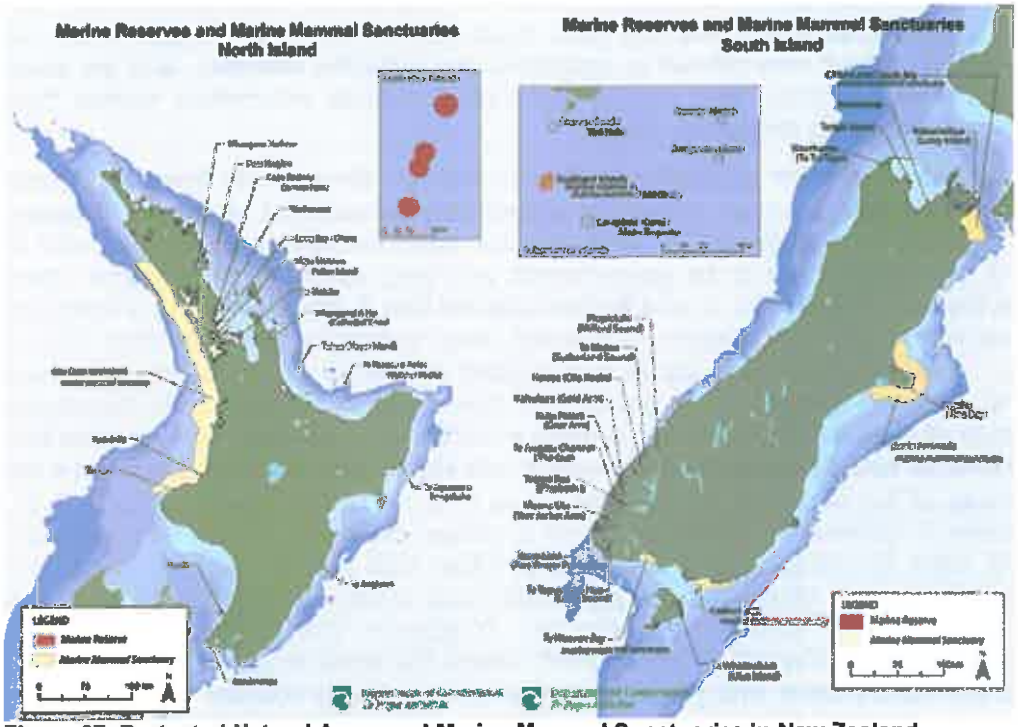

Figure 27: Protected Natural Areas and Marine Mammal Sanctuaries in New Zealand

4.2.12 Benthic Protection Areas

The Government established 17 Benthic Protection Areas (BPA) in 2007; closing large areas of seabed to bottom trawling and shellfish dredging. As a result 1.2 million km^2 of seabed was protected which equates to ~32% of the EEZ. The nearest BPA to the ECPB Operational Area is Hikurangi Deep – 120 km to the east and the Mid Chatham Rise – 80 km to the southeast (Figure 28).

Figure 28: Benthic Protected Areas in relation to the ECPB Operational Area

4.2.13 Kaikoura Areas of Significant Natural Value

Environment Canterbury administer the Regional Coastal Plan for the Canterbury Region, of which Kaikoura is a part of (RCEP, 2011). The Regional Coastal Plan has defined those areas which have high natural, physical or cultural value and require a measure of integrated management and defining these areas and their significance is crucial to the purpose of the Resource Management Act in promoting the sustainable management of natural and physical resources.

Areas of significant natural value are identified only within the CMA, however these values often extend landward of this administrative boundary, i.e. seal colonies, coastal landforms and landscapes.

The Kaikoura area is rich and diverse in intertidal ecosystems, reefs, beaches, headlands and rocky platform with a diversity of marine life along a largely undeveloped coastline that is well accessible. Within the Regional Coastal Plan for the Canterbury Region, the areas that are defined as having significant natural value are shown in Figure 29, while a description of the northern areas of significant natural value that are in close proximity to the ECPB Operational Area are defined below.

- **Clarence River** – is a spectacular landscape feature and considered outstanding for the experience it provides recreationalists. The Clarence River valley has huge gorges, dramatic waterfalls and stark cliffs, while the limestone ridge running through the valley is an interesting geological feature. The Clarence River delta system has a breeding population of banded dotterel and is also visited by Caspian terns, both of which are nationally threatened;

- **Waipapa to Irongate** – along this section of coastline, NZ fur seals use Ohau Point as a haulout and breeding site, while other marine mammals are common offshore. Reef heron can also be found here and are listed as nationally threatened;
- **Kaikoura Peninsula** – has two NZ fur seal haulout areas, while a number of seabirds use the peninsula for both feeding and breeding. Marine mammals are common offshore and drives a valuable tourism industry due to the Kaikoura canyon providing nutrient rich deep water close to shore;
- **Kahutara River to Oaro** – has two nature reserves present in this stretch of coastline which is also an important area for red-billed gulls, spotted shags and white-fronted terns. NZ fur seals and marine mammals are common along this stretch of coast;
- **Oaro to Haumuri Bluffs** – are part of a regionally significant landscape feature with spectacular cliffs and a natural rock arch. The bluffs are an important habitat and haulout area for NZ fur seals, while yellow-eyed penguins are known to roost in an area at the bluffs. Elephant seals and leopard seals have been observed here previously;
- **Conway River mouth** – drains the hill country south of the Kaikoura ranges and enters the sea at Conway Flat. The river mouth lagoon is a significant wetland providing habitat for birds such as black-fronted terns, dotterels, black swans, white-faced herons and black-backed gulls;
- **Waiau River Mouth and Shag Rock coastline** – provides breeding and roosting habitat for a number of seabirds as well as a NZ fur seal colony that is increasing in number;
- **Napenape** – has steep limestone coastal features with a NZ fur seal colony present to the south of Napenape Bluff. This stretch of coastline also supports a number of coastal bird species; and
- **Motunau Island** – has a distinctive flat tip and lies 1.2 km south and offshore from the Motunau River mouth. There is a breeding colony of 5,000 little blue penguins here with a number of other bird species which breed on the island.

4.2.14 Marlborough Coastal Ecologically Significant Marine Sites

The Marlborough region has an extensive 1,722 km long coastline with a large number of ecologically significant marine sites that support rare, unique or special features within the CMA (Figure 29). The Marlborough coastline extends from Cape Soucis in Tasman Bay throughout the Marlborough Sounds and south to Willawa Point, near Kekerengu on the east coast. Within the Marlborough Sounds there are a large number of ecologically significant sites that have been defined by MDC, DOC and a group of marine scientists (Davidson et al., 2011) and given the scale of the map and the number of sites, they have not been shown or provided within this report. For the purpose of this assessment, only the sites on the east coast of the south island have been considered, as they are the closest sites to the ECPB Operational Area and an overview of these areas has been provided below.

- **Tory Channel** – connects the inner Queen Charlotte Sound with Cook Strait, where strong tides flow through the narrow, deep (30-75 m) passage. Strong tidal flows from the Cook Strait introduce cold, saline, nutrient-rich water into the inner Queen Charlotte Sound. As a result of this the Tory Channel and Queen Charlotte Sound have a diverse range of intertidal and subtidal species, including marcroalgae, invertebrates, fish and mammals;
- **Brothers Islands** – are rocky stacks located approximately 5 km east of Cape Koamaru in the Cook Strait. There are approximately 600 pairs of diving petrel and 1,000 pairs of fairy petrel that breed on the two main islands, and is one of the five largest colonies for these species in the Marlborough region;

- **Port Underwood** – large coastal, relatively shallow (11-15 m) inlet approximately 10 km wide with two arms and a highly indented coastline. It is used for marine farming and has a circulation that is dominated by moderate tidal and wind-generated currents;
- **Cook Strait Whale Migratory Corridor** – is utilised by humpback whales as they move north from Antarctic feeding grounds to tropical waters for calving and breeding during winter months (May-August). Other large whales also utilise Cook Strait, including; southern right whales (winter months), blue whales (possibly all year round but very little is known about this species distribution) and sperm whales (probably all year round in the deeper waters of the Strait, i.e. >300 m (Davidson *et al.*, 2011). The ECPB 2D MSS is anticipated to commence at the start of April 2014 and will run for approximately 40-50 days. All efforts will be made where operationally feasible to acquire the southern part of the ECPB Operational Area first, working north so that the distance between the acoustic source and the Cook Strait increases over time. The DOC migratory monitoring occurs over the peak of the migratory season and runs during the month of June each year, by which the ECPB 2D MSS will be completed;
- **Cloudy and Clifford Bays (subtidal)** – includes the area from Cape Campbell north to the entrance of Tory Channel and is home to a resident population of Hector's dolphin. This area is an important area for dolphins with the primary area being between the mouths of the Wairau and Awatere Rivers, and offshore as far as the 100 m depth contour (Davidson *et al.*, 2011). A marine mammal sanctuary is in place for most of this area (Section 2.5);
- **Wairau Lagoon** – is a 2,300 ha tidal estuary and coastal wetlands within a number of low-lying islands. The Wairau Lagoon is the largest and biologically most important estuary on the east coast of the South Island where almost 90 species of birds have been recorded (Davidson *et al.*, 2011). Two flatfish species also use the lagoon and is an important nursery area;
- **Lake Grassmere** – is a large shallow, tidal lagoon which is visited by a number of migrating wading birds. However the main area of Lake Grassmere has been extensively modified by salt works; and
- **Cape Campbell to Ward Beach** – has a relatively straight coastline with limestone outcrops in the north near Cape Campbell. Cape Campbell is renowned for its cliffs, large mudstone shore platforms and offshore reefs, while to the south there is expansive sand and gravel beaches. Most information on the ecology of this section of coast is in regards to the intertidal zone, little is known about the subtidal zones however there are diverse rocky reef and giant kelp beds present offshore. Water clarity is often cloudy due to the heavy sediment loading from the Clarence and Waima (Ure) Rivers further south, soft limestone and siltstone along the coast, sediment run off from modified catchments and the coast's exposure to southerly storms.

Figure 29: Kaikoura Areas of Significant Natural Value and Marlborough Ecologically Significant Areas

4.2.15 Wellington Coastal Conservation Areas

The Wellington region has a number of coastal conservation areas which include two marine reserves, a Taiapure and four Areas of Significant Conservation Value (ASCV). There are also 20 areas of important conservation value listed in the Greater Wellington Regional Coastal Plan (GWRCP, 2000), some of which are defined below and are shown in Figure 30.

- **Kapiti Marine Reserve** – extends offshore from Waikanae and encompasses the Kapiti Island Nature Reserve and Waikanae Estuary Scientific Reserve with an area of 2,167 ha. The Kapiti Marine Reserve is on the west coast of the North Island and well away from the ECPB Operational Area;
- **Taputeranga Marine Reserve** – is on Wellington's south coast and has an area of 854 ha. It lies at the meeting place of three oceanic currents which shape the exposed coastline into a wide range of habitats which provides home to a number of

different marine animal and plant species. In sheltered parts kelp plants grow up to 20 m and approximately 400 seaweed species have been recorded within the reserve;

- **Palliser Bay Taiapure** – contains food species that are of particular importance to the local Maori community and the Taiapure allows for the Maori to propose regulations for the sustainable management of culturally important seafood resources;
- **Waikanae Estuary Scientific Reserve** – an ASCV which has a range of important habitats for indigenous plant and animal species with a nationally significant wetland present. This ASCV is on the west coast of the North Island;
- **Pauatahanui Inlet** – contains seagrass and saltmarsh habitats and is nationally important for migratory shorebirds and wading birds. It is also important as a nursery area and is rich in invertebrate fauna. Again this ASCV is on the west coast of the North Island;
- **Turakirae Head** – is classified as being of national significance as a geological feature and for wildlife, while also being a regionally significant NZ fur seal haulout area;
- **Lake Onoke** – is important for wildlife and conservation values as well as being a breeding ground for threatened bird and fish species;
- **Castlepoint** – has conservation, scenic, geological and scientific values as well as providing a nesting area for numerous seabirds and is visited by NZ fur seals;
- **Honeycomb Rock & Kahau Rocks** – are an outstanding natural feature. They are a site of regional significance for indigenous flora and fauna on an extensive offshore reef system. It is also a winter haulout area for NZ fur seals;
- **Cape Palliser – Kupe's Sail** – has geological formations of regional significance. Cape Palliser includes a regionally significant seal rookery and a red-billed gull breeding colony;
- **Kaiwahata River outlet** – contains a fossil forest of nationally significance and is classified as an outstanding natural feature; and
- **Whakataki – Maraikona foreshore** – contains geological features of regional significance such as the tongue and groove shore platform at Whakataki. It also has significant habitats for wildlife.

Figure 30: Greater Wellington Areas of significant conservation value and DOC Area of Ecological Importance

4.2.16 Horizons Areas of Significant Conservation Value

Horizons manage the CMA on both the west and east coasts of the North Island. The east coast region within Horizons jurisdiction is approximately 40 km long, from Cape Turnagain south to the Owahanga River mouth. Within this stretch of coast, Cape Turnagain is classified as having significant conservation value within the coastal plan 'One Plan'. A brief description is provided below and can be seen in Figure 30.

- Cape Turnagain – is an important haul out area for marine mammals as well as an important feeding, roosting and breeding area for birds, especially the blue penguin. It is regarded as a site of high value to iwi and is classified as a site of geological importance.

4.2.17 Hawkes Bay Outstanding Natural Features and Landscapes

Within the HBRC Regional Coastal Environment Plan areas of natural features and landscapes have been identified to protect them from inappropriate subdivision, use and development. A summary of each of these significant areas is provided below and they can be seen in Figure 31.

- **Porangahau Estuary** – is a long, narrow estuary formed behind a low, largely unvegetated longshore bar. It encloses a variety of estuarine habitats ranging from saltmarsh, to intertidal sand and mudflats, and shallow tidal channels. It is a nationally significant wildlife and fisheries habitat, and supports nationally significant dune vegetation types. The area is significant to Ngati Kere and provided the first authenticated records of moa hunting occupation in the North Island, has vast shell middens in the dune systems and pa sites at either end of the estuary. It is classified as a nationally significant wildlife habitat and is an important feeding and wintering area for migratory waders. The estuary also has outstanding fisheries values as it contains diverse fish assemblages and biologically important fish habitat;
- **Blackhead Point – Pohatupapa Point Intertidal Platform** – is a siltstone intertidal rock platform which supports biologically diverse intertidal assemblages and regionally significant wildlife habitats for at least 15 species of native birds. Between 85 – 100 species of plants, macroinvertebrates and fish have been recorded at this platform;
- **Aramoana – Blackhead Beach, Central Hawke's Bay** – is the area of shoreline between the mouth of the Ouepoto Stream and 100 m south of Long Range Road at Blackhead. Intertidal rock platforms are along this stretch of coastline which supports biologically diverse intertidal assemblages and regionally significant wildlife habitats, providing feeding habitat for at least 15 species of native birds.
- **Te Angiangi Marine Reserve** – was established in 1997 covering 446 ha between Blackhead and Aramoana Beach. The reserve contains several marine habitat types (boulder bank area, rocky intertidal platforms and a sheltered bay) that protects a typical piece of Central Hawke's Bay coast and provides home to a variety of marine life;
- **Ouepoto – Paoanui Point** – contains two extensive intertidal rock platforms separated by a sandy beach and a large inshore reef system known as Charity Reef both of which are important traditional fisheries to Whatuiapiti. Intertidal siltstone and mudstone platforms have high wildlife values providing feeding habitat to at least 15 native bird species and supports a number of plant, macroinvertebrates and fish species. It is a nationally important fossil locality as it contains the youngest larger fossil foraminifera in NZ;
- **Mangakuri Intertidal Platform** – is part of a series of six very similar siltstone intertidal reef platforms between Blackhead Point and Kairakau, supporting a diverse range of intertidal assemblages which are regionally significant wildlife habitats. The intertidal platform is covered with large numbers of boulders and is barely elevated above low water which provides suitable habitat for large brown algae beds. The diversity and abundance of fish and invertebrate fauna makes his area important feeding areas for birds;
- **Kairakau Intertidal Platform** – is covered by numerous boulders, with the northern end topped by a boulder bank and the southern end by a narrow sandy beach. This area and the nearshore reef systems represents traditional fisheries to tangata whenua. Comprised of siltstone and mudstone platforms with high wildlife values and similar to the other platform reefs along this coastline provides feeding habitat for at least 15 species of native birds;

- **Hinemahanga Rocks** – are part of a reef system that forms a chain of small islets between the mouth of the Mangakuri River and the mouth of the Te Apiti Stream, representing the remnants of Oceanic Ridge basalts subducted at a tectonic plate boundary. The site of six stacks consist of pillow lava with interbedded re-brown limestone and mudstone, while manganese nodules are scattered through limestone interbedded with pillow lave on one of the stacks;
- **Waimarama** – is situated 20 km south of Cape Kidnappers and coincides with the boundaries of the Waimarama Fishing Reserve which recognises the importance of the area as a source of kaimoana for the tangata whenua (Ngati Kurukuru, Ngati Whaikaiti, Ngati Ura Kiterangi, Ngati Hikatoa). It is the only NZ fur seal haulout area in the Hawke's Bay region. A wide variety of marine habitats in this area make it regionally significant which include fine sand surf beaches, broad siltstone intertidal rock platforms, hard basaltic and limestone shores, shallow sand and rubble habitat and extensive shallow reef systems;
- **Cape Kidnappers** – is the most prominent landscape feature in southern Hawke's Bay. The waters surrounding the Cape are important preening and washing areas for gannets which also have a colony at Cape Kidnappers. The area is important to tangata whenua as the intertidal and near shore reef systems provide an important source of Kaimoana. The Black Reef and Saddle gannet colonies are Nature Reserves, and the Plateau colony is a Government Purpose Reserve (protection of gannets);
- **Tukituki River Mouth** – is a small 43 ha estuary formed behind an unstable shingle river mouth bar and is surrounded by a flat, low-lying alluvial plain. It contains large numbers of gulls, terns and shags, with smaller numbers of wading birds. Three pa sites, Waipukureku, Matahiwi and Te Kauhanga are situated near the Tukituki river mouth, with the estuary and offshore area supporting important traditional fisheries for kahawai, flatfish and whitebait. The estuary is an important feeding area for little black shags and little shags, while the river mouth bar is the main roost for Caspian tern;
- **Waitangi Estuary** – is a large tidal area formed at the confluence of the Clive, Ngaruroro and Tutaekuri rivers and is enclosed by an unstable shingle river mouth bar. The estuary, bar and associated wetlands are important nesting, roosting and feeding areas for many species of wetland and coastal birds;
- **Ahuriri Estuary** – is situated adjacent to the city of Napier and receives approximately 90% of the runoff from the city area, but despite this still contains high wildlife and fisheries values and is classified as having nationally significant wildlife habitat;
- **Pania Reef** – is the most significant seabed feature in southern Hawke Bay, situated approximately 800 m north of the Port of Napier breakwater and consists of a broken linear series of banks and pinnacles extending 3.2 km in a northeast direction. Pania rock itself rises to within 1.6 m of the surface and is situated approximately half way along the reef. It is the only significant offshore reef system inside Hawke Bay west of Mahia Peninsula and has habitats consisting of mussel beds, urchin-grazed barrens, kelp forest and deep reef areas dominated by sponges, hydroid trees and large colonies of jewel anemones. Large populations of reef fish are also present;
- **Wairoa Hard** – is a large area extending along the coast from the mouth of the Moeangiangi River to the mouth of the Waihua River and offshore to a depth of 35-45 m (~ 11 km). It is characterised by coarse marine sediments (significant pebble and/or cobble fraction) that are believed to be fluvial sediments brought down by the Mohaka and Tukituki Rivers, and deposited as flood plains during the low stand of sea level in the late Pleistocene. During the subsequent rise in sea level these sediments are thought to have been reworked into beach gravels. Wairoa hard is

recognised as a significant snapper nursery area as well as juveniles of a number of other fish species;

- **Wairoa Estuary & Coastal Wetlands** – also comprises the Ngamotu Lagoon and forms part of a chain of coastal wetlands (Whakamahi, Ohuia, Warau, Te Paeroa and Whakaki lagoons), which collectively constitute the largest such system on the east coast of the North Island and are recognised as nationally significant wildlife habitat. The area provides habitat for significant populations of both threatened and common coastal bird species as well as a large waterfowl population;
- **Long Point** – is the western most part of Mahia Peninsula and has significant ecological flora and fauna wildlife values, while the subtidal area contains spectacular underwater scenery with subtidal limestone canyons, abundant and diverse range of fish species and the coastal landscape is outstanding. The intertidal marine rock platforms support a population of coastal bird species that include rare species such as variable oyster catcher, golden plover, Caspian tern, eastern bar-tailed godwit and white-fronted tern;
- **Portland Island** – is the only significant island on the Hawke's Bay Coast and has significant ecological, fauna and flora wildlife values and is a significant landscape feature;
- **Bull Rock** – is an isolated rock reef located in open water approximately 7 km due east of the northern tip of Portland Island. The reef rises from a mud bottom at 40 m to break the surface at low spring tides which supports a rich and diverse species assemblage, with a reputation as one of the top scenic dive sites on the east coast of the North Island;
- **Table Cape** – comprises the eastern most part of Mahia Peninsula and contains significant ecological, fauna, flora and wildlife values as well as being a coastal landform of international significance; and
- **Maungawhio Lagoon/Pukenui Beach** – is a wildlife management reserve located on the eastern side of the northern end of Mahia Peninsula which has significant ecological, fauna and flora values. The lagoon is located on the eastern side of the Mahia tombola, a nationally significant geological features. Pukenui Beach comprises part of the sediment source for the tombola and the intertidal beach is the feeding area for many of the estuary's wildlife species.

Figure 31: Hawkes Bay Regional Council areas of significant conservation value and DOC Area of Ecological Importance

4.3 Cultural Environment and Customary Fishing

Maori have a strong relationship with the sea and the collection of kaimoana is a fundamental part of their life, and for coastal hapu, kaimoana is often vital to sustain the mauri (life force) of tangata whenua. Collection of kaimoana allows Maori to provide a food source for whanau (family) and hospitality to manuhiri (guests).

In Te Wai Pounamu (the South Island), one tribe, Ngai Tahu occupies all but the most northern part of the Island, with the entire Canterbury region being within the rohe of Ngai Tahu.

Ngai Tahu Whanui is tangata whenua within the rohe of Ngai Tahu. Te Runanga o Ngai Tahu represents the tribal collective of Ngai Tahu Whanui and was established by the Te Runanga o Ngai Tahu Act 1996 to give a legal identity to the tribe.

The Kaikoura coastline took its name from Tama Ki Te Rangi, an early explorer who decided to explore the South Island. When he stopped at the place now known as Kaikoura, he ate some of the crayfish that populate the area over an open fire. As such the area was named Te Ahi Kaikoura ki Te Rangi – the fires where Tame Ki Te Rangi ate crayfish (RCEP, 2011).

As discussed in Section 4.2.1.1, Te Korowai o Te Tai o Marokura is group that stand for local leadership in the care for Tangaroa and in decisions on the use and protection of the marine environment around Kaikoura. The vision of Te Korowai o Te Tai o Marokura is to ensure the sea is richer and healthier so that it can be used sustainably and provide the needs of present and future generations. In March 2014 this vision was put into practice with the NZ Government releasing a number of measures to protect the marine environment and the marine mammals that call Kaikoura home. These measures included a marine reserve, a whale sanctuary, a NZ fur seal sanctuary, five customary areas and new recreational fishing regulations (see Section 4.2.1.1). The proposed ECPB Operational Area is a long way north of these proposed protected areas and would not have influenced or encroached within these areas had they been gazetted already.

The Marlborough Sounds region is rich in Maori history and culture, where Maori place great importance on links to their traditional sites both on land and in the sea and value their mahingakai. Eight iwi have manawhenua within the Marlborough region. Iwi history, iwi interests and the areas over which the various tribes hold manawhenua status differs considerably and are somewhat complex.

Tangata whenua of Hawke's Bay have strong traditional and cultural relationships with the sea. They are the kaitiaki (guardians) of their coastal resource and as such have also assumed the responsibility to ensure that the mauri of these resources is safeguarded. The entire Hawke's Bay CMA and coastal margin is of significance to Ngati Kahungunu. Water in particular has high spiritual, social and cultural values to Maori and the predominant view of Maori in Hawke's Bay is that water is an essential ingredient of life, therefore water and associated resources can form a basis for identification, belonging and mana (HBRC, 2012)

Ngati Kahungunu is the third largest tribal group in NZ. Ngati Kahungunu is a grouping of sub tribes and hapu, all of whom are descendants of Kahungunu with 86 Kahungunu marae within the traditional rohe of the tribe. The full extent of the rohe stretches from the Wairoa district at the most northern point down to the bottom of the east coast of the North Island

There are a number of marine species which iwi value highly and include: snapper, kahawai, blue cod, flat fish, small sharks, grey mullet, sea urchin (kina), scallops, mussels, paua, pipi, toheroa, cockles and tuatua (MPI, 2014d).

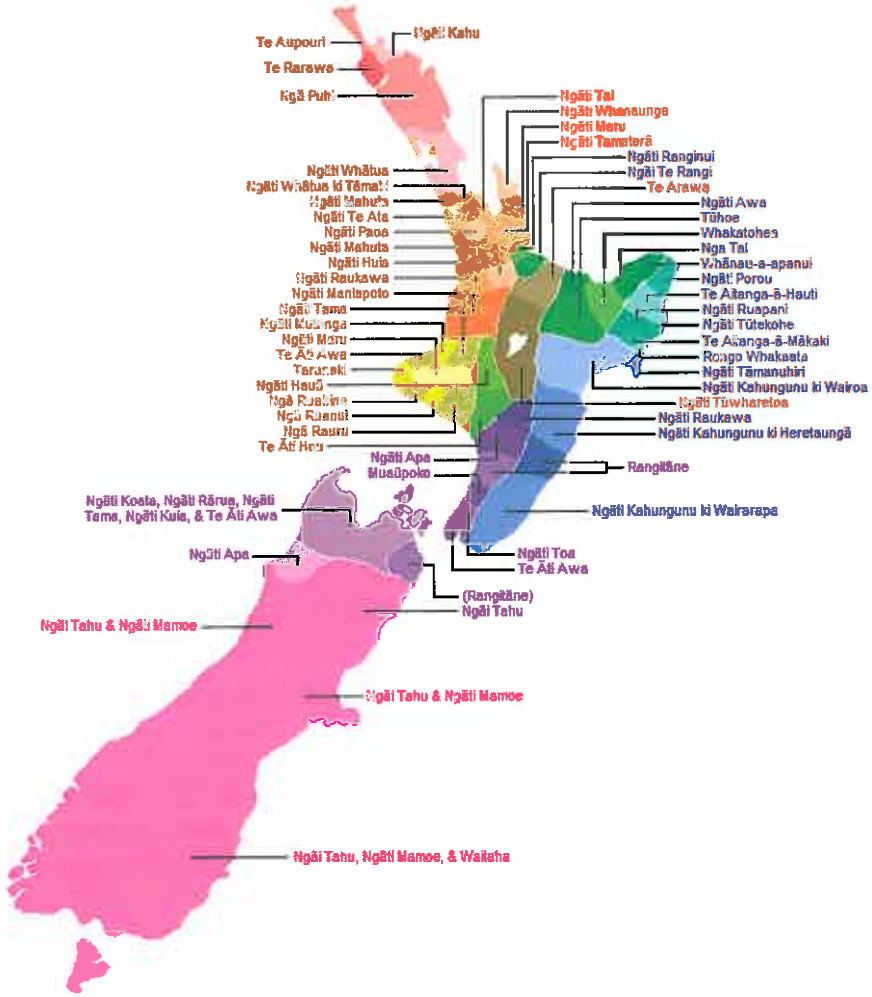

Figure 32: New Zealand Iwi boundaries

Fishing and gathering of kaimoana along the NZ coastline is a fundamental part of being a Maori and living along the NZ coast, where tangata whenua hold a very strong relationship with the sea. Traditional management entails a whole body of knowledge about the resources from the sea and how and when to access it. Customary knowledge is held sacred by tangata whenua and only passed on to those who will look after that knowledge.

The Fisheries (Kaimoana Customary Fishing) Regulations (1998) allows traditional management to govern the fishing practices within an area that is deemed significant to tangata whenua. Under these regulations, tangata whenua are able to establish management areas (mataitai reserves) to oversee fishing within these areas and create management plans for their overall area of interest.

Mataitai comprise of traditional fishing grounds established for the purpose of recognising and providing kaimoana collection and customary management practices. Commercial fishers cannot fish within a Mataitai reserve, however recreational fishers can. Tangata whenua are also able to exercise their customary rights through a customary fishing permit under the Fisheries (Amateur Fishing) Regulations 1986.

A Taiapure can be put in place under the Fisheries Act (1996) and Kaimoana Customary Fishing Regulations (1998) to allow local management of an area. These areas are required to be customarily or significant to an iwi or hapu as either a food source or for cultural or spiritual reasons. A Taiapure does not stop all fishing, it simply allows tangata whenua to be involved in the management of both commercial and non-commercial fishing in their area.

A rohe moana comprises of areas where Kaitiaki are appointed for the management of customary kaimoana collection within the area/rohe under the Kaimoana Customary Fishing Regulations (1998). The Customary Fishing Regulations allow hapu to: appoint Tangata Kaitiaki; establish management controls; give authorisation (or permits) to exercise customary take; specify responsibility for those acting under the customary fishing regulations; provide penalties to be imposed for breach of the regulations; and to allow for restriction or prohibitions over certain fisheries areas to prevent depletion or over-exploitation.

Ngati Kere is a coastal hapu of Ngati Kahungunu Iwi located at Porangahau on the southern Hawke's Bay coast and have a very strong affiliation to the coastal region where seafood is a very important resource. The marine boundaries of Ngati Kere were first established in English law at the Maori Land Court, Waipawa 1886, in the 'Porangahau Block' and have been reaffirmed by the establishment of the 446 ha Te Angiangi Marine Reserve in 1997, the Te Taiapure o Porangahau in 1992 and the Ngati Kere Tangata Kaitiaki (Wakefield & Walker, 2005).

Ngati Konohi is a coastal hapu of Ngati Porou Iwi located at Whangara Mai Tawhiti, 16 km north of Gisborne and were among the first North Island iwi/hapu to have their rohe moana affirmed and Tangata Kaitiaki appointed under the Kaimoana Customary Fishing Legislation. The Te Tapuwae o Rongokako Marine Reserve was established in November 1999 as a result of a joint application between Ngati Konohi and DOC. The reserve protects 2,452 ha of coastal and marine habitats between East Cape and Mahia Peninsula, in the rohe moana of Ngati Konohi. The Te Tapuwae o Rongokako Marine Reserve is ~130 km to the north of the ECPB Operational Area.

Within the western and northern portions of the ECPB Operational Area there are a number of rohe moana areas established under the Kaimoana Customary Fishing Regulations, however most are inshore of the actual survey area (Figure 33).

There are no Taiapure's or Mataitai's within the ECPB Operational Area as they generally have a coastal affinity, however, they are present along the coastline inshore of the ECPB Operational Area (Figure 33).

Figure 33: Culturally important areas surrounding the ECPB Operational Area
(**Note**: Rohe Moana boundaries may not be accurately representative of each particular hapu)

4.4 Anthropogenic Environment

This section focuses on the users of the environments surrounding the ECPB Operational Area; with particular emphasis on recreational and commercial fishing, shipping, and the petroleum industry.

4.4.1 Recreational Fishing

The ECPB Operational Area is not often fished by recreational fishers due to its distance offshore (mostly beyond 12 Nm CMA) and the shallowest sections of the Operational Area are deeper than 200 m.

However, inshore of the ECPB Operational Area in both the North and South Island's support significant recreational fisheries for snapper, kingfish, hapuku/bass, trevally, kahawai, tarakihi, blue cod, blue nose, gurnard, paua, mussels, trumpeter, ling, albacore, butterfish, sea perch, kina, blue moki and crayfish.

The marine environment is now being accessed for recreational fishing by an increasing number of people with a relative degree of success; mainly due to improving technology and bigger faster boats. Unlike the commercial fishing industry, recreational fishers are not

managed under a quota system; but instead are regulated under daily catch limits and minimum legal sizes, established by MPI to preserve fish stocks from overexploitation and conserve them for the future generations.

Notifications will be sent out to the fishing clubs along the coastline inshore of the ECPB Operational Area which will inform fishers of the MSS and help alleviate any potential conflict.

4.4.2 Commercial Fishing

Ten Fisheries Management Areas (FMA) have been implemented within NZ waters to manage the Quota Management System (QMS) and is regulated by MPI (Figure 34). Over 1,000 fish species live in NZ waters (Te Ara, 2014d) of which the QMS provides for commercial utilisation of 96 species while ensuring sustainability (MPI, 2014e). These species are divided into separate stocks and each stock is managed independently to ensure the sustainable utilisation of that fishery.

Figure 34: Fisheries management areas within NZ waters

Within NZ the commercial fishing activities are monitored closely; in 2009 the calculated asset value of NZ's commercial fish resource was $4.017 billion, an increase of 47% from 1996 (Statistics NZ, 2014). The top 20 species of fish contributed 91% of the value of NZ's commercial fish resource; with hoki contributing 20% alone.

The Wellington region has four important fisheries and are NZ's largest commercial fish resources: hoki, rock lobster, paua and orange roughy. The Wellington region spans two FMAs (FMA8 & FMA2) and although it is difficult to extract an exact export value for fisheries in the region it was estimated in Oliver and Milne (2012) to be more than $150 million per year.

MPI undertook an analysis of fishing effort specifically for the ECPB PPP 56061 for the 2008/09 – 2012/13 fishing years which has been used within this MMIA to provide a summary of commercial fishing activities and what species are targeted (Figure 35).

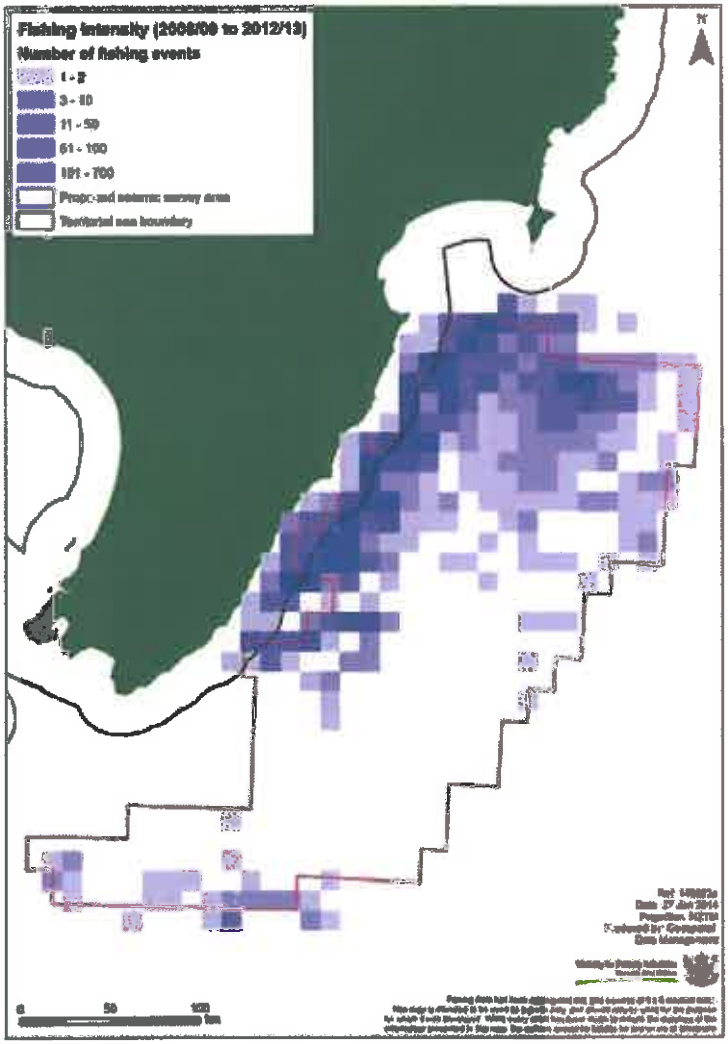

Figure 35: Fishing effort within PPP 56061 during the 2008/09 – 20012/13 fishing years

Fishing effort was analysed for all fishing events that started, passed through or ended within PPP 56061 which provided the top five species by volume for these fishing events.

The estimated catch of the top five species from fishing events that started, passed through or ended within PPP 56061 are shown below in (Table 9) with orange roughy having the biggest landings returned, although these numbers have been decreasing over the last three fishing seasons. When the fishing events by target species were assessed, the most commonly targeted species within PPP 56061 was scampi, followed by blue nose, orange roughy, alfonsino and ling.

Table 9: Top five species caught in PPP 56061 during 2008/09 – 2012/13 fishing year (tonnes)

Species	2008/09	2009/10	2010/11	2011/12	2012/13	Total
Orange roughy	570	489	624	403	373	**2,459**
Alfonsino	424	523	393	388	329	**2,057**
Hoki	100	117	464	63	158	**903**
Bluenose	254	317	114	113	73	**871**
Cardinal fish	313	212	103	39	16	**684**
Others	579	799	756	482	492	**3,108**
Total	**2,239**	**2,458**	**2,455**	**1,488**	**1,441**	**10,082**

The three main types of fishing methods used along the section of coastline that PPP 56061 covers are; surface longline, bottom longline and trawling. The number of fishing events by fishing method that started or ended in PPP 56061 during the 2008/09 – 2012/13 fishing years can be seen in Table 10. Over the last five fishing years, trawling has been the most commonly used fishing method within PPP 56061, although there is a considerable amount of bottom longlining with a small amount of surface longlining activity.

Table 10: Fishing events by method within PPP 56061 during 2008/09 – 2012/13

Method	2008/09	2009/10	2010/11	2011/12	2012/13	Total
Trawl	1,158	1,648	1,542	844	799	**5,991**
Bottom longline	569	806	425	438	216	**2,454**
Surface longline	52	176	84	76	77	**465**
Other	37	14	2	39	12	**105**
Total	**1,816**	**2,644**	**2,053**	**1,397**	**1,104**	**9,014**

When the trawling activity over the five fishing years was plotted it can be seen that most of the fishing is undertaken from October to March which coincides with the new fishing year when quota becomes available again and the more settled weather. The proposed ECPB 2D MSS is scheduled to commence late-March which is when the least amount of trawling takes place within PPP 56061 (Figure 36). Bottom longline fishing events appear to be year-round with a possible decrease in March. It can be seen that bottom fishing intensity (both trawling and bottom longlining) generally occurs within the inshore section of PPP 56061 along the east coast of the North Island, with a small amount of fishing activity along the very southern boundary (Figure 37).

Whereas surface longlining is mainly restricted to January-June when the warmer waters and pelagic fish are present. The surface longlining all occurs in the northern part of PPP 56061 (Figure 38). The fishing industry has been notified of the proposed ECPB 2D MSS (Appendix 2) and approximate commencement data and all groups and fishers that utilise the area have been notified. All efforts will be made where possible to start acquiring in the southern part of the ECPB Operational Area.

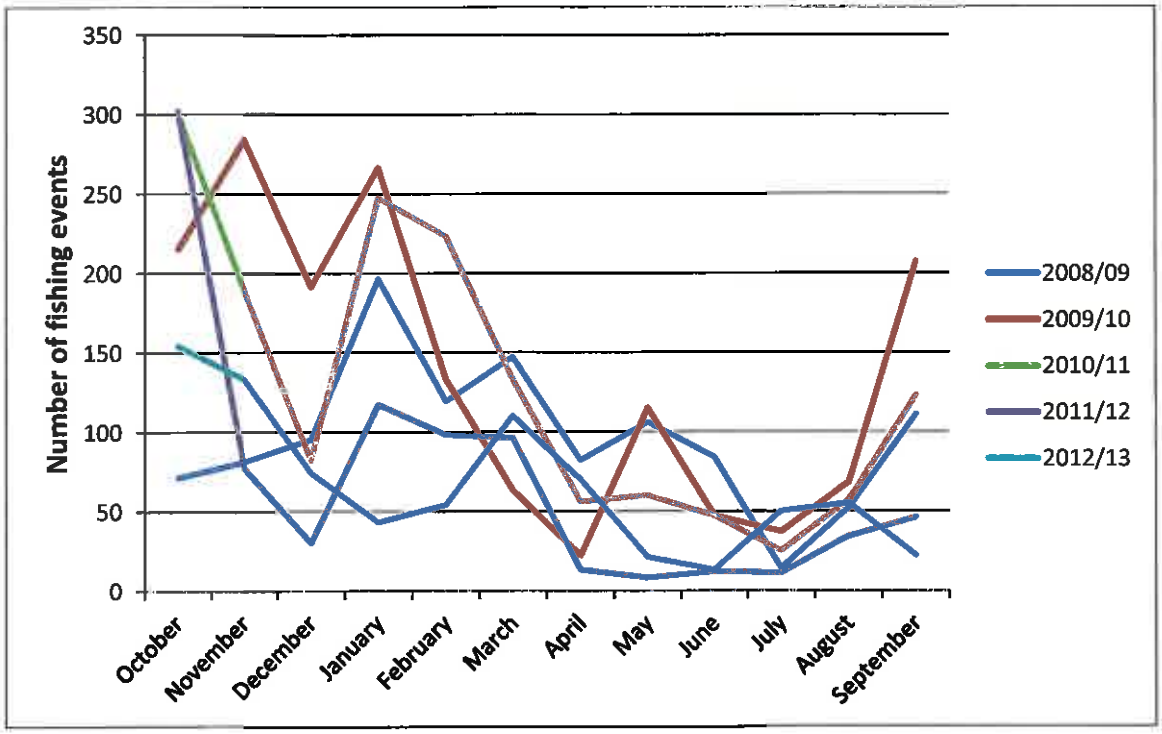

Figure 36: Number of trawl events per month within PPP 56061 during 2008/09 – 2012/13 fishing years

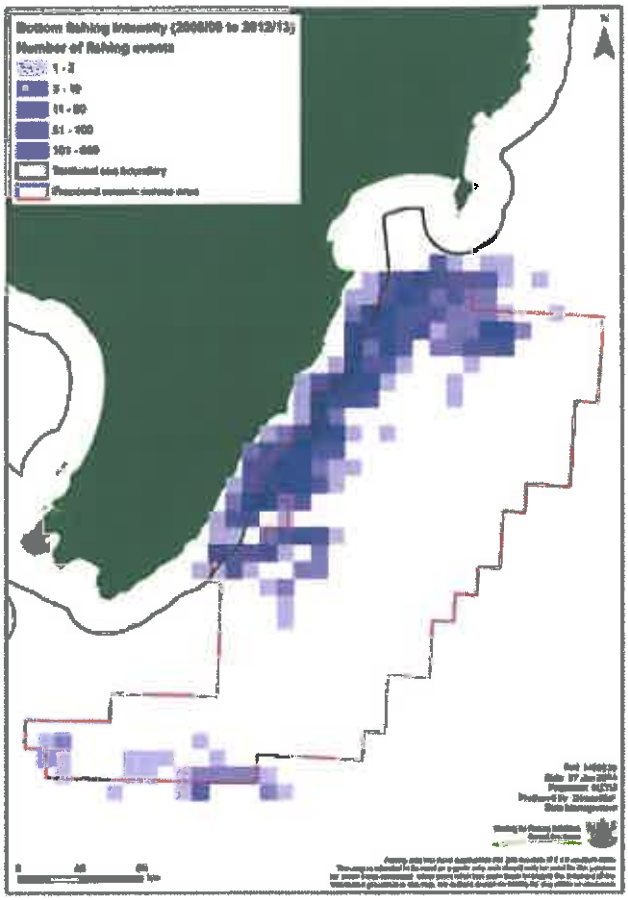

Figure 37: Bottom fishing (Trawl & Longline) intensity during 2008/09 – 2012/13 fishing years

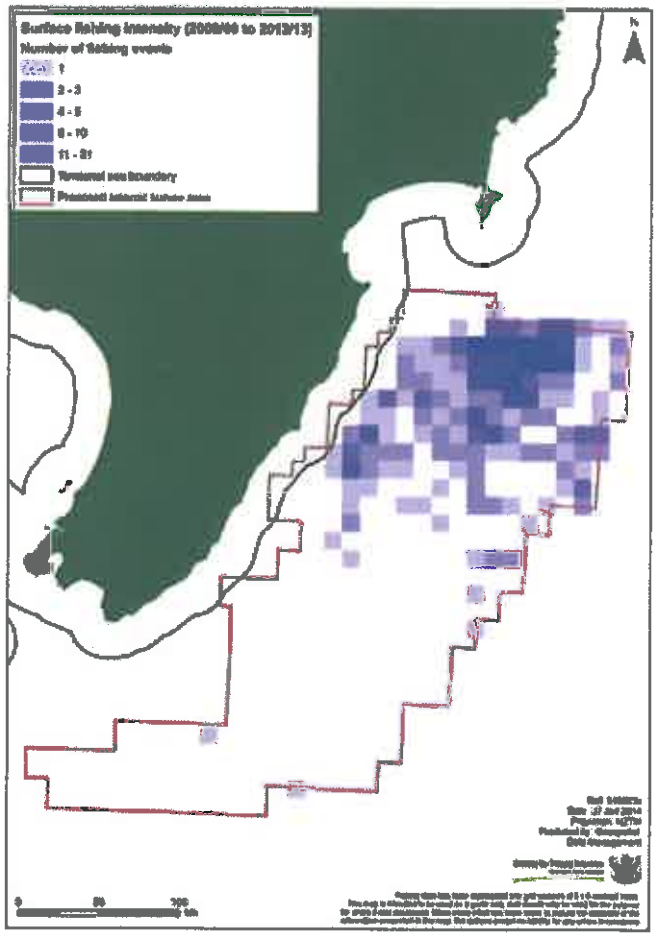

Figure 38: Surface fishing intensity during 2008/09 – 2012/13 fishing years

Hoki is NZ's largest fishery with approximately 47,000 tonnes of processed fish exported in 2010 all over the world, including China, Europe and the United States. These exports contribute more than $170 million to the NZ economy so it is a very valuable resource to NZ. Hoki fishing takes place in offshore waters at depths of 200 – 600 m at several fishing grounds around NZ; the closest to PPP 56061 being along the east coast of the North Island (Figure 39). From the fisheries assessment that was prepared for the 2008/09 – 2012/13 fishing years, hoki was the third highest commercial fish species caught within PPP 56061 (Table 10).

Hoki spawn in winter in the deep-canyons off the South Island of which there are two main spawning grounds – west coast South Island and Cook Strait, and are considered to comprise from two intermixing biological stocks where spawning takes place simultaneously. The closest spawning ground to the ECPB Operational Area is the Cook Strait where spawning occurs from late June to mid-September (MPI, 2009). Females release multiple batches of eggs with moderately high fecundity – a 90 cm female will spawn over 1 million eggs in a season. The fertilised hoki eggs float up to the surface waters where they become part of the plankton, living a pelagic lifestyle. After three days the eggs hatch into larvae, firstly without mouths, then after a few days their mouths develop. The developing hoki feed on zooplankton, their preference being the tiny crustacean *Calocalanus*, and if food is plentiful grow quickly. After one year, juvenile hoki can grow to between 27 – 35 cm total length (MPI, 2009). The larvae move inshore by advection or upwelling and are widely dispersed north and south, resulting in fish up to one year old can be found in most coastal areas of the South Island and parts of the North Island (MPI, 2014). As they grow they then migrate to the fisheries grounds, mainly the Chatham Rise and around the subantarctic

islands (Figure 39). The major nursery ground for juvenile hoki aged 2 – 4 years is along the Chatham Rise in depths of 200 – 600 m.

As discussed in Section 4.2.2 if plankton are present within 5 m of an acoustic source, mortality can occur. The same is likely to happen with any hoki juveniles living within the epipelagic zone feeding on zooplankton. However, the closest spawning area to the ECPB Operational Area is >150 km and given the ECPB 2D MSS is scheduled for late March, will happen before the spawning takes place during the winter months.

Figure 39: Hoki Fishing and spawning grounds
(Source: http://www.teara.govt.nz/en/diagram/5360/hoki-fisheries-and-spawning-grounds)

Consultation has been undertaken with Deepwater Group, Hawkes Bay Seafoods, Star Offshore Services Ltd, Sanfords, Independent Fisheries, Maruha (NZ) Ltd, Talley's, Sealord, and NZ Federation of Commercial Fisherman to advise them of the proposed ECPB 2D MSS and the array of gear that will be behind the *Aquila Explorer*. A summary of the engagement is provided in Appendix 2. These companies will be provided with the contact details of the vessel closer to the commencement date. A Notice to Mariners will be issued for the ECPB 2D MSS and broadcast over maritime radio.

4.4.3 Commercial Shipping

There are thirteen major commercial ports and harbours within NZ, consisting of major ports, river ports and breakwater ports. Ports are important gateways for freight, transport and trading both nationally and internationally. The closest ports to the ECPB Operational Area is Napier Port and CentrePort Wellington.

Commercial shipping vessels generally use the most direct path when travelling between ports; the general shipping routes between NZ ports are shown in Figure 40. The ECPB Operational Area is located offshore from the shipping route between Napier Port and CentrePort Wellington. Between these ports and any other NZ port there is no dedicated shipping lane; vessels will generally take the shortest route with consideration of the weather conditions and forecast at the time. A Notice to Mariners will be issued ahead of the ECPB 2D MSS commencing and with adherence of all vessels to the COLREGS there should be no conflict between shipping vessels and the *Aquila Explorer*. The routes for foreign destinations from NZ ports is likely to vary and has not been included in Figure 40, although it is likely they could pass through or in close proximity to the ECPB Operational Area.

Figure 40: General shipping routes surrounding the ECPB Operational Area

4.4.4 Petroleum Exploration

Until recently NZ has had limited exploration outside of the Taranaki Basin, and although the Taranaki Basin is NZ's premier oil and gas exploration region, other basins have started to attract significant interest as emerging basins of petroleum potential.

The East Coast region is geologically complex, it has strong gas shows found from three exploration wells drilled within the East Coast Basin. However, these offshore wells were drilled on low-fold and low-power seismic surveys in the late 1960's and 1970s, although industry standard seismic data was acquired by Crown Minerals in 2005.

More than 40 wells have been drilled onshore in the East Coast Basin since the 1870's, with a few wells that were producing oil. There are also over 300 locations onshore where oil has seeped to the surface showing the formations have generated oil.

Exploration within the Pegasus basin is still at its very early stage and no wells have been drilled to date. The ECPB 2D MSS will be the third MSS conducted within this basin over recent years to further understand the underlying geology.

5 Potential Environmental Effects and Mitigation Measures

This section presents a review of the potential environmental effects which may arise from the operation of the ECPB 2D MSS programme in the marine environment, although it is specifically focused on effects to marine mammals. A literature review was undertaken of the environmental sensitivities along the east coast of NZ, to summarise the potential environmental effects which may result from the ECPB 2D MSS, from both planned and unplanned activities. Mitigation measures that will be implemented for the ECPB 2D MSS are also discussed for each activity.

The significance of each of these potential environmental effects was determined under the assumption that the proposed mitigation measures are in place. Four categories were determined for the scale of effects on marine mammals; however, this classification has also been applied indirectly to the wider marine environment and potential effects highlighted within this MMIA, ranging from negligible to major and are summarised below. This classification has been derived from the STLM due to the known SEL's at varying distances from the acoustic source and the thresholds for behavioural or injury criteria to marine mammals as defined within the Code of Conduct.

- **Negligible Effect** – marine mammals beyond 2.1 km from the acoustic source will be unaffected; based on the STLM results where all SEL's are below 171 dB re 1 $\mu Pa^2.s$ which is the sound level for behavioural effects for marine mammals within the Code of Conduct. No significant effects are expected within the marine environment or on other marine fauna. After exposure to the sound source, no recovery or mitigation measures are required;
- **Minor Effect** – Marine mammals between 2.1 km and 1.5 km from the acoustic source could be slightly influenced by sound levels, which is derived from the STLM. No noticeable effects observed within the marine environment or on other marine fauna are expected. The STLM showed that at 1.5 km from the acoustic source the SEL was predicted to be between 173.1 and 170 dB re 1 $\mu Pa^2.s$ across the different bathymetric contours of the ECPB Operational Area. No mitigation measures are required to return to the original behaviour or environmental conditions;
- **Moderate Effect** – the behaviour of marine mammals is likely to be influenced 1.5 km and 350 m from the acoustic source. This is based on the STLM results that show beyond 330 m from the acoustic source the SEL's are below 186 dB re 1 $\mu Pa^2.s$. Behavioural effects to marine mammals are likely to occur and physical effects may develop closer to the source, but is presumed to be temporary. Mitigation measures may be required; most likely operating to best practice for a return to the original environmental condition or behaviour; and
- **Major Effect** – environmental effect requires mitigation measures to be implemented, and once implemented the original situation takes a relatively long period of time to recover, in some cases not at all. For marine mammals this is likely to occur within 350 m of the acoustic source, based on the STLM. Modelling showed that the SEL is greater than 186 dB re 1 $\mu Pa^2.s$ SEL within 330 m of the source (Koessler & Duncan, 2014) which is the SEL believed to result in some form of injury to marine mammals as defined in the Code of Conduct. No recovery is anticipated from this type of environmental effect. The STLM results will be validated and ground truthed as per the requirements of the Code of Conduct when operating a MSS in an AEI. The details of the STLM validation are provided in Section 5.3.2.1.

To accurately assess the potential environmental effects that could potentially result from a MSS, both the planned and unplanned activities have to be taken into account. The

following sections assess these potential effects and what mitigation measures will be implemented for the ECPB 2D MSS to keep environmental effects to ALARP.

5.1 Planned Activities – Potential Effects & Mitigation Measures

5.1.1 Physical presence of *Aquila Explorer* and the Seismic Array

The *Aquila Explorer* and the associated seismic array towed behind the vessel, as well as the *Amaltal Mariner* has the potential to interfere with a number of commercial, recreational, social and environmental operations and resources. This potential interference is discussed further in the following sections.

5.1.1.1 Interference with the fishing community and marine traffic

There is the potential for the ECPB 2D MSS to interfere with fishing activities due to the length of the seismic array that will be towed behind the *Aquila Explorer*. During the ECPB 2D MSS fishing vessels (mainly commercial) will be caused a temporary loss or reduction of access to any fishing grounds within the ECPB Operational Area; however, this would only occur for the duration of the ECPB 2D MSS (~40-50 days).

It has long been considered by commercial fishers that MSS's can be disruptive to their fishing operations, and is a view widely held around the world (McCauley et *al.*, 2000). Handegard *et al.* (2013) summarised that acoustic source emissions have previously caused behavioural changes in caged fish, damaged auditory systems, and generated changes in horizontal and vertical fish distribution patterns as well as changes in catch per unit effort for fisheries in close proximity to MSS's.

Commercial fishers who use the ECPB Operational Area as part of their fishing grounds have been advised of the ECPB 2D MSS and will be contacted closer to commencement with further details. To date the communications have been positive with the commercial fishing industry (Appendix 2). The acquisition of the ECPB 2D MSS could cause temporary displacement of fish stocks; however there is some uncertainty over this as most of the commonly targeted and caught species within the ECPB Operational Area are all deep water fish (Section 4.4.2) and very few studies have been undertaken on deepwater fisheries and effects from MSS's.

In the North Sea, geophysical surveys have been conducted continually over the last 40 years and during recent years MSS vessels have been operating on fishing grounds in the Norwegian and Barents Seas. Studies that have been undertaken have focused on the assessment of the potential impacts that a MSS may have on catch rates for the fishing industry. Bendell (2011) summarised a study undertaken off the coast of Norway where longline catches were investigated during the acquisition of a two week seismic survey with a peak source level of 238 dB re 1µPa@1m. The study showed that catch rates reduced by 55-80% within the survey area and for a distance up to 5 km. However, once the MSS ceased, catch rates returned to normal within 24 hours (Bendell, 2011).

It is assumed from the summary above that any effect on fisheries is likely to be temporary, and although it may result in an increased fishing effort if fishing is harder during the MSS period, it is unlikely to be of lasting harm to any fish populations.

Trawling is the most common method of commercial fishing in the waters within and surrounding the ECPB Operational Area, it is a mobile method of fishing, so no fishing gear is left deployed on the seabed which has the potential to cause conflict. However, surface longlining can result in many kilometres of line set and left for a number of hours, and without their awareness of the survey taking place had the potential to cause conflict. These fishers have been advised of the ECPB 2D MSS taking place. As discussed in Section 3.1, a tail buoy on the end of the streamer will mark the overall extent of the MSS array and avoid any uncertainty as to how far the streamer extends behind the *Aquila Explorer*.

To ensure that the potential environmental effects are minimised to ALARP, Schlumberger will operate 24 hours a day, 7 days a week (weather and marine mammal encounters permitting) to minimise the overall duration of survey; comply with the COLREGS (radio contact, day shapes, navigation lights etc.); have a support vessel present at all times; notify commercial fishers of the ECPB 2D MSS and ECPB Operational Area; issue a Notice to Mariners and have a tail buoy attached to the end of the streamer to mark the end of the seismic array.

With the mitigation measures in place, the effects from the ECPB 2D MSS on any fishing, commercial or private vessels is believed to be ***minor***. However, it is likely that fish may undertake avoidance behaviour of the ECPB Operational Area due to the acoustic noise, resulting in temporary displacement from the area while the ECPB is acquiring. The extent of this displacement is likely to fall within the normal geographic range of each particular species (Bendell, 2011), however given this potential displacement or avoidance for fish stocks to occur, the ECPB 2D MSS has the potential for ***moderate*** effects on fish stocks and their natural habitat preferences.

5.1.1.2 Interference with Marine Archaeology, Cultural Heritage or Submarine Infrastructure

The seismic array used for the ECPB MSS will not come into contact with the seabed or coastline inshore of the ECPB Operational Area. The solid streamer used in the ECPB MSS has self-recovery devices fitted which release once the streamer reaches a certain depth (i.e. 48 m) bringing the streamer back to the surface for retrieval should they be severed and start sinking. Most of the areas that are culturally significant are on the intertidal and shallow subtidal reefs located inshore of the ECPB Operational Area. It would only be the result of a rupture to the vessels fuel tank that could cause them to be influenced, but with the mitigation measures in place as discussed through this MMIA, this should not occur. Therefore it is considered that the potential interference with any marine archaeology, cultural heritage or submarine infrastructure is ***negligible***.

5.1.1.3 Changes in Abundance or Behaviour of Fish

It has been reported that MSS acquisition can temporarily alter the behavioural patterns of certain fish species (rockfish, cod, haddock, blue whiting); which can result in fish diving deeper and away from the acoustic source or tightening up in their school structure (McCauley *et al.*, 2000). The ECPB Operational Area is situated mostly over very deep water ranging in depth from approximately 200 – 3,000 m, however based on the McCauley *et al.*, (2000) study, there is the potential for NZ fish species to behave similarly and temporarily move away from an area if the SEL's result in their discomfort. Off the Taranaki coastline it has previously been thought that pelagic fish such as tuna are harder to catch when a MSS was been undertaken, however WesternGeco (a business segment of Schlumberger) undertook a 3D MSS in January 2013, no effects were observed on the Taranaki gamefish season. In fact it was the best gamefish season the province has had for six years (see catch records from New Plymouth Sportfishing & Underwater Club below), with marlin even being hooked up in front of the seismic vessel.

- 2004/05 – 90 (45 weighed & 50 tagged and released);
- 2005/06 – 25 (9 weighed & 16 tagged and released);
- 2006/07 – 10 (6 weighed & 4 tagged and released;
- 2007/08 – 120 (66 weighed & 54 tagged and released);
- 2008/09 – 19 (14 weighed & 5 tagged and released);
- 2009/10 – 30 (13 weighed & 17 tagged and released);
- 2010/11 – 43 (21 weighed & 22 tagged and released);

- 2011/12 – 36 (5 weighed & 31 tagged and released); and
- 2012/13 – 67 (25 weighed & 42 tagged and released).

The ECPB 2D MSS will operate 24 hours a day, 7 days a week (weather and marine mammal encounters permitting) to ensure the survey period will be as short as possible (~40-50 days). As a result during the ECPB 2D MSS the potential effect on fish species within close proximity to the ECPB Operational Area is considered to be ***moderate***.

5.1.1.4 Changes in Seabird Behaviour

Seabirds can interact with vessels at sea; they can use the vessels for perching opportunities that would not otherwise be available as well as negative interactions which could include injury to birds through collision or entanglement in the vessels rigging, particularly at night. Research has shown artificial lighting can cause disorientation in seabirds, although this is mainly for fledglings and novice flyers, particularly when vessels are operating close to shore (Telfer *et al.*, 1987). It is believed seabirds use starlight to navigate, hence the potential for artificial lights to interfere with their ability to navigate (Black, 2005; Guynup, 2003).

Seabirds have good eyesight and are agile flyers so the risk of any collisions during the day is unlikely compared to at night.

There is limited experimental data on the reaction of seabirds to MSS operations. A study undertaken in the Wadden Sea (intertidal zone of the North Sea) concluded that bird counts showed no significant deviation in the numbers and seasonal distribution of shorebirds and waterfowl as a result of a seismic survey (Webb & Kempf, 1998). Although temporary avoidance of individual areas of distances up to 1 km was observed due to the activities of the boats and crew.

Acoustic damage to birds could arise if one was to dive in very close proximity to the acoustic source while it was active. Although there is potential for some birds to be alarmed as the seismic array passes by them, they are likely to be beyond any harmful range (Macduff-Duncan & Davies, 1995), and once the acoustic source is operating, it is not likely that birds will be in the water close to the array.

Various aspects of the ECPB 2D MSS will reduce the potential for any long term interference or damage to seabirds or reduce their ability to navigate, including the seismic and support vessels will always be underway and any diving birds in close proximity to the acoustic source are unlikely to do so due to their prey (baitfish) are likely to have fled the immediate area around the operating acoustic source. As a result the proposed ECPB 2D MSS is considered to have ***negligible*** effects on seabirds.

5.1.1.5 Introduction of Marine Pest or Invasive Species

Ballast water discharges, sea chests and hull fouling on vessels has the potential to introduce and spread marine pests or invasive species to NZ waters.

Most MSS vessels have their hulls regularly cleaned and painted with antifouling to prevent the establishment and growth of fouling communities. The *Aquila Explorer* was slipped in November 2013 where the hull was cleaned and new antifoul paint was applied. This dry-docking will have minimised the risk of any invasive species entering NZ waters on the *Aquila Explorer's* hull or seachests.

The support vessel *Amaltal Mariner* is based in NZ and poses no risk associated with ballast water or hull fouling of new organisms entering NZ waters, although there is the potential for invasive species within NZ to be transferred between regions. Therefore, the potential to introduce marine pests or invasive species as a result of the ECPB 2D MSS is ***negligible***.

5.1.1.6 Interaction of Aquila Explorer with Marine Mammals

Within the ECPB Operational Area, under the NZ threat classification list, two marine mammals classified as 'nationally critical' (Bryde's whale and killer whale) and two as 'nationally endangered' (southern right whale and bottlenose dolphin) could potentially be present during the ECPB 2D MSS (Table 8).

The potential to disrupt the behaviour of an individual or group of marine mammals would be a result of an interaction or collision with a vessel involved in the ECPB 2D MSS or entanglement with the seismic array. Studies on a total of 292 records of confirmed or possible ship strikes to large whales have shown that 11 marine mammal species were confirmed as victims (Jensen & Silber, 2003); seven of which have been identified that could occur within the ECPB Operational Area (killer, minke, sei, southern right, sperm, humpback and blue whales). From the study, the most commonly reported species of marine mammal hit was the finback whales (75 strikes) and humpback whales (44 strikes).

Jensen & Silber (2003) showed that vessel-type plays a role in the likelihood of mortality from any vessel interaction. Of the 292 mammal strikes; in 134 cases the vessel type was known of which navy vessels and container/cargo ships/freighters were the most common. Seismic vessels (described as research) accounted for one of the 134 known vessel marine mammal strikes. During acquisition the *Aquila Explorer* will be travelling at <4.5 kts, well below the mean speed which has accounted for most of the ship strikes (18.6 kts).

The *Aquila Explorer's* operations will be operating in adherence to the Code of Conduct and will also have 4 MMO's onboard for the duration of the ECPB 2D MSS (operating procedures and mitigation measures further detailed in Section 2.3.1 and Section 5.3). Therefore as a result of compliance with the Code of Conduct, general operating procedures in accordance with best practice and the mitigation measures implemented, it is assumed that the effects on marine mammals arising from the ECPB 2D MSS would be ***minor***.

5.1.2 Acoustic Source Sound Emissions

Sound emissions associated with the ECPB 2D MSS have the potential to disturb marine mammals and other fauna through a number of ways, however these disturbances will be reduced by operating to the Code of Conduct and mitigation measures implemented. The potential effects to marine mammals could include: physiological effects from exposure to sound; behavioural disturbance or displacement; deep diving mammals surfacing too quickly which can result in 'decompression sickness'; disruption to feeding, breeding or nursery activities; interference with the use of acoustic communication signals or indirect effects such as changes in abundance or behaviour of prey for marine mammals, seabirds and fish.

Low frequency sound sources produced in MSS's are directed downwards towards the seafloor and propagate efficiently through the water with little loss due to attenuation (absorption and scattering). Attenuation depends on propagation conditions; in good conditions background noise levels may not be reached for >100 km, while in poor propagation conditions it may reach background levels within a few tens of kilometres (McCauley *et al.*, 1994).

Sound waves decay exponentially and travel until they either come in contact with an object or are dissipated by normal decay of the signal. Low frequency sound attenuates slowly and is why it is generally used in MSS; however most of the sound energy attenuates very close to the acoustic source.

When an acoustic source is activated, most of the emitted energy is low frequency (0.01 – 0.3 kHz), but pulses also contain higher frequency energy (0.5 – 1 kHz), although these higher frequencies are often weak (Richardson *et al.*, 1995). The low frequency component of the sound spectrum attenuates slowly while the high frequency sound attenuates rapidly to levels similar to those produced from natural sources.

The acoustic pulse associated with a MSS produces a steep-fronted detonation wave which is transformed into a high-intensity pressure wave (shock wave with an outward flow of energy in the form of water movement). This results in an instantaneous rise in maximum pressure, followed by an exponential pressure decrease and drop in energy. The environmental effects on marine mammals and other fauna associated with MSS's focus on these sound waves generated from the acoustic source.

There is the potential for MSS operations to have an adverse effect on marine mammals and was the underlying principle for the development of the Code of Conduct and the associated mitigation zones from the acoustic source. Within the Code of Conduct – Schedule 2, it classifies all the cetaceans listed as Species of Concern and includes all NZ cetacean species except common dolphins, dusky dolphins and NZ fur seals (DOC, 2013).

Marine mammals are believed to stay away or avoid an operating acoustic source used in a MSS (Thompson *et al.*, 2013), which is thought to be a way of reducing their exposure to the higher sound levels. However during soft starts or using mitigation acoustic sources NZ fur seals have been attracted to the acoustic source. During other surveys in North Taranaki, whenever the seismic vessel approached the shallower waters, common dolphins were observed heading straight for the vessel to come and bow ride while the vessel was under acquisition and the acoustic source was active.

Pinnipeds are often observed approaching an active acoustic source running at full capacity, suggesting that their inquisitive nature may override any fright or discomfort these animals may experience. A desktop study is nearly complete that focusses on pinnipeds behaviour around an operating seismic vessel, as well as those seals that were observed to be in a known sleeping position, and whether they are woken by the approaching seismic vessel. The data used within this study has drawn on all of the MMO reports that have been completed in NZ waters and any interactions or behavioural responses observed and recorded for NZ fur seals around the seismic vessel. The results from this desktop study are expected in 2014.

5.1.2.1 Sound Transmission Loss Modelling

Schlumberger commissioned Curtin University to conduct STLM in accordance with the Code of Conduct for undertaking a MSS within an AEI. Acoustic propagation modelling was used to predict received SEL's from the ECPB 2D MSS to assess for compliance with the mitigation zones in the Code of Conduct (Appendix 5). The modelling methodology to produce the results summarised below accurately deals with both the horizontal and vertical directionality of the acoustic array and with the different water column and seabed variations in depth and range found throughout the ECPB Operational Area (Koessler & Duncan, 2014).

The ECPB Operational Area spans an area of complex bathymetry (Figure 12) so seven different geoacoustic regions representing different bottom substrate types were chosen to represent the probable benthic sediment compositions and sub-bottom layering. The information was obtained from published literature on NZ regional seabed geology and the acoustic properties of marine sediments (Koessler & Duncan, 2014). The seven regions referred to are differentiated by the likely geoacoustic properties of their seabeds. In the case of the long range modelling, variations in topography, such as the presence of canyons, are automatically accounted for by the inclusion of the bathymetry along propagation path. However, there are some limitations to the accuracy of this approach, which are discussed below. The short range modelling procedure precludes taking variations in topography into account, however such variations would be expected to have minimal impact on predicted sound levels at the existing mitigation ranges of 200 m, 1 km and 1.5 km specified in the Code of Conduct.

The STLM was predicted for the proposed ECPB 2D MSS acoustic source (6,300 in^3) and was based on three different water depths at three different modelling locations within the

ECPB Operational Area (Figure 41). The acoustic source was modelled to be operating 10 m below the sea surface - received sound levels in the water column increase with increasing array depth.

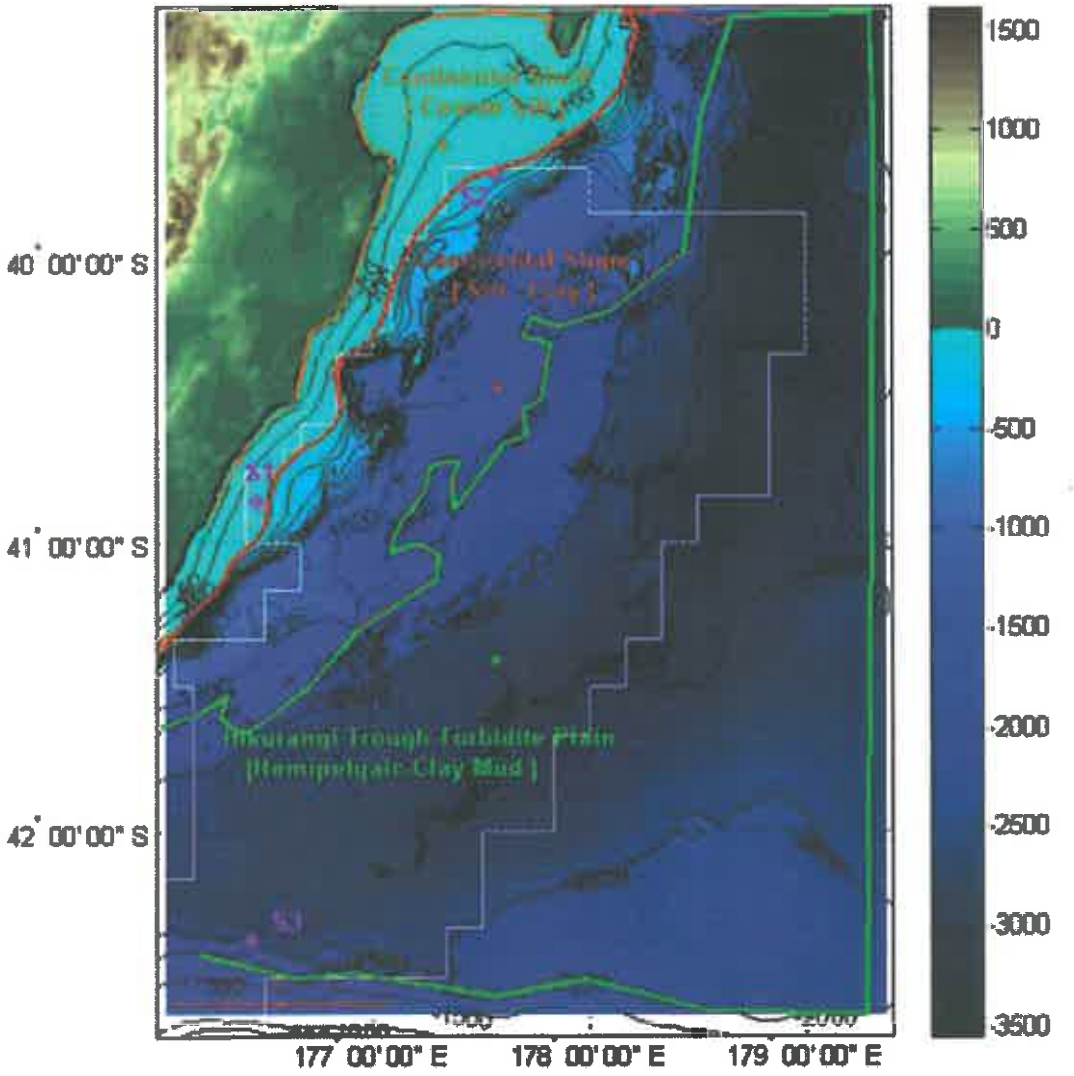

Figure 41: Source modelling locations (S1, S2 & S3) within ECPB Operational Area

The STLM used vertical and horizontal cross-sections through the frequency dependent beam patterns of the array to demonstrate the strong angle and frequency dependence of the sound radiation from the acoustic source array. The horizontal beam pattern shows that in the horizontal plane a large amount of the energy is radiated in the in-line direction (azimuths of 0° and 180°) as a result of the acoustic source configuration (Figure 42). A significant amount of energy is radiated in the cross-line direction but only to mid-frequencies. These beam patterns are characteristic of an acoustic array with wide spacing between elements or in the case of the ECPB 2D MSS, wide spacing between the sub-arrays.

The standard mitigation zones within the Code of Conduct are shown in Figure 42 and are indicated by a solid black circle (200 m), dashed black circle (1.0 km) and dash-dot black circle (1.5 km) relative to the maximum received SEL's.

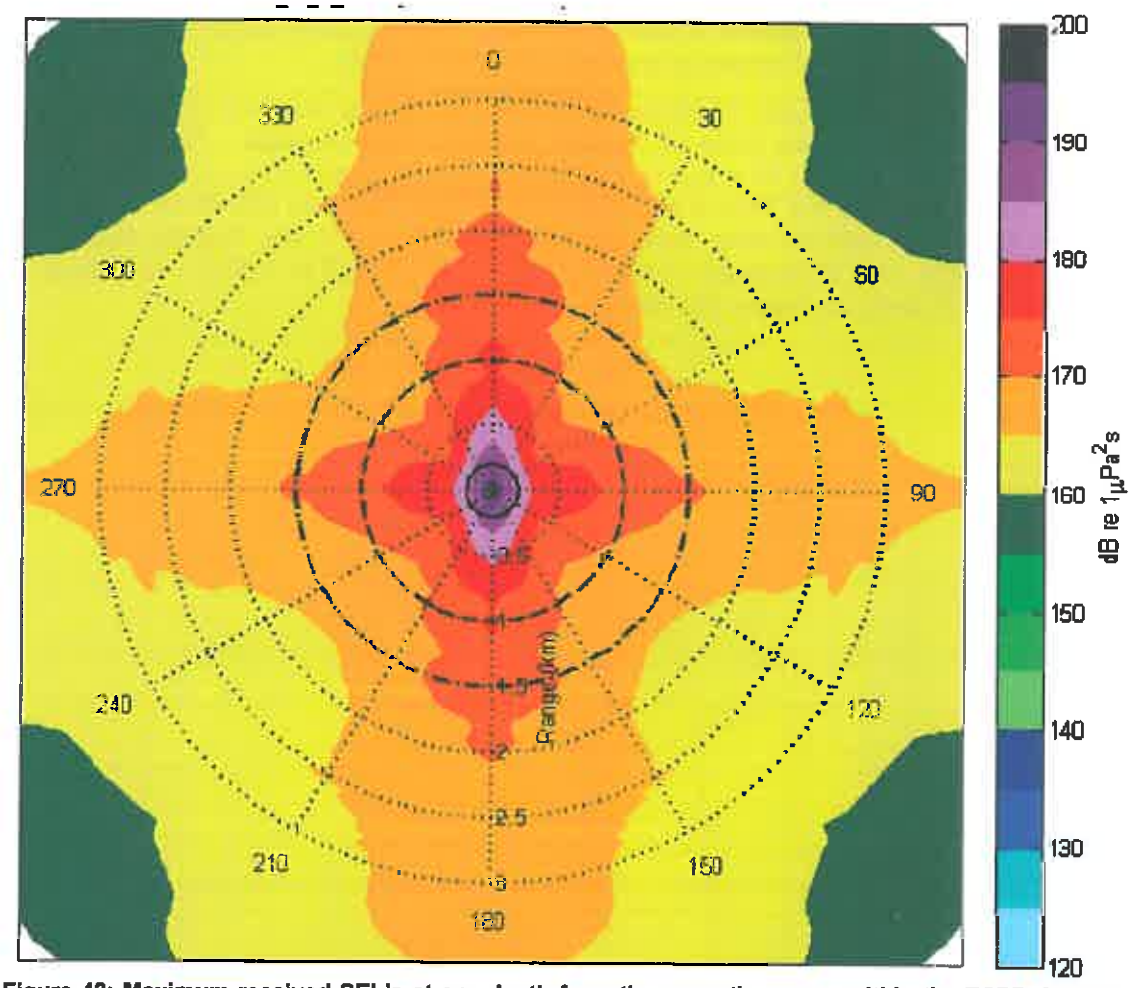

Figure 42: Maximum received SEL's at any depth from the acoustic source within the ECPB Operational Area

The shallowest depth within the ECPB Operational Area was utilised for the STLM to take a conservative approach as the highest short range received SEL's occur in shallow water due to the contribution of acoustic energy reflected from the seabed. Lower received SEL's result when the source is operating in deeper waters, and when the SEL's are compared for the three different source locations (S1, S2 & S3), it is shown that this is indeed the case (Table 11).

The initial STLM results identified that the modelled location S1 had SEL's that were greater than 171 dB re 1 µPa².s (behaviour criteria) and 186 dB re 1 µPa².s (injury criteria) at the respective mitigation zones within the Code of Conduct. Additional modelling was undertaken to determine at what distances from the acoustic source the SEL's were 100% below the levels stipulated within the Code of Conduct for behaviour and injury criteria (Table 11).

Table 11: Ranges at which SEL's drop below thresholds in both shallow and deep waters

	Source Location S1	Source Location S2	Source Location S3
186 dB re 1 µPa².s	330 m	300 m	240 m
171 dB re 1 µPa².s	2,050 m	1,900 m	1,400 m

At the three source locations modelled, the maximum SEL's within the ECPB Operational Area are predicted to be between 189 and 187.4 dB re 1 µPa².s at a range of 200 m, between 175.8 and 173.2 dB re 1 µPa².s at a range of 1 km, and between 173.1 and 170 dB re 1 µPa².s at a range of 1.5 km (Koessler & Duncan, 2014). As discussed above the higher

levels occur in the shallower waters at source location S1 due to short range reflections from the seabed and the large total volume of the acoustic source array.

An assessment was undertaken to determine the percentage of received shots below the standard thresholds within the Code of Conduct as a function of range. The percentage levels are plotted in Figure 43 for a source in shallow water (S1) and a source in deep water (S3). The results showed that 95% of shots are predicted to be below 186 dB re 1 $\mu Pa^2.s$ at a range of 200 m and 78% of shots below 171 dB re 1 $\mu Pa^2.s$ at 1 km. For the deeper S3 location (Figure 43), 95% of shots are predicted to be below 186 dB re 1 $\mu Pa^2.s$ at a range of 200 m and 93% of shots are below 171 dB re 1 $\mu Pa^2.s$ at 1 km.

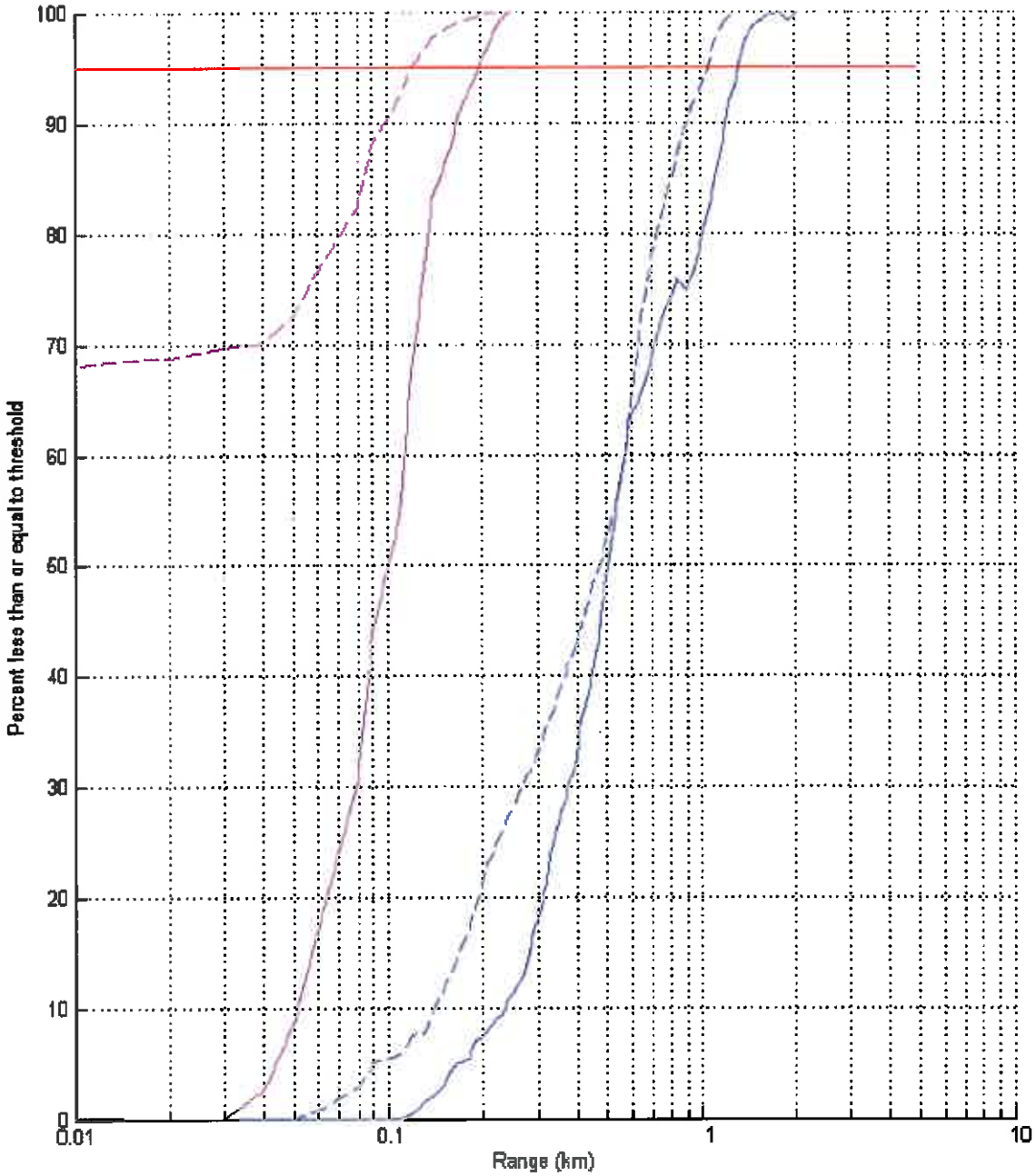

Figure 43: Percentage of received shots below thresholds of 186 dB re 1 $\mu Pa^2.s$ (blue) and 171 dB re 1 $\mu Pa^2.s$ (magenta) as a function of range for sources S1 (solid) and S3 (dash). Percentages are calculated over all azimuths and depths

As the water depth increases, the SEL's decrease as shown in Table 11 and Figure 43. However a conservative approach has been taken in defining new mitigation zones for the ECPB 2D MSS and these results will be ground-truthed at the start of the ECPB 2D MSS with results forwarded to DOC as soon as possible.

The Code of Conduct states that if the STLM shows the SEL's are predicted to exceed either 171 dB re 1 $\mu Pa^2.s$ at distances corresponding to the relevant mitigation zones for Species of Concern, or 186 dB re 1 $\mu Pa^2.s$ at 200 m, consideration will be given to either extending the radius of the mitigation zone or limiting the acoustic source power accordingly. However due to the depth of the targets below the seabed Schlumberger are aiming for in the deep water the acoustic source cannot be reduced as this will jeopardise the survey results.

As a result, a conservative approach has been taken, where the results from the shallowest part of the ECPB Operational Area have been used to determine the new mitigation zones, even though this depth and SEL results only apply to a very small proportion of the entire ECPB Operational Area, and there are only a few survey lines which actually run up into these depths on top of the shelf edge (Figure 1).

Therefore the new mitigation zones that will be incorporated into the ECPB 2D MSS and applied for the entire ECPB Operational Area are:

- 2.1 km – Species of Concern with Calve;
- 2.1 km – Species of Concern without Calve; and
- 350 m – Other marine mammals.

This sees an increase of 600 m beyond the previous mitigation zone for Species of Concern with calve and 150 m for all other marine mammals.

Long range modelling was undertaken at a location that was chosen as being likely to produce the highest SEL's inshore of the ECPB Operational Area and this was modelled out to a 250 km radius from the source location. This distance was modelled so that the maximum expected SEL's could be determined that are likely to be received at Kaikoura, approximately 250 km away. Again Schlumberger have taken a conservative approach, choosing the source location to model for worst case, where in reality the acoustic source will only be operating in this location for a very small portion of the overall ECPB 2D MSS duration. It is initially proposed to commence the ECPB 2D MSS in the south and work north where operationally possible so as the survey is completed the distance between the acoustic source and the Kaikoura region will only increase.

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 such as this where the bathymetry is very steep and sound is propagating almost parallel to the contours. There are now several research groups 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. In this particular case these three dimensional effects would be expected to have most effect well to the southwest and well to the northeast of the source location where they would increase sound levels on the seaward side of the steep bathymetry while reducing them on the landward side (A Duncan pers. comm.). They would have negligible effect close to the source where the sound is travelling more or less perpendicular to the bathymetry contours.

The long range modelling results shown in Figure 44 identifies the strong and complicated directionality of the SEL's due to a combination of the directionality of the acoustic array which produces the maximum amount of radiated energy in the in-line direction and to a lesser extent in the cross line direction. The effect of variable bathymetry causes rapid

attenuation upslope from the source and enhances propagation downslope (Koessler & Duncan, 2014). 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.

This is illustrated in Figure 45 which shows a vertical cross-section through the sound field produced by the source modelled at the long-range modelling location within the ECPB Operational Area. The highest SEL's are transmitted vertically downward into the seabed, however due to the total volume and frequency dependent beam pattern of the acoustic source array, energy is trapped in the ocean interior (Koessler & Duncan, 2014).

This cross-sectional slice of sound exposure in Figure 45 is along 240°T and 60°T and the cross-section slice shows the SEL's predicted to reach the Kaikoura area (left side of plot). The model predicted that the SEL's that may reach the Kaikoura region are between 115 – 125 dB re 1 $\mu Pa^2.s$. Within the ocean ambient noise levels have been shown to be 101-112 dB re 1 $\mu Pa^2.s$ (Greene, 1986) and 80-120 dB re 1 $\mu Pa^2.s$ (www.seismicsurvey.com).

The source location for the long range modelling was selected as it was most likely to emit the highest SEL's inshore and down to the Kaikoura region. Schlumberger wanted to take a cautious and conservative approach when undertaking the STLM in order to assess what the SEL's that could potentially reach the shore line or Kaikoura region where there is an important marine mammal tourism industry. The SEL's of 115 – 125 dB re 1 $\mu Pa^2.s$ are well below the 171 dB re 1 $\mu Pa^2.s$ stated within the Code of Conduct which is believed to potentially effect the behaviour of marine mammals (DOC, 2013).

As part of the consultation undertaken during the formation of this MMIA, Whale Watch Kaikoura stated that they know the behaviour of the whales that reside there very well and would be able to determine if they were being influenced by any increased noise levels as a result of the ECPB 2D MSS. Whale Watch Kaikoura use a hydrophone deployed over the side of their vessels to listen for the diving sperm whales for where and when they will next surface, however these hydrophones are unlikely to be sensitive enough to pick up any noise emitted from the ECPB 2D MSS, approximately 250 km north.

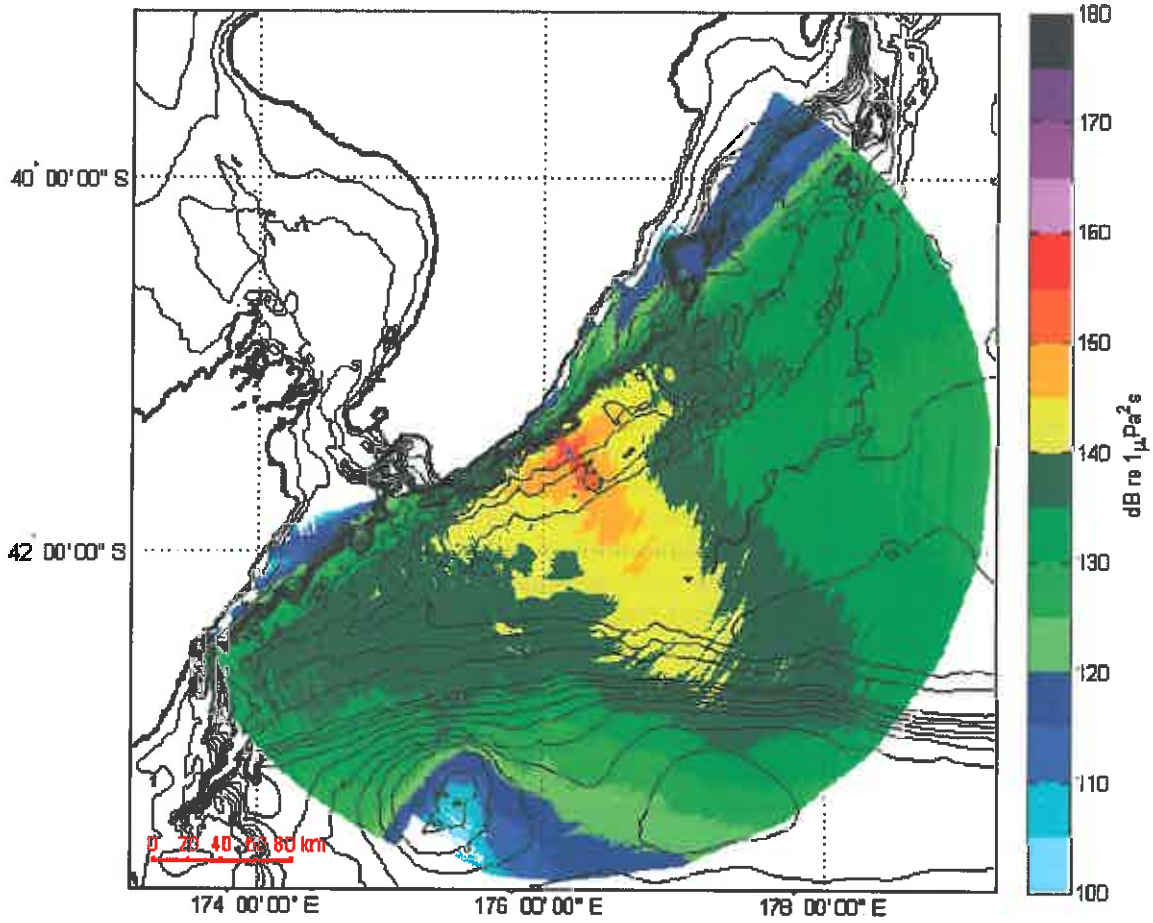

Figure 44: Geographical distribution of long range modelled SEL's. Survey line azimuth is 320°T

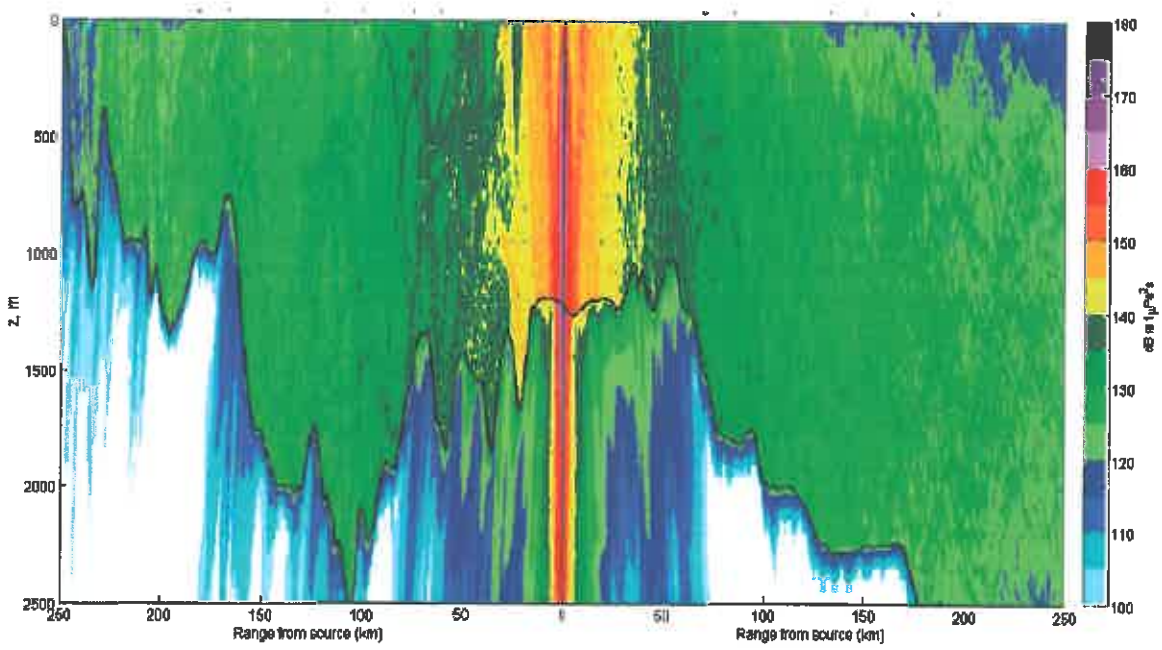

Figure 45: Vertical cross-section through the sound field in the inline direction (240°T and 60°T). Black line is seabed

5.1.2.2 Physiological Effects on Marine Mammals and Fauna

Marine mammals can use sound actively or passively for foraging, navigation, communication, social behaviour, reproduction, parental care, avoidance of predators and overall awareness of the environment (Thomas *et al.*, 1992; Johnson *et al.*, 2009).

Sound intensities that would result in physiological effects are largely unknown for most marine animals, with current knowledge based on a limited number of experiments (Richardson *et al.*, 1995; Gordon *et al.*, 2003). However, it is believed that to cause immediate serious physiological damage to marine mammals, SELs need to be very high (Richardson *et al.*, 1995); and these are only found close to the acoustic source. The STLM showed that the SELs for injury criteria as identified in the Code of Conduct is likely to be at a range of less than 330 m from the acoustic source.

Most free-swimming marine mammals have been observed to swim away from an acoustic sound well before they are within range that any physiological effects could occur. However, in the Woodside Maxima 3D MSS, where an extensive scientific study was undertaken around Scott Reef, Australia, using remote underwater videos to assess the behaviour of reef fish, which are generally sight-attached to the reef when they are exposed to an approaching acoustic source. As the active seismic vessel approached the fish went into the reef to hide, then once the vessel had passed the fish came back out of the coral reef and went back to their normal activities. Further studies of caged fish exposed to the operational acoustic source of 2,905 in^3 in shallow water found that there was no damage to the fish's auditory system (Colman *et al.*, 2008). There is a lack of conclusive data on the physiological effects of acoustic sound on marine mammals. Marine mammals are protected species so they cannot be sacrificed for physical examinations and the physical size of most marine mammals does not generally allow captive studies to occur.

In adherence to the Code of Conduct, pre-observations and soft start procedures will help minimise any potential risk to marine mammals to as far as practicably possible prior to commencing the ECPB 2D MSS. Likewise, if a marine mammal approaches the seismic vessel or acoustic source and enters the relevant mitigation zone, then the trained and qualified MMOs onboard the vessel have the authority to shut down the acoustic source in accordance to the Code of Conduct.

A study was undertaken on the changes in occurrence of harbour porpoises across a 2,000 km^2 survey area during a commercial 2D MSS in the North Sea (Thompson *et al.*, 2013). Passive acoustic monitoring and digital aerial surveys were used to assess the response of the harbour porpoises from a 470 in^3 acoustic source array over ranges of 5 – 10 km, at received peak-to-peak sound pressure levels of 165-175 dB re 1 µPa and SEL's of 145 – 151 dB re 1µPas^{-1}. However, it is noted that the acoustic source used within this experiment is far smaller than the acoustic source to be used in the ECPB MSS, but the general results are assumed to apply, although given the larger source the mammals may move further away or for a slightly longer period. It was shown that animals were typically detected again at affected sites within a few hours, and the level of response declined throughout the 10 day survey period. The number of acoustic detections within the survey area decreased significantly during the MSS period in the impact area compared to the control area, but this effect was small in relation to natural variation (Thompson *et al.*, 2013). It was concluded from the Thompson *et al.* (2013) study that prolonged seismic survey noise did not lead to broader-scale displacement into suboptimal or higher-risk habitats, and suggested that impact assessments should focus on sub-lethal effects resulting from changes in foraging performance of animals within affected sites. Within the ECPB Operational area there are no known habitats that have been identified for concentrating marine mammals as very little work has been conducted in that part of offshore NZ, so the results from the ECPB MMO reports will add to the knowledge of marine mammal distribution along the east coast of NZ.

For marine fauna which cannot flee from an approaching seismic vessel and acoustic source (i.e. plankton, fish eggs and some sessile organisms) they could be at risk of physiological effects from sound exposure.

Elevated SEL's can lead to a threshold shift in hearing, which in most cases is believed to only be temporary, while exposure to an extreme SEL or multiple or prolonged exposure to a loud sound could cause a permanent threshold shift. Studies on beluga whales and dolphins have shown that temporary threshold shift occurred until SELs were in the order of 225 – 230 dB, which for a MSS is within a few tens of metres from the acoustic source (OGP/IAGC, 2004). The ECPB 2D MSS will be operating in accordance with the Code of Conduct, to minimise the risks to marine mammals as far as practicably possible.

Studies undertaken on fathead minnows (*Pimephales promelus*) have shown that threshold shift in hearing is directly correlated to the frequency and duration of sound exposure (Skolik & Yan, 2002). Temporary threshold shift (less than 24 hours) was observed after one hour of exposure to white noise at >1 kHz, but no threshold shift occurred at 0.8 kHz. The frequency of the acoustic sound for the ECPB 2D MSS is between 2 – 250 Hz, and the sound emissions will only occur every 10 – 11.5 seconds during acquisition. Another study on northern pike (*Esox lucius*), broad whitefish (*Coregonus nasus*) and lake chub (*Couesius plumbeus*) exposed to a 730 in^3 acoustic source (significantly smaller than the ECPB 2D MSS acoustic source) found varying degrees of threshold shift, but recovery occurred within 24 hours of exposure (Popper *et al.*, 2005). For the ECPB 2D MSS there is the potential that the acoustic source could induce temporary effects on fish species that are in close proximity to the acoustic source, but any lasting physiological effects of the ECPB 2D MSS on fish species would likely be ***negligible***.

Larval stages of fish and invertebrates generally live in the surface waters where they have a pelagic lifecycle in their early developmental stages, feeding on phytoplankton and zooplankton. It is at this stage in their life cycle that they could be exposed to acoustic noise if a MSS is being conducted in close proximity. Studies have shown that mortality of plankton communities can occur if they are within 5 m of an active acoustic source (DIR, 2007).

A study conducted in NZ at the Leigh Marine Laboratory exposed scallop larvae (*Pecten novaezelandiae*) to seismic pulses in tanks to assess the effect of acoustic noise on the early development stages of scallop larvae (Aguilar de Soto *et al.*, 2013). Scallop larvae were placed in noise flasks in a thin plastic mesh and suspended at a depth of 1 m in a tank filled with seawater (2 m diameter and 1.3 m deep). The noise flasks were suspended 5-10 cm in front of a sound transducer emitting a pulse every 3 seconds. Noise exposure started immediately after the flasks were put into the tank, which was within one hour after fertilisation. Control samples were also used with no acoustic source present. A total of 4,881 scallop larvae were utilised in the study and were sampled at seven fixed intervals (24, 30, 42, 54, 66, 78, and 90 hours) after fertilisation to observe the development through the different larval phases.

At completion of the Aguilar de Soto *et al.* (2013) study, 46% of the noise-exposed larvae showed malformations, which were evident as abnormal growth, with localised bulges in the soft body of the larvae, but not in the shell. In the tanks with no noise exposure, no malformations were found in the four control flasks. It appears that the Aguilar de Soto *et al.* (2013) study is the first evidence that continual sound exposure can cause growth abnormalities in larvae. It was concluded in the study that the small size of the scallop larvae and the absence of strong tissue density gradients in early developmental phases that the observed damage was related to particle motion rather than the pressure component of the noise exposure. Recordings within the tank showed that the sound levels within the tank during the experiment was 160 dB re 1 µPa at 1m, but the particle velocities experienced by the larvae imply far-field pressure levels of 195-200 dB re 1 µPa. The report further concluded that given the strong disruption of larval development, weaker but still significant

effects could be expected at lower exposure levels and shorter exposure durations. From the STLM, a SEL of 195-200 dB re 1 µPa is confined within 200 m of the acoustic array.

However these results have to be treated with caution when applying them to industry standard MSS's. In the Aguilar de Soto *et al.* (2013) study, the acoustic source was activated within a small confined tank, 5-15 cm from the larvae at a shotpoint interval of 3 seconds, compared to most MSS where they have a shotpoint interval of approximately 8-11 seconds. The study was undertaken on larvae that had only been fertilised one hour previously; the ECPB 2D Operational Area is located 9 km offshore from the East Coast at its closest point, so although there is the potential for shellfish larvae to be within the water column, the likelihood that any shellfish larvae have just been fertilised is very low. During acquisition the *Aquila Explorer* will be continuously moving at 4.5 kts, so any larvae present in the immediate vicinity of the acoustic source will not be exposed to the acoustic sound for the periods that the scallop larvae were exposed to in the Leigh Marine Laboratory. In Aguilar de Soto *et al.* (2013) it clearly shows there is strong evidence that acoustic sound can cause malformations in larvae, however the exposure times of larval phases during the ECPB 2D MSS should be much less than those in the scallop larval study. It is assumed that the exposure results of Aguilar de Soto *et al.* (2013) could be applied to other shellfish and fish in early larval developmental stages, but due to the distance offshore, the continual movement of the vessel, the effects on fish and shellfish larvae is believed to be ***minor - moderate*** if they are in close proximity to the acoustic source.

There is currently little information on how marine organisms process and analyse sound, making assessments about the impacts of artificial sound sources in the marine environment difficult (Andre *et al.*, 2011). Research has shown that effects of acoustic noise produced from a MSS on macroinvertebrates (scallop, sea urchin, mussels, periwinkles, crustaceans, shrimp, gastropods and squid) results in very little mortality below sound levels of 220 dB re 1µPa@1m, while some show no mortality at 230 dB re 1µPa@1m (Royal Society of Canada, 2004). Sound levels required to cause mortality, based on the STLM would only be reached in very close proximity to the acoustic source (Koessler & Duncan, 2014). The effects that have been observed generally occur in shallow water, and given the depth of the ECPB Operational Area (>200 m) the effects on benthic invertebrates is believed to be ***minor***.

Of the three main forms of marine macrofauna (mammals, fish and invertebrates), cephalopods belong to the last group, which is also the least understood. Situated in the food chain between fish and marine mammals, they are also key bio-indicators for ecosystem balance in vast and complex marine ecosystems (Andre *et al.*, 2011). Although startle responses have been observed in caged cephalopods exposed to acoustic sources with received SEL's of 174 dB re 1 µPa (McCauley *et al.*, 2000), studies addressing noise-induced morphological changes in these species have been limited (Andre *et al.*, 2011). In the McCauley *et al.*, (2000) study the squid showed avoidance of the acoustic source by keeping close to the water surface at the cage end furthest away from the acoustic source, where a sound shadow exists near the water surface of almost 12 dB re 1 µPa. However, in Andre *et al.* (2011) four cephalopod species were exposed to low frequency sounds (50-400 Hz sinusoidal wave sweeps with a 1 second sweep period for two hours) which identified the presence of lesions in the statocysts, which are believed to be involved in sound reception and perception. The sound levels received from these sound waves were measured with a calibrated hydrophone within the tanks which showed sound levels of 157 ± 5 dB re 1 µPa, with peak levels at 175 re 1 µPa. It was therefore concluded that the effects of low frequency acoustic noise for a long period of time could induce severe acoustic trauma to cephalopods (Andre *et al.*, 2011). Based on the STLM, these peak sound levels can be found within approximately 1.5 km from the acoustic source used for the ECPB 2D MSS (Figure 41).

Both squid and octopus are species of cephalopod and are present in waters surrounding the ECPB Operational Area, however octopus generally live a cryptic lifestyle around reef structures and generally closer to shore and a lot shallower than 200 m. Squid are a pelagic species and can be found in these east coast waters, with majority of the commercial squid

fishing throughout NZ taking place in the summer months from January through to May (MPI, 2014f). The majority of commercially caught squid within NZ waters is caught off the bottom of the South Island and Auckland Island's. Squid are a very short lived but fast growing species where they only live for one year with spawning occurring between May and July (MPI, 2014g). Squid are caught along the east coast region and could be encountered within the ECPB Operational Area (Section 4.2.4). The ECPB 2D MSS will be commencing towards the end of the squid fishing season throughout southern NZ, so it is possible that squid could be present within the ECPB Operational Area, and if they were present and in close proximity (<1.5 km) to the operating acoustic source there is the potential for trauma to these species. As a result, if squid were present in the close proximity (<1.5 km) to the acoustic source the effects on them could be ***moderate***, however the adaptations they have in place to reflect their short life cycle, i.e. fast growth rates and high fecundity levels, there is not anticipated to be any overall significant effects on the squid populations on the east coast of NZ.

In Moriyasu *et al.* (2004) a summary of a literature review on the effects of acoustic noise on invertebrate species was undertaken. One study used a single acoustic source with source levels of 220-240 dB re 1 µPa on mussels, periwinkles and amphipods at distances of 0.5 m or greater. Results showed there was no discernible effects on the mussels or amphipods as a result of the acoustic sound at these close distances. A study in the Wadden Sea exposed brown shrimp to a 15 acoustic source sub array with a source level of 190 dB re 1 µPa at 1 m from the source in a water depth of 2 m and found no mortality of the shrimp or any evidence of reduced catch rates. This result of no observed effect was attributed to the absence of gas-filled organs with a rigid exoskeleton.

However a study on the Iceland scallop and sea urchins exposed to an acoustic source (233 dB 1 µPa) at a distance of 2 m showed that one of the three scallops exposed had a shell which split and 15% of the spines in the sea urchins fell off when exposed.

The mitigation measures and operational procedures in place for the duration of the ECPB 2D MSS to minimise potential effects of acoustic noise on marine macrofauna include; the acoustic sound wave is directed downwards from the source; the observed avoidance behaviour of marine mammals and other mobile fauna while the acoustic sources are operating, and adherence to the Code of Conduct.

From the summary above it is believed that overall the ECPB 2D MSS could have ***moderate*** physiological effects on marine mammals and fauna.

5.1.2.3 Behavioural Effects on Marine Mammals and Fauna

In response to an operating MSS, behaviours of marine mammals and fauna can include fright, avoidance and changes in vocal behaviour (McCauley *et al.*, 1998; McCauley *et al.*, 2003). This has been observed in Mysticetes (baleen whales) as they operate at lower sound frequencies (moans at 10 – 25 Hz). Whereas Odontocetes (toothed whales and dolphins) are not likely to be detrimentally affected, as they operate at sound frequencies far higher than those generated by acoustic sources (> 5 kHz). The ECPB 2D MSS will operate at a sound frequency of between 2 – 250 Hz.

Observations have shown that MSS may cause some changes in localised movements and behaviours of cetaceans; generally swimming away from the acoustic source but in some instances rapid swimming at the surface and breaching (McCauley *et al.*, 1998; McCauley *et al.*, 2003). Although acoustic noise from a MSS does not appear to cause any changes to the regional migration patterns of cetaceans (McCauley *et al.*, 2003).

It has been observed that humpback whales exposed to seismic surveys, consistently changed course and speed to avoid any close encounters with an operating seismic array (McCauley, *et al.*, 2000). Sound levels for this avoidance response to occur were estimated at 160 – 170 dB re 1 µPa peak to peak. From the ECPB 2D MSS STLM, these sound levels appear to be present within ~5 km from the acoustic source (Figure 42).

A study on pink snapper held in captivity and exposed to acoustic source signals demonstrated minor behavioural responses ranging from startle to alarm, suggesting that fish may actively avoid an active seismic source in the wild (McCauley *et al.*, 2003).

The Madden Canyon off Porangahau, Hawke's Bay is present within the ECPB Operational Area (Figure 12). Limitations within the STLM methodology currently prevent 3D sound propagation modelling. Due to the modelling limitations there is currently no capability to assess how sound travels down a canyon such as this and only improvements in technology will allow this. As a result it has to be assumed that there may be higher levels of sound within a canyon as the sound propagates down the slope, however given there is only one survey line which passes through the Madden Canyon, and the next closest lines are 20 km away to the north and south, the potential for high sound exposure will only last for a short period of time. Based on Woodside's 3D Maxima scientific study within shallow waters, where there was no effect observed on the coral reef fish or any damage to their auditory systems (Colman *et al.*, 2008), the same principle could apply to the fish species living within the deeper waters within the Madden Canyon and the ECPB Operational Area.

The ECPB Operational Area is located in deep water (>200 m), however there is the potential that pelagic fish and marine mammals may either avoid or move away from the acoustic source while the ECPB 2D MSS is being acquired. As a result there would be a behavioural effect resulting in some fish or marine mammals moving beyond their core habitat at that time of year or potentially moving away from an easily accessible food source. As a result of the summary above and the unknown nature of how sound will propagate within the Madden Canyon, the ECPB 2D MSS has the potential to have ***moderate*** effects on marine mammals and fish behaviour.

5.1.2.4 Disruption to Feeding Activities

The potential effects to marine species identified in this MMIA that could be present in the ECPB Operational Area include disturbance to feeding activities and displacement from habitat for the MSS duration. Any marine mammals that are in close proximity to the acoustic source are likely to move away from the immediate area when the acoustic source is active to avoid increased noise levels. If marine mammals are forced to leave large aggregations of krill or a different food source as a result of the ECPB 2D MSS acoustic noise, it is a deviation from their natural behaviour and could have an impact on their ability to capture prey easily, forcing them to expend more energy hunting food. However, there is no significant area identified within the ECPB Operational Area that aggregates any marine mammals i.e. upwellings so if any marine mammals moved away for a short duration it is not anticipated to have any detrimental effects caused through reduction of feeding grounds or habitat.

Thompson *et al.* (2013) indicated that prolonged seismic survey noise did not lead to broader-scale displacement into suboptimal or higher-risk habitats, and animals were typically detected again at affected sites where a MSS had been conducted within a few hours following the acoustic source being stopped, and the level of response declined throughout the 10 day survey period.

Any migrating humpback whales that are passing through the Cook Strait are not believed to be feeding, as during the autumn and winter months they fast and feed on their fat reserves built up from the polar waters. However, it is assumed the ECPB MSS will be complete or well to the north of the Cook Strait before any humpback whales are observed within Cook Strait.

The distribution of any feeding sperm whales within the ECPB Operational Area is currently unknown but Schlumberger will be operating to conservative mitigation zones as determined by the STLM, of which the biggest mitigation zone has been selected for the entire ECPB 2D MSS. Sperm whales echolocate loud and have a strong signal and can be heard using PAM technology out to 3 km, so it is assumed if sperm whales are in the area they will be heard.

However the long distances that they can be heard with PAM is somewhat dependent on background noise and sea state (R Slade pers. comm.).

Once the seismic vessel and acoustic array has passed through an area, or once the ECPB 2D MSS is complete, the sound source within the marine environment will have dissipated and there will be no further environmental effects on any species residing there. The survey lines extend for many kilometres through the ECPB Operational Area so the vessel will not be concentrating in any one particular area. Therefore, given there is no known feeding aggregations or grounds, the potential disruption and disturbance to marine mammals feeding activities within or adjacent to the ECPB Operational Area is believed to be ***moderate.***

5.1.2.5 Interference with Acoustic Communication Signals

Vocalisations from cetaceans, used for communication and navigation, are the most studied and understood forms of acoustic communication in the marine environment. The ability to perceive biologically important sound is very important to marine mammals and any acoustic disturbance through human generated noise has the potential to interfere with their natural functions (Di Iorio & Clark, 2009).

If a MSS emits sound in the same frequency range as the sounds generated by cetaceans and interferes with or obscures signals in locations which are biologically significant to cetaceans, there is the potential for significant environmental effects (Richardson *et al.*, 1995).

The known frequencies of echolocation and communication calls for selected species of toothed whales and dolphins is summarised in Table 12. The known spectrum of echolocation signals are at much higher frequencies (6 – 130 kHz) than the high end of the operational range of MSS acoustic sources (<1 kHz). The greatest potential for interference of acoustic signals is at the highest end of the seismic spectrum and the lowest end of whales and dolphins communication spectrum.

Table 12: Cetaceans communication and echolocation frequencies

Species	Communication Frequency (kHz)	Echolocation Frequency (kHz)
Bottlenose dolphin	0.8 – 24	110 – 130
Common dolphin	0.2 – 16	23 – 67
Killer whale	0.5 – 25	12 – 25
Long finned pilot whale	1 – 18	6 – 117
Sperm whale	0.1 – 30	2 – 30
Blue whale	0.01 – 0.04	0.01 – 0.4

Toothed whales communication calls partially overlap with the high end of an acoustic source's operational range, the acoustic energy emitted from the acoustic source array for the ECPB 2D MSS is between 0.02 – 0.25 kHz; well below the lower frequency limits of most toothed whales. Sperm whale, common dolphin and blue whales vocalise at a frequency (0.01 – 0.4 kHz) that could be influenced from the frequencies emitted during a MSS (Table 12).

Blue whales have been shown to increase their calls (emitted during social encounters and feeding) when a MSS using a low-medium power source is operational compared to non-exploration days (Di Iorio & Clark, 2009; Melcon *et al.*, 2012). A mean sound pressure used in this study was relatively low (131 dB re 1µPa (30 – 500 Hz) with a mean sound exposure level of 114 dB re 1µPa^{2}s. It is at these SEL's that blue whales will change their calling behaviour in response to a low-medium acoustic source and was presumed to have a minor environmental effect (Duchesne *et al.*, 2007).

The STLM for the ECPB 2D MSS is confined to approximately 3 km from the acoustic source for the short range modelling, however the long range modelling extends out to 250 km. From this it can be seen that the SEL of 114 dB re 1µPa²s that results in blue whales changing their calling behaviour could potentially be found out to approximately 250 km from the acoustic source when the *Aquila Explorer* is in the shallowest part of the ECPB Operational Area in which the worst case scenario was modelled. The ECPB 2D MSS is spread over a 58,000 km² Operational Area so the acoustic source will not be concentrated in any particular area for extensive periods of time.

With these emitted sound levels from the ECPB MSS there is the possibility that when the vessel is acquiring the inside portion of a few of the lines, there is the potential to interfere with how blue whales communicate with each other, where the whales may need to increase their calling to try and increase the probability that their signal is successfully received by conspecifics. This communication interference could influence the potential for blue whales to find mates or find aggregations of krill if their calls are not heard. However, the ECPB area is not known to hold numbers of blue whales or there is no literature on any resident blue whales being within the general area.

In 2009-2010 the Ministry of Economic Development undertook a 2D MSS within the Pegasus Basin, Great South Basin and Bounty Trough between mid-November and end of March, acquiring approximately 8,000 km of 2D seismic data. During these surveys a total of 1,296 hours of visual surveys and 1,045 hours of PAM surveys were undertaken spanning 87 days, and no blue whales were observed during the MSS (BPM, 2010). As a result although there is the potential for blue whales to be in the area, it is unlikely.

It is thought that the blue whale increases its calling to increase the probability that its signal will be successfully received by conspecifics. In the study by Di Iorio & Clark (2009) the survey area was crossed by a busy shipping lane and vessel noise was common. It was concluded that noise from shipping did not account for any changes in acoustic behaviour of the blue whales. From the available literature the effects of seismic surveys on blue whales are unknown, other than increasing their calling when an acoustic source is operating (Di Iorio & Clark 2009).

From the reviewed studies and literature available it is believed that the ECPB 2D MSS could have a ***moderate*** effect on marine mammal's use of naturally produced acoustic signals. However, once the ECPB 2D MSS is complete there will be no more influence or interference with any mammal's communication or echolocation frequencies.

5.1.3 Solid and Liquid Wastes

During the ECPB 2D MSS various types of waste will be produced (sewage, galley waste, garbage and oily water) and if inappropriate management occurred there is the potential for an environmental effect. Each type of waste requires correct handling and disposal; the volume of waste generated will depend on the number of crew onboard each vessel and the MSS duration.

5.1.3.1 Generation of Sewage and Greywater

The liquid wastes that will be generated during the ECPB 2D MSS will include sewage and Greywater (wastewater from toilets, washrooms, the galley and laundry). The *Aquila Explorer* and *Amaltal Mariner* have onboard sewage treatment plants which ensures a high level of treatment before the waste is discharged. All vessels involved in the ECPB 2D MSS also have an International Sewage Pollution Prevention Certificate (ISPPC).

As a result of the high level of treatment the sewage generated by the vessels involved in the ECPB 2D MSS receives, it is believed that only ***negligible*** effects on the marine environment would occur.

5.1.3.2 Generation of Galley Waste and Garbage

In accordance with the NZ Marine Protection Rules, only biodegradable galley waste, mainly food scraps will be discharged to sea after it has been comminuted and can pass through a 25 mm screen. Comminuted waste can be discharged beyond 3 Nm from shore and given the high energy offshore marine environment, these discharges will rapidly dilute to non-detectable levels very quickly.

All solid and non-biodegradable liquid wastes will be retained onboard for disposal to managed facilities ashore through the waste management contractor.

For all disposal options MARPOL Annex V stipulations will be followed with records kept detailing quantity, type and approved disposal route of all wastes generated and will be available for inspection. All wastes, including hazardous returned to shore will be disposed of in strict adherence to local waste management requirements with all chain of custody records retained by Schlumberger.

As a result of these operating procedures in place and adherence to MARPOL the environmental effects from galley waste and garbage on the marine environment is likely to be ***negligible***.

5.1.3.3 Generation of Oily Waters

Oily waters on any vessel is generally derived from the bilges. The *Aquila Explorer* has a bilge water treatment plant that achieves a discharge that is superior to NZ and MARPOL requirements of 15 ppm.

All vessels involved in the ECPB 2D MSS have approved International Oil Pollution Prevention Certificates (IOPPC) and have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place.

As a result of operating in compliance to the above procedures, the environmental effects of any discharges to the marine environment would be ***negligible***.

5.1.3.4 Atmospheric Emissions

Exhaust gasses from the *Aquila Explorer's* engines, machinery and air compressor generators are the principle sources of air emissions (combusted exhaust gasses) likely to be emitted to the atmosphere. Most of these gaseous emissions will be in the form of carbon dioxide, although smaller quantities of other gasses (oxides of nitrogen, carbon monoxide and sulphur dioxide) may be emitted. The *Aquila Explorer* has an International Air Pollution Prevention Certificate (IAPPC) which ensures that all engines and equipment are regularly serviced and maintained.

Potential adverse effects from these emissions are related to the reduction in ambient air quality in populated areas and potential adverse effects/health effects on personnel. However, given the distance offshore and exposed nature of the ECPB Operational Area and the anticipated low level of emissions, the environmental effects arising from the ECPB 2D MSS is believed to be ***negligible***.

5.2 Unplanned Activities – Potential Effects & Mitigation Measures

Unplanned activities are rare during MSS operations; however if they were to occur, would likely be a result of a streamer break or loss, fuel/oil spill or a vessel collision. All marine operations have some potential risk, no matter how low and this assessment has covered the potential of this occurring.

5.2.1 Streamer Break or Loss

The potential for damage to occur to a seismic streamer could result from snagging with floating debris; or potential rupture from abrasions, shark bites or other vessels crossing the streamer.

The streamer to be used in the ECPB 2D MSS is a solid streamer so if it were to break or be severed there is little potential for an environmental effect on the marine environment. The solid streamer is negatively buoyant and requires movement to maintain depth so if the streamer was severed it would start sinking. The streamer has Self Recovery Devices (SRD) fitted which deploy for retrieval once the streamer sinks below 48 m depth. This will prevent any potential for crushing or damage to the benthic communities.

The ECPB 2D MSS will be undertaken by experienced personnel using international best practice and as a result of the streamer type to be used for the ECPB 2D MSS, if the streamer was severed or lost the environmental effect would be ***negligible***.

5.2.2 Fuel or Oil Spills

The potential for a fuel or oil spill during the ECPB 2D MSS could arise from; leaking equipment or storage containers or hull/fuel tank failure due to a collision or sinking. The largest potential for an environmental effect would result from a hull/fuel tank failure as the other potential for spills would be generally contained on the vessel.

If a spill from the *Aquila Explorer's* fuel tank did occur, the maximum possible spill if the fuel tanks were full would be 1,254 m^3 of marine gas-oil. However for this to occur there would have to be a complete failure of the vessel's fuel containment system or catastrophic hull integrity failure. The high-tech navigational systems onboard, adherence of the COLREGS and operational procedures to international best practice will ensure that the potential for a spill is unlikely to occur.

All vessels involved in the ECPB 2D MSS have an approved and certified SOPEP and IOPPC as per MARPOL 73/78 and the Maritime Protection Rules Part 130A and 123A which are onboard the vessels at all times. In addition the *Aquila Explorer* has a HSE Management Plan and Emergency Response Plan which would be used in the event of an emergency, including fuel spills.

Therefore, due to the safety, environmental and maritime requirements that will be implemented for the ECPB 2D MSS, the risk of a fuel or oil spill occurring is considered to be ***negligible***.

5.2.3 Vessel Collision or Sinking

If a collision occurred whilst the *Aquila Explorer* was at sea, the biggest threat to the environmental would be the vessel reaching the sea floor and the release of any hazardous substances, fuel, oil or lubricants. However, this is very unlikely as the risks are mitigated through the presence of a support vessel at all times and adherence to the COLREGS. As a result, the potential risk for a vessel collision or sinking is considered to be ***negligible***.

5.3 Mitigation Measures

Schlumberger will adhere to the mitigation measures identified in the Code of Conduct for operating a Level 1 MSS to minimise any adverse effects to marine mammals from the MSS operation (DOC, 2013). Due to the ECPB Operational Area being within an AEI and as a measure of best operator practice, Schlumberger will implement additional mitigation measures, over and above the Code of Conduct. While undertaking the ECPB 2D MSS, if there are any instances of non-compliance to the Code of Conduct and the mitigation measures identified below, the Director-General will be notified immediately.

The operational procedures that Schlumberger will follow will be detailed in the MMMP (Appendix 4) and circulated among the MMO's and crew, with a summary of these operating procedures and mitigation measures listed in the following sections.

5.3.1 2013 Code of Conduct Mitigation Measures

The 2013 Code of Conduct was updated following the 2012 – 2013 summer period where a number of MSS's were acquired in the Taranaki Basin, with operators voluntarily adhering to the 2012 Code of Conduct. During these surveys a number of operational issues were identified and led to a review of the 2012 Code of Conduct before the next MSS season (2013 – 2014 summer period). For the ECPB 2D MSS the requisite mitigation measures specific to a Level 1 MSS are identified in Section 2.3.1. However, due to the ECPB 2D MSS operating in an AEI and Schlumberger's desire to operate to best operator practice, additional mitigation measures are to be implemented. These additional measures are discussed in Section 5.3.2.

5.3.2 Additional Mitigation Measures for the ECPB 2D MSS

5.3.2.1 Sound Transmission Loss Modelling

As discussed in Section 5.1.2.1 STLM has been undertaken to predict SEL's at various distances from the *Aquila Explorer*, with the modelling based on the specific configuration of the acoustic source to be used for the ECPB 2D MSS and the environmental conditions (i.e. bathymetry, substrate and underlying geology) of the ECPB Operational Area.

Results were used to validate the mitigation zones identified for a Level 1 MSS in the Code of Conduct. The Code of Conduct requires for MSS's undertaken in an AEI that the SEL has to provide the relative distances from the acoustic source which behavioural criteria (171 dB re 1µPa^2-s SEL) and injury criteria (186 dB re 1µPa^2-s SEL) could be expected. The STLM showed that the SEL's were higher than the behaviour and injury criteria and as a result the radius of the mitigation zones have been increased.

The STLM for the ECPB 2D MSS showed that compliance will be achieved with the Code of Conduct criteria (behaviour criteria < 2.05 km and injury criteria < 330 m). As a result adherence to the revised mitigation zones of 2.1 km for Species of Concern (with and without calve) and 350 m for other marine mammals should minimise the potential risk of negative effects to marine mammals.

As per the requirements in Appendix 1 of the Code of Conduct, the STLM will be validated during the ECPB 2D MSS and the results will be provided to DOC. At the start of seismic operations, a vessel self-noise assessment will also be undertaken by the PAM Operators and will be provided to DOC.

The STLM validation will be undertaken by the *Aquila Explorer's* Chief Field Geologist and the lead MMO onboard the *Aquila Explorer*. To complete this validation, SEL's (dB re 1µPa) will be recorded by receivers in the streamer located at five different offsets from the acoustic source; 200 m, 350 m, 1,000 m, 1,500 m and 2,100 m. These recordings will take place within the ECPB Operational Area and will record SEL's across different depth measurements within the ECPB 2D Survey Area, as SEL's are likely to decrease in the deeper waters (Koessler & Duncan, 2014). A heading will be selected along one of the track lines and the test sequence will be performed along this line. In order to confirm and provide a reference to the first suite of results, another test sequence will be performed before the end of the MSS, most likely on the opposite heading.

5.3.2.2 Additional marine mammal observations outside ECPB Operational Area

The *Aquila Explorer* will travel to the ECPB Operational Area once it has finished its prior MSS commitments for other operators. On transit to the ECPB Operational Area, a MMO will

be on the bridge to observe for any marine mammals that would add to the knowledge and distribution of marine mammals around NZ.

Any marine mammal observations outside the ECPB Operational Area will be recorded in the 'Off Survey' forms developed by DOC.

5.3.2.3 Necropsy will be undertaken on any stranded marine mammals

If any marine mammals are stranded or washed ashore during the ECPB 2D MSS inshore of the ECPB Operational Area along the coastline from Banks Peninsula to Mahia Peninsula, Schlumberger would engage Massey University to undertake a necropsy to try and determine the cause of death and whether it was a result of any pressure-related or auditory injuries. DOC will be responsible for all aspects of undertaking the necropsy and coordination with pathologists at Massey University; however Schlumberger will cover the associated costs. Schlumberger will meet these costs for any necropsies required during the ECPB 2D MSS and for a period of two weeks after MSS completion.

5.3.2.4 Exclusion of the southwest region of PPP 56061

Schlumberger have chosen to not utilise all of the available area within PPP 56061 for the ECPB 2D MSS as a way of extending the distance between the ECPB Operational Area and the Kaikoura region. This decision was made following Schlumberger's initial consultation visits where cultural importance of the Kaikoura region was clearly evident, as was the marine mammal tourism industry that coexists with the abundance of marine life in the area and drives Kaikoura's local economy.

5.3.2.5 Notification of any marine mammal carcass observed at sea

If a marine mammal carcass is observed at sea during the ECPB 2D MSS, the location and species (where possible) and any other useful information will be recorded and the lead MMO will notify and provide this information to DOC at the earliest opportunity.

5.3.2.6 Information sharing with Whale Watch Kaikoura and Dolphin Encounter

Schlumberger will be in contact with Whale Watch Kaikoura during the ECPB MSS. If there are any unusual behaviours of the whales noticed by Whale Watch Kaikoura they will contact the Schlumberger representative to discuss. Schlumberger will provide weekly MMO reports to Whale Watch Kaikoura and Dolphin Encounter.

5.4 Cumulative Effects

The East Coast and Pegasus Basins is currently used for shipping and fishing activities within the inshore and northern portion of the ECPB Operational Area. Studies on blue whales, where the survey area was overlapped by a busy shipping lane concluded that shipping noise did not account for any changes in the acoustic behaviour of blue whales (Di Iorio & Clark, 2009); hence noise from shipping traffic has not been considered in this cumulative effects assessment.

At the time of preparation of this MMIA and through consultation with DOC National Office, there is not known to be any other MSS being conducted on the east coast of NZ at the same time as the ECPB 2D MSS. Another 2D MSS is being conducted within the Pegasus Basin but is anticipated to be completed prior to the ECPB 2D MSS commencing. As a result the cumulative effects from two concurrent MSS operating has not be considered as part of this assessment.

There is the potential that during a MSS, if animals avoid an area due to the increased sound exposure; these species could result in additional exposure to predators as well as the loss of foraging or mating opportunities. However, once the ECPB 2D MSS is complete, any resonant noise within the ECPB Operational Area or surrounding marine environment would

diminish. Following this the potential effects from increased sound exposure to marine mammals and fauna would cease and the animals could return to their preferred habitat.

The requirements and mitigation measures for a Level 1 MSS will be adhered to for the ECPB 2D MSS; the *Aquila Explorer* are using the minimum acoustic source required to achieve the objectives of the ECPB 2D MSS, and will either shut down or delay starts if any marine mammals are within the relevant mitigation zones.

Therefore, given it is believed that only the ECPB 2D MSS will be operating on the east coast of NZ from early April 2014 and with the mitigation measures in place; the potential cumulative effects on marine mammals, marine fauna or the marine environment from the ECPB 2D MSS will be ***negligible***.

5.5 Summary of Environmental Effects and Mitigation Measures

The potential environmental effects and associated mitigation measures that will be implemented for the ECPB 2D MSS as identified in this MMIA are summarised in Table 13.

Table 13: ECPB 2D MSS planned and unplanned activities and the potential effects and mitigation measures to be implemented

Aspect or Source	Potential Environmental Effect	Likelihood of Occurrence or Exposure	Proposed Mitigation Measures	Residual Effect
Planned Activities				
Physical presence of *Aquila Explorer* and the seismic array.	Interference with the fishing community and marine traffic.	Very low with mitigation measures in place.	24/7 operations to minimise overall duration of MSS (~40-50 days). Compliance with COLREGS, support vessel present at all times and notice to mariners issued.	Moderate.
	Interference with marine archaeology, cultural heritage or submarine infrastructure.	Extremely unlikely given distance offshore and the streamer will come in contact with the seabed.	Best Practice. Solid streamer with SRD.	Negligible.
	Changes in abundance or behaviour of fish.	Low.	24/7 operations (weather and marine mammal encounters permitting) to minimise overall duration of MSS.	Moderate.
	Changes in seabird behaviour.	Likely - vessels may provide resting opportunities. Collisions or entanglements are unlikely during daylight, but could occur at night.	No mitigation options available. MMOs will record any seabird strikes that are witnessed.	Negligible.
	Introduction of marine pests or invasive species.	Low.	Recent dry-dock of *Aquila Explorer* (November 2013) and new antifouling paint. Adherence to ballast water and hull fouling regulations.	Negligible.
	Interaction with marine mammals.	Low.	Compliance with the Code of Conduct and mitigation zones. Two MMOs and two PAM operators will be observing for mammals 24 hours/day.	Minor.
Acoustic Source Sound Emissions.	Physiological effects on marine mammals and fauna.	Low due to mitigation measures in place.	Compliance with Code of Conduct. Four trained MMO/PAM operators with use of PAM 24/7. Pre-start observations, soft start and delay start/shut down procedures. STLM showed that 100% of receptions were predicted below injury criteria at a range of 330 m, and below behaviour change at a range of 2.05 km from the acoustic source.	Moderate.
	Behavioural effects on marine mammals and fauna.	Potential to occur.		Moderate.
	Disruption to feeding, mating, breeding or nursery activities.	Potential to occur.		Moderate.
	Interference with acoustic communication signals.	Will occur.		Moderate.
Solid and liquid wastes.	Generation of sewage and greywater.	Will occur.	Only biodegradable waste will be discharged and will dilute to non-detectable levels. On-board sewage treatment plant, adherence to MARPOL and approved ISPPC.	Negligible.
	Generation of galley waste and garbage.	Will occur.	Waste management plan where only biodegradable and comminuted waste will be discharged. Adherence to MARPOL.	Negligible.
	Generation of oily waters.	Will occur.	Adherence to MARPOL and approved IOPPC and SOPEP.	Negligible.
Atmospheric emissions.	Atmospheric emissions.	Will occur.	Approved IAPPC. Regular maintenance of motors, equipment and generators and monitoring of fuel consumption.	Negligible.
Unplanned Activities				
Streamer break or loss.	Water or seabed impact.	Low.	Solid streamer with SRD fitted and support vessel present at all times.	Negligible.
Fuel or oil spills.	Water and coastal impact.	Low due to mitigation measures.	Compliance with COLREGS and SOPEP in place.	Negligible.
Vessel collision or sinking.	Water and coastal impact.	Extremely unlikely.	24/7 operations to minimise duration of survey. Compliance with COLREGS and support vessel present at all times. Notice to Mariners issued and broadcast on Maritime Radio. All users of ECPB Operational Area have been advised of the ECPB 2D MSS operation.	Negligible.

6 Environmental Management Plan

The management of environmental risks associated with Schlumberger's activities is integral to their business decision-making processes. Potential environmental risks/hazards are identified during planning stages and throughout operations, and their associated risks are assessed and managed via a structured management system. These mechanisms ensure that Schlumberger's high environmental standards are maintained, the commitments specified in this MMIA are achieved and that any unforeseen aspects of the proposed ECPB 2D MSS are detected and addressed.

The Environmental Management Plan (EMP) is essential for the successful implementation of the ECPB 2D MSS; highlighting the key environmental objectives, the mitigation measures and monitoring programmes to be followed as well as the regulatory and reporting requirements and commitments outlined in this MMIA.

The mitigation measures for the ECPB 2D MSS will be implemented to eliminate, offset, or reduce any identified environmental effects to ALARP.

The *Aquila Explorer* also has its own independent EMP which documents the implementation of their environmental management system as part of their Health, Safety and Environmental Quality Planning process for their operations, waste accounting system, waste management plan and emergency response plan, including for small oil and fuel spills.

The EMP for the ECPB 2D MSS is provided in Table 14 and will be undertaken in conjunction with the MMMP (Appendix 4).

6.1 Implementation

All contractors involved in the ECPB 2D MSS have their own management systems that are consistent with the requirements of the ECPB 2D MSS. To ensure environmental performance and before any contracts were signed Schlumberger assessed contractors previous environmental performance; included clauses in the contract documents specifying contractor responsibilities; indicated the requirements for contractor training and the requirements for appropriate monitoring, feedback and sharing information between Schlumberger and the contractor (i.e. weekly waste-generation reports).

The *Aquila Explorer* will have specific personnel with designated responsibilities in regard to environmental protection, supervision and execution of the EMP. However, the Master will have ultimate responsibility for ensuring the *Aquila Explorer* is operated with a high regard for environmental protection.

The ECPB 2D MSS will be conducted in accordance to (but not limited to) the Code of Conduct, all relevant Maritime regulations, Marine Protection Rules, Environmental Best Practice Guidelines for the Offshore Petroleum Industry (MfE, 2006) and the Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013 (HSE, 2013). As a result of compliance with the Code of Conduct, if any marine mammals are observed within the relevant mitigation zones, the four qualified observers onboard the *Aquila Explorer* have the authority to delay or shut down an active seismic array.

Table 14: ECPB 2D MSS Environmental Management Plan

Environmental Objectives	Parameters to be Controlled	Control Frequency	Proposed Actions	Legislation and Protocols to be Applied
Minimise interference with fisheries community.	Presence of fishing boats.	Pre-survey. Continuous.	24/7 operation to minimise MSS duration. Information provided to fishing authorities, fishing and boating clubs. Support boat investigation and Notice to Mariners issued.	COLREGS. International best practice.
Minimise introduction of marine pests.	Hull fouling. Ballast water discharge.	Continuous.	Antifouling systems in place (recently slipped in November 2013). Adherence to ballast water regulations. Regular maintenance undertaken.	International best practice. Import Health Standard for Ships' Ballast Water from All Countries (Biosecurity Act 1993). Draft Craft Risk Management Strategy for Vessel Biofouling.
Minimise disruption and physiological effects to marine mammals and marine fauna.	Presence of marine mammals within mitigation zones while acoustic source is active.	Continuous observation 24 hours per day by four qualified observers. Use of PAM 24/7.	Compliance with Code of Conduct and Section 5.3.2. 24/7 operation to minimise MSS duration. Presence of two qualified MMOs and two qualified PAM operators (PAM used 24/7). Pre-start observations, soft start and delay start/shut down procedures.	The Code of Conduct. Marine Mammals Protection Act 1978 & Marine Mammals Protection Regulations 1992.
Minimise effects on sea water quality.	Liquid wastes.	Continuous.	Discharge to sea in accordance with MARPOL and NZ regulations.	MARPOL 73/78. NZ Maritime Transport Act 1994.
	Oil and other waste.	Continuous.	Disposed at an approved shore reception facility in compliance with legal procedures and maintain a waste disposal log. Approved SOPEP and IOPPC.	MARPOL 73/78. NZ Maritime Transport Act 1994.
	Bio-degradable wastes.	Continuous.	Can be discharged overboard beyond 12 Nm from the coastline or 3 Nm if comminuted.	MARPOL 73/78. NZ Maritime Transport Act 1994.
Solid waste management.	Solid waste.	Continuous.	Dispose at an approved shore reception facility in compliance with local regulatory requirements. Waste disposal log will be kept.	MARPOL 73/78. NZ Maritime Transport Act 1994.
	Bio-degradable wastes.	Continuous.	Discharged overboard from seismic and support vessels, will be comminuted so can occur beyond 3 Nm from coastline.	MARPOL 73/78. NZ Maritime Transport Act 1994.
Minimise effects on air quality.	Atmospheric emissions.	Continuous.	Proper maintenance of equipment and generators. Approved IAPPC and regular monitoring of fuel consumption.	Best practice.
Minimise accidental events.	Streamer break or loss. Collisions. Fuel/oil spills.	Continuous.	24/7 operations to minimise survey duration. Hull is built to Ice Class rating. Solid streamer used with SRD's fitted. COLREGS and presence of a support vessel. Approved SOPEP in place.	Best Practice. COLREGS.

7 Conclusion

Within the petroleum industry, a MSS is considered a routine activity and a requirement to discover and further develop oil and gas fields. Well-established standard operating procedures are in place within the petroleum industry to reduce any potential environmental effects that could arise from a MSS to ALARP.

Schlumberger will comply with the Code of Conduct, NZ Maritime Rules, NZ Marine Protection rules, Schlumberger's internal HSE documents and implement international best practice to ensure there is no harm to any marine mammals, marine fauna, the marine environment or any personnel.

As well as adhering to the Code of Conduct, Schlumberger will implement additional mitigation measures as a reflection of conducting the ECPB 2D MSS in an AEI. The mitigation zones within the Code of Conduct for a Level 1 MSS were validated by STLM and as a result the mitigation zones for the ECPB 2D MSS have been increased to ensure that if compliance with the mitigation zones is achieved, the ECPB 2D MSS should not result in any injury to marine mammals. Schlumberger will have two independent and suitably qualified MMO's and two independent and suitably qualified PAM operators on board the *Aquila Explorer*, and with the use of PAM, observations will be carried out 24/7 while the acoustic source is active.

There is a long history of MSS's around the NZ coastline and to date there has been no significant environmental effects on marine mammals or the marine environment which have been recorded by independent MMO's.

The *Aquila Explorer* is a specialised MSS vessel that has advanced seismic acquisition technology and environmentally sensitive operational equipment onboard in order to reduce any environmental effects on marine mammals or the marine environment to ALARP.

This MMIA identifies and discusses the potential environmental effects from the ECPB 2D MSS and the mitigation measures that will be implemented to ensure that any potential effects are ALARP.

From the information provided in this MMIA, it is believed that the potential for any adverse effects on the marine environment or marine mammals are ***minor – moderate*** if the ECPB 2D MSS is undertaken in compliance with the Code of Conduct and the mitigation measures discussed in this MMIA.

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Appendices

This report contains the following appendices.

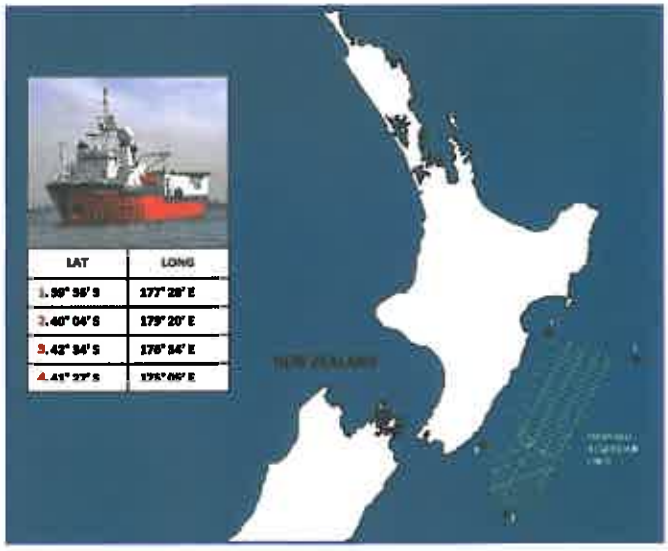
Number	Title
1	ECPB 2D MSS Information Sheet
2	Consultation Register with Key Stakeholders
3	Technical Details of the PAM system
4	Marine Mammal Mitigation Plan for the ECPB 2D MSS
5	Sound Transmission Loss Modelling

APPENDIX 1

ECPB 2D MSS Information Sheet

EAST COAST AND PEGASUS MULTICLIENT 2D Seismic Survey

Information for the Local Community



Schlumberger Multiclient, utilizing a leading geophysical services company, is conducting a geophysical survey in the Pegasus and East Coast basin offshore New Zealand in the second quarter of 2014 to gather geological information on potential oil and gas reservoirs.

The survey is being conducted under a permit from New Zealand Petroleum and Minerals and plays an important role in the New Zealand government's plan to create jobs and growth through unlocking the area's petroleum potential.

The survey area offshore east coast of the lower North Island is depicted in the map insert. Each line represents a path to be sailed by the vessel. The survey will be conducted by the vessel ***Aquila Explorer***, with support vessel ***Amaltal Mariner***. Weather permitting, the survey should take between forty and fifty days to complete.

Environmental responsibility

Schlumberger Multiclient understands its environmental responsibilities and is a leader in conducting safe geophysical operations in environmentally sensitive areas.

In 2014, an independent expert advisor was appointed to conduct a detailed environmental impact study of the Pegasus and East Coast basins, which included extensive discussions with relevant authorities and local communities.

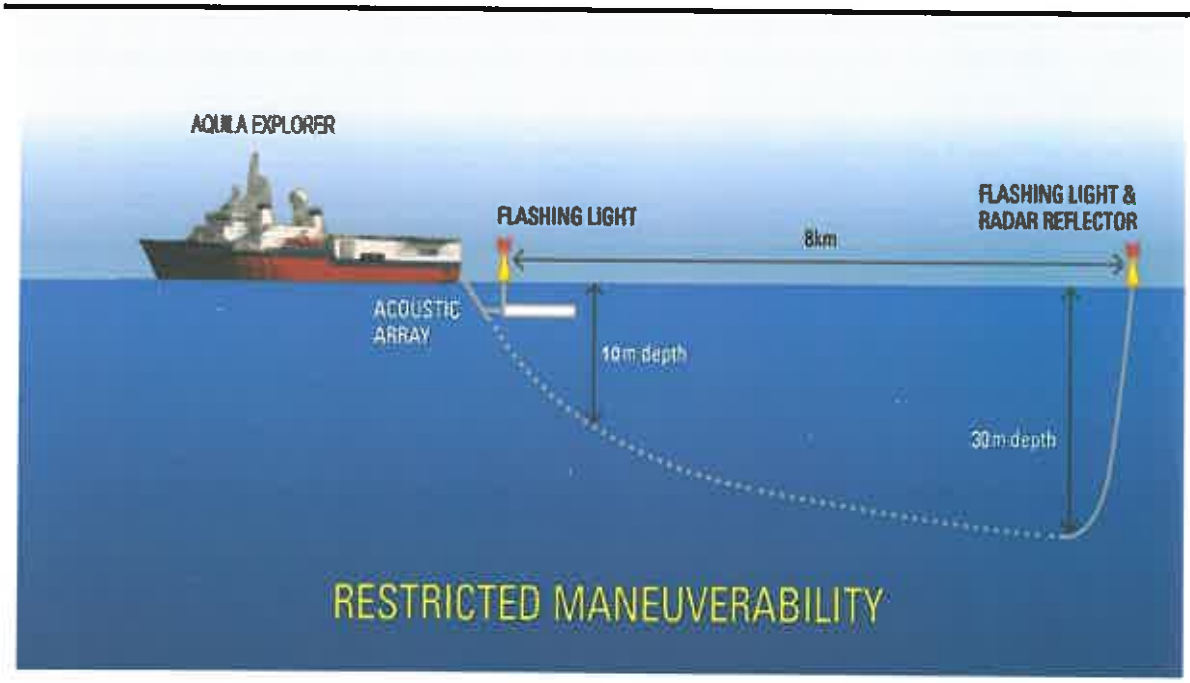
Schlumberger Multiclient will implement comprehensive environmental protection measures defined by the Department of Conservation (DOC) 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations.

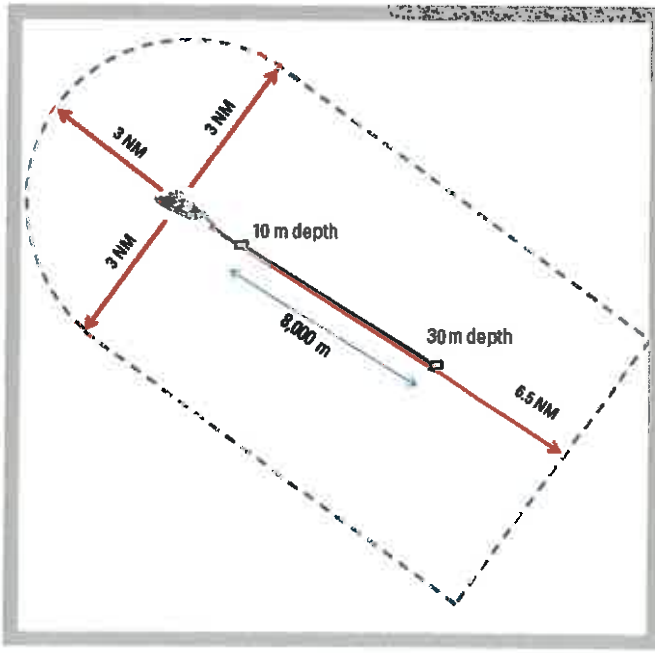
About Schlumberger

Schlumberger has more than 80 years' experience providing seismic data acquisition, processing and imaging services to the oil and gas industry.

We have conducted successful marine geophysical surveys in Australia, New Zealand, the Arctic, Asia, North America, Latin America, Europe, and Africa, including in some of the world's most environmentally sensitive areas.

Survey Parameters





NOTICE TO FISHERMAN:

From April to May 2014, the **Aquila Explorer** will be conducting a survey using a single 8km long streamer towed behind the vessel, just below the water surface. The end of the streamer is marked with a tail buoy fitted with flashing lights and a radar reflector. The streamer may obstruct vessels navigating in the area and fishing gear can damage the equipment.

During the seismic acquisition the Aquila Explorer may be travelling up to 6.5 knots and has restricted ability to maneuver.

Fisherman are advised to give the vessel a wide berth; stay clear a least 6.5 NM astern, 3 NM abeam and ahead. VHF operating channel will be 73 with constant monitoring of channel 16.

APPENDIX 2

Consultation Register with Key Stakeholders

Stakeholder	Consultation Summary
DOC – National Office 19-12-2013	Schlumberger and DOC met at the start of the MMIA process to introduce the ECPB 2D MSS and the proposed ECPB Operational Area. The intention was to discuss the mitigation measures that would be implemented, details of the updated 2013 Code of Conduct and the sensitivities in the area, as well as whether DOC were aware of any other MSS being proposed to be undertaken in the East Coast or Pegasus Basins at the same time.
Kaikoura District Council 17/12/2013	Introduced Schlumberger and the proposed MSS and the MMIA process. KDC ran through what any potential impact on the whales and dolphins would do to the community and local economy, given the economy is based around the marine mammal tourism industry.
Te Runanga o Kaikoura 18/12/2013	Introduced Schlumberger and the proposed MSS. Runanga raised their concerns for offshore exploration activities; climate change, marine mammals – what happens if a spill occurs and what response options are available, Mahingakai – locals use seafood to supplement their groceries and oil spill response – the lack of within NZ. Have concerns over the marine food chain, not just any effects on marine mammals. Also raised the Gulf of Mexico and that the locals have the fear of a similar event occurring within NZ waters, and stated that the stakes are very high for Kaikoura given the economy is based around marine mammals. The Runanga would like to have observers trained up to be onboard the seismic vessels.
Port Nicholson Block Settlement Trust 19/12/2013	Introduced Schlumberger and proposed MSS. Raised the importance of the Cook Strait trenches and their importance. The Nicholsons trench is important as hoki breeding grounds. Have a number of fishers that will fish near the MSS area from around the top of the south, Wellington, Wairarapa, Castle Point and Napier. A follow up meeting to be held with more details of the MSS. Port Nicholson want to know what learning opportunities are available to them. Keen to establish a relationship with Schlumberger to potentially involve some of the trusts scientists.
MBIE 19/12/2013	Met to discuss the processing of the PPP and what the time frames are if there are requests for more time to make a decision by consulted parties. MBIE provided an overview on the 500 m non-interference zone which is in place for everything involved in the MSS activity so from bow of vessel to tail buoy.
Kahungunu ki Wairarapa Port Nicholson Settlement Trust Rangitane o Wairarapa 29/1/2014	Introduced Schlumberger and the proposed MSS and talked through the EEZ Act, Code of Conduct and MMIA process. Raised concerns on seismic effects to fisheries and effects on Kaimoana which are both very important to local iwi. All those attending what to see science – hard facts and figures over the effects of MSS on the marine environment. Discussed some of the items covered within the MMIA. Conservation – protection of natural resources is vital to these groups. Schlumberger are to provide further information and a summary of the MMIA report to the iwi so that it can be distributed. Discussed what the acoustic source sounds like out at sea, from above and below the water, asked if Schlumberger had a sound file of an acoustic source releasing.
Hawkes Bay Regional Council	Provided an overview of Schlumberger and the proposed MSS as well as what the difference is between a 3D and 2D MSS and how they work. Discussed survey area in relation to the CMA, timing of the proposed survey, who else Schlumberger were consulting with. The

30/01/2014	aim was to inform HBRC of the proposed activity so if they receive any calls then they are aware of what is being conducted out at sea.
Ngati Kahungunu Iwi Inc 30/01/2014	Gave an overview of Schlumberger and the proposed MSS. Ngati Kahungunu also provided an overview of their history, their rohe, and members. Ngati Kahungunu have settled on fisheries with the crown and currently working through treaty settlements with land claims. Were interested in receiving the fisheries assessment, MMIA and MMO reports once completed.
Hawkes Bay Seafoods 30/01/2014	Introduced the proposed MSS area and explained what the actual 2D MSS involved. The initially had concerns as it was believed explosives were being used, but once the details were explained, Hawkes Bay Seafoods had no main concerns over the programme. A notice to mariners will be issued prior to the survey commencing which will inform their fishers of the operation.
Star Offshore Services 30/01/2014	Introduced the proposed MSS area as SOS has a number of boats which fish the area. The director is also a director of FMA 2 and will also advise the board of the proposed MSS and Survey Area and will make sure all information is distributed to all the fishers in the area.
Te Runanga o Ngai Tahu 31/01/2014	Introduced Schlumberger and the proposed MSS and MSS Area. TRONT explained their rohe and the various Runanga's view of oil and gas exploration. Expressed the importance of the tourism industry, especially at Kaikoura but also at Banks Peninsula which could be affected if there was a large oil spill in the future. TRONT want to see the MMIA and STLM report. Discussed the mitigation measures in place and what will happen if a marine mammal strands during or after the survey. TRONT are looking at getting 4 MMO's trained up from their own people so they can be present on the vessels for MSS in their rohe. Made the suggestion to work with Whale Watch Kaikoura to see if they observe any unusual mammal observations during the MSS acquisition.
Department of Conservation – Kaikoura 18/02/2014	Introduced Schlumberger and the proposed MSS to DOC Kaikoura. DOC provided some good local background knowledge to the Kaikoura coastal environment and the marine mammals/species that either reside or pass through on their migratory paths. Provided us with the distances which the aircraft keep away from marine mammals during their tours.
Whale Watch Kaikoura 18/02/2014	Introduced Schlumberger and proposed MSS. Discussed what they have in place with the Anadarko survey and MMO report notifications and Schlumberger are to put similar measures in place. Discussed the importance of marine mammals to the Kaikoura region. WW have a lot of baseline data and knowledge on how the mammals behave so will be aware if any changes arise in their behaviour during the MSS. Schlumberger will provide the STLM and MMIA to WW. WW have concerns over seismic surveys and deep sea oil drilling, however are more concerned the closer a seismic survey is to Kaikoura. WW were relieved when they sighted the Survey Area as it was further off the coast than was anticipated.
Dolphin Encounter 18/02/2014	Introduced Schlumberger and the proposed MSS. The large proportion of their tours are working with dusky dolphins. Believes dusky's head up the east coast of the north island during March-May but there is no real known information so is interested in any sightings of these dolphins during the survey. Weekly sighting reports will be provided to Dolphin Encounter.

Runanga o Kaikoura 19/02/2014	Second meeting with the Runanga to discuss more specific details of the proposed seismic survey and to answer any questions the Runanga had of the process. The Runanga expressed their concern at the latter stages of exploration and that they would want to do a Cultural Impact Assessment at the drilling stage of exploration, rather than at the seismic stage. Schlumberger provided answers to the Runanga's questions over oil and gas exploration. The Runanga's three main concerns for oil and gas exploration is climate change, effects on marine mammals and its tourism, and mahingakai – resulting from an oil spill. Schlumberger will provide the Runanga with the STLM and MMIA.
GWRC February 2014	Spoke with the consents manager to introduce the Schlumberger survey and the survey area. They are interested to learn more about seismic surveys as they have had no previous experience so EOS will call in to visit them when next in town to discuss.
Horizons Regional Council March 2014	Spoke with Horizons Regional, left a message with the consents manager and then spoke to one of the consents officers to explain the survey off the Horizons CMA. Discussed that the actual survey lines are beyond their CMA. Provided the information sheet in Appendix 1 for further clarification.
University of Otago March 2014	Introduced the ECPB Seismic survey and survey area in relation to Otago University's interest in undertaking research off the Kaikoura coastline using hydrophones to record sound emissions from an acoustic source. Schlumberger are willing to discuss the option of working collaboratively with Otago University during the MSS. Otago University have been provided with the information sheet attached in Appendix 1 and discussions going forward will be held into whether any research will be conducted during the ECPB 2D MSS. Schlumberger asked Otago University what research will be carried out, what the information will be used for and Schlumberger also requested to have access to any survey results. Discussions will be ongoing discussions around the potential for research to be conducted.

Dan Govier

From: P lnh#P ruilvvh|
Sent: Z hgqhvgd|#4;#Ghfhp ehu#5346#7=35#s1p 1
To: Gdq#Jryihu
Subject: UH#Ndlhrxud#Vlw

Dan , at present I am assisting some researchers with our vessel . I am available now as I have just got back , but thats probably not going to work .Unfortunately at the moment its work every good sea day which makes planning difficult . I can be contacted on
Thanks

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Tuesday, 17 December 2013 9:21 a.m.
To:
Subject: Kaikoura Visit

Hi Mike,

I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we are taking the opportunity to come down to Kaikoura and introduce Schlumberger and the proposed seismic survey programme to the Runanga and other stakeholders.

The final survey details are not yet confirmed; but we would like to come and meet you and have a chat if it works out.

Would you be available to meet with us either late this afternoon or potentially tomorrow early afternoon?

Sorry this is such short notice but the Christmas/New Year period is quickly approaching and we wanted to come and visit as soon as we could. We are flying into Christchurch midday Tuesday and will then drive up to Kaikoura.

If this suits please let me know and we can try to schedule a meeting

I will try your office later this morning.

Kind Regards,
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Ghqqlv#Exxup dq
Sent: Wxhvgd|/#1;#Iheuxdu|#5347#15=48#sp 1
To: Gdq#Iryhu
Subject: UH=Ndhrxud#ylvlw

Hi Dan

Just wondering what time you were thinking in regards late afternoon. I have a fencing job underway down on our farm property and didn't want to be too late getting away.

Cheers,

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 17 February 2014 4:01 p.m.
To:
Subject: Kaikoura visit

Hi
We touched base briefly back in December when I was trying to catch up with you while in Kaikoura on a quick visit but our schedules did not allow a catch up. I am travelling to Kaikoura tomorrow with Schlumberger who are proposing to take a seismic survey in the East Coast and Pegasus Basins in March this year. The survey area is approximately 180 km from Kaikoura.

If you are available late afternoon tomorrow we could call in and introduce the company and the proposed survey and answer any questions you may have

Any questions please ring me on my mobile or send me an email and I can pick that up while we are travelling tomorrow.

Thanks
Dan

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Nelson 7041

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Dan Govier

From: Nhlwk#P dz vrq
Sent: P rqgd|/#5:#Mqxdu|#5347#5=59#s1p 1
To: Gdq#Jryhu
Subject: UH=#Kdznhv#Ed|#Frqwdfw

Hi Dan,

Yes talk to Hawkes Bay Seafoods & Star Fish.
They are the 2 main players plus also Moana Pacific.

Cheers

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 27 January 2014 1:56 p.m.
To:
Subject: Hawkes Bay contacts

Hi .....,
Thanks for your time last week to chat about the proposed seismic survey, that was appreciated.

I am just wondering if you have any contacts for Napier/Hastings for commercial fishing companies. I have had a look and see that Hawkes Bay Seafoods seems to be one of the bigger organisations over there?. I am involved in a seismic survey that stretches up to Hastings and while I was there later this week I was going to try and call in and see someone.

No problems if you don't.

Thanks
Dan

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P.O. Box 2065
Nelson 7041

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Dan Govier

From: Ddwdl#Furvv
Sent: Wkxugd|/#53#P dufk#5347#5=85#s1p 1
To: *Gdq#Jryhu*
Cc: Vkdxq#Dqguhz dwkd
Subject: UH=#Vfkoxp ehujhu#Vhlvp lf#VXuyh|#qirup dwrq#Vkhhw

Ok, thanks Dan

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 20 March 2014 2:50 p.m.
To:
Cc:
Subject: RE: Schlumberger Seismic SUrvey Information Sheet

Hi
No problems, yes it would be good to catch up with you and explain more about the process etc.

I will let you know when I am next over in Wellington and we can see if schedules allow a meeting.

Cheers
Dan

From:
Sent: Thursday, 20 March 2014 2:46 p.m.
To: 'Dan Govier'
Cc:
Subject: RE: Schlumberger Seismic SUrvey Information Sheet

Thanks again Dan – please continue to keep us posted, and of course we'd be happy to meet to understand the process / seismic survey work further.

Regards

GREATER WELLINGTON REGIONAL COUNCIL
Te Pane Matua Taiao
Shed 39 | Harbour Quays
PO Box 11646, Manners St, Wellington 6142

www.gw.govt.nz

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 20 March 2014 1:28 p.m.
To:
Subject: Schlumberger Seismic SUrvey Information Sheet

You are still on my list to provide some further details of Schlumberger's proposed seismic survey and I will try to call in to your office at some stage to discuss further.

However in the interim please find attached an information sheet for the proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

If you have any questions or concerns relating to the attached information sheet or the proposed seismic survey please let me know.

Thanks
Dan

Dan Govier
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Nelson 7041

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Dan Govier

From: Dqqhwwh#Eurvqdq
Sent: Wkxuvgd|/#53#P dufk#5347#4:58#p 1
To: *Gdq#Jryhu*
Subject: UH=#Vfkoop ehujhu#qirup dwirq#Vkhhw

Thanks Dan

Kind regards

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, March 20, 2014 1:23 PM
To:

Subject: Schlumberger Information Sheet

Hi all,
Please find attached an information sheet for a proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

If you have any questions or concerns relating to the attached information sheet or the proposed seismic survey please let me know.

Thanks
Dan

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P.O. Box 2065
Nelson 7041

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Dan Govier

From: Gu#Dghdn#Z k|wh
Sent: Vdwxugd|/58#Mdqxdu|#5347#9-88#s1p 1
To: Gdq#Uryhu
Subject: Rxw#r i#R iilfh-#Kdz nhv#Ed|#Vlw

Tēnā koutou katoa:

I am currently on maternity leave returning to work full-time from Monday 3rd Feb 2014.

Nga mihi,

Dan Govier

From: Mqq|
Sent: Vdwxugd|#58#Gqxdu|#5347#-69#sp 1
To: Gdq#Dryhu
Cc: Qjdlr#Gu#Dghdn#Z k|wh
Subject: UH-#Kdznhv#Ed|#Ylw

Hey Dan, I was looking at Wednesday not Thursday. Wil that be a problem?

---

om: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Saturday, 25 January 2014 6:55 p.m.
To:
Cc:
Subject: RE: Hawkes Bay Visit

Tēnā koe

Thanks very much for your very quick reply over the weekend.

That sounds good for Thursday at 1pm at the Iwi office.

, Hastings is that where we will meet you?

Nga mihi
Dan

From.
Sent: Saturday, 25 January 2014 5:44 p.m.
To: Dan Govier
Cc:
Subject: RE: Hawkes Bay Visit

Tēnā koe Dan

Short notice seems to work with our schedule which functions on a 'Yesterday mode' and so we have a couple of hapū Hui that day however, I think it is important for us to meet and am thinking we could meet at 1.00pm at the Iwi office – in between the two hapū hui?

Ngā mihi

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Saturday, 25 January 2014 1:48 p.m.
To:
Subject: Hawkes Bay Visit

Tēnā koe

I was given your contact details by

I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we would like to take the opportunity to come to Hastings and introduce Schlumberger and the proposed seismic survey programme to you.

Would you be available to meet with us this Thursday 29th of January?

Sorry this is such short notice.

If you require any further information in regards to this email or the proposed visit please get in touch.

I will try phoning the office on Monday as well.

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Qjdlr
Sent: P rqgd|#5:#Mqxdu|#5347#15=8<#b1p 1
To: Gdg#Jryhu#hqq|
Cc: Gu#Dghdn#Z k|wh
Subject: UH=#Kdz nhv#Ed|#Vlw

Kia ora Dan,

Will you becoming by yourself or will you have company?

Regards

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 27 January 2014 12:31 p.m.
To:
Cc.
Subject: RE: Hawkes Bay Visit

Kia ora
Thank you very much for that, I will look forward to meeting [redacted] at 1pm at your office in Hastings.

Nga mihi

Dan

From:
Sent: Monday, 27 January 2014 12:20 p.m.
To: Dan Govier
Cc:
Subject: Re: Hawkes Bay Visit

Kia ora Dan

[redacted] will meet with you on Thursday at our office.

Sent from my iPhonea

On 26/01/2014, at 1:09 pm, "Dan Govier" <dan@eosltd.co.nz> wrote:

Hi
Sorry we cannot make Wednesday as we are all booked up for the day.

So there is no chance to meet with you Thursday at all?

Nga mihi
Dan

From:
Sent: Saturday, 25 January 2014 7:36 p.m.
To:
Cc:
Subject: RE: Hawkes Bay Visit

Hey Dan, I was looking at Wednesday not Thursday. Wil that be a problem?

---

om: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Saturday, 25 January 2014 6:55 p.m.
To:
Cc:
Subject: RE: Hawkes Bay Visit

Tēnā koe

Thanks very much for your very quick reply over the weekend.

That sounds good for Thursday at 1pm at the Iwi office.

is that where we will meet you?

Nga mihi
Dan

From
Sent: Saturday, 25 January 2014 5:44 p.m.
To: Dan Govier
Cc:
Subject: RE: Hawkes Bay Visit

Tēnā koe Dan

Short notice seems to work with our schedule which functions on a 'Yesterday mode' and so we have a couple of hapū Hui that day however, I think it is important for us to meet and am thinking we could meet at 1.00pm at the Iwi office – in between the two hapū hui?

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Saturday, 25 January 2014 1:48 p.m.
To:
Subject: Hawkes Bay Visit

Tēnā koe

I was given your contact details by i

I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we would like to take the opportunity to come to Hastings and introduce Schlumberger and the proposed seismic survey programme to you.

Would you be available to meet with us this Thursday 29th of January?

Sorry this is such short notice.

If you require any further information in regards to this email or the proposed visit please get in touch.

I will try phoning the office on Monday as well.

Nga mihi
Dan

<image001.jpg>

Dan Govier

From: Qjdlr
Sent: Wkxwgd|/#53#P dufk#5347#:=78#s}p 1
To: Gdq#Jryhu#Gu#Dghdh#Z k|wh>#Vhqq|
Subject: Uh=#Vfkoxp ehujhu#Vhlvp I#Wxuyh|#Dsul#5347

Kia ora Dan

Sent from my phone on the smartphonetwork.

-------- Original message --------
From: Dan Govier <dan@eosltd.co.nz>
Date: 20/03/2014 1:40 PM (GMT+12:00)
To:

Subject: Schlumberger Seismic Survey April 2014

Tēnā koutou,

Please find attached an information sheet for the proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

If you have any questions or concerns relating to the attached information sheet or the proposed seismic survey please let me know.

The MMIA is still being finalised, so once this is complete I will send you all a copy.

Nga mihi

Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Vwxdu#Udqw
Sent: Wxhvgd|#4:#3hfhp ehu#5346#=87#dp 1
To: Gdq#Jryhu
Subject: UH=#Ndhrxud#yhlw

Hi Dan
Tuesday afternoon is fine. any time after 2pm.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday. 16 December 2013 11:54 p.m.
To:
Subject: Kaikoura visit

Hi
I was given your contact details by [redacted] PEPANZ.

I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we are taking the opportunity to come down to Kaikoura and introduce Schlumberger and the proposed seismic survey programme to the Runanga and other stakeholders.

The final survey details are not yet confirmed; but we would like to come and meet you and have a chat

Would you be available to meet with us either on the afternoon of Tuesday 17th or potentially Wednesday early afternoon?

Sorry this is such short notice but the Christmas/New Year period is quickly approaching and we wanted to come and visit as soon as we could. We are flying into Christchurch midday Tuesday and will then drive up to Kaikoura, so we could possibly call in for a chat when we arrive, probably around mid-afternoon.

If this suits please let me know and we can try to schedule a meeting

Kind Regards,
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Qhz#hdolqg#Shwurdxp #<P lqhudv
Sent: Wkxuvgd|/#53#P dufk#5347#5=75#sp 1
To: Gdq#Jryhu
Subject: UH#Vfkoxp ehujhu#Vhlvp I#Wxuyh|#Dsuo#5347

Hello Dan,

I can acknowledge receipt of your email and attachment.

I have forwarded the details to the relevant team.

Regards,

Business Service Advisor, New Zealand Petroleum & Minerals
Ministry of Business, Innovation & Employment

L87

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From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 20 March 2014 1:05 p.m.
To:

Subject: Schlumberger Seismic Survey April 2014

Hi all,
Please find attached an information sheet for a proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

If you have any questions or concerns relating to the attached information sheet or the proposed seismic survey please let me know.

Thanks
Dan

Dan Govier
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+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Gdylg#Jrelqvrq
Sent: P rqgd|/#57#P dufk#5347#k=69#1p 1
To: Gdq#Jrylhu#Dqguhz#Vdxqghuv
Subject: UH=#Vfkoxp ehujhu#Vhlvp lf#Vxuyh|#Dsuo#5347

Many thanks Dan, hope the survey goes well – good weather, no gear breakages.

Cheers,

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 20 March 2014 1:52 p.m.
To:
Subject: Schlumberger Seismic Survey April 2014

Hey guys

FYI - please find attached an information sheet for the proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

Thanks
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Udhz |q#Vrcrp rq
Sent: Iulgd|#64#Mdqxdu|#5347#43=89#p 1
To: Gdq#Jryhu
Cc: P dul#Eduwhww#Jqd#Vrcrp rq#H{w,
Subject: Uh=Ndhrxud#Ylw

Hi Dan

Thanks for the New Years greetings and I hope you had a good break also.

Unfortunately I cannot make the 17th, as I will be in Christchurch at another meeting for another large project in the Hurunui area. However I could make the 12, 14, 19, 25, 26 or 27 February if any of these days suited? I would also suggest we invite opied) from Ngai Tahu and of course anybody else from the runanga that can attend on any of these days and hopefully one of these days can suit them also.

Sent from my iPad

On 31/01/2014, at 8:58 am, "Dan Govier" <dan@eosltd.co.nz> wrote:

> Kia ora
> Happy new year, I hope you had a good Christmas and an enjoyable break with family in Perth.
>
> I am just following up on where we left off last year regarding the proposed seismic survey for Schlumberger.
>
> We would like to come and visit you on Monday 17th February to introduce the proposed seismic survey and have a discussion around the process, what is involved, mitigation measures in place and to answer any concerns that anyone in the Runanga have.
>
> If you are available we would look to travel to Kaikoura Sunday night so that we could hold a meeting in the morning, maybe 9am?
>
> Please let me know if this can work, as timing is tight and I need to schedule Tristan and Ken to travel to NZ from Perth.
>
> We have just met with this morning down in Christchurch.
>
> Nga mihi,
> Dan
> <image002.jpg>

From:
Sent: Monday, 16 December 2013 1:13 p.m.
To: Dan Govier
Cc:
Subject: RE: Kaikoura Visit

Yes 9.30 will be fine at our end thanks Dan.

Dan Govier

From: J lqd# #Vhyh
Sent: Wxhvgd|/#:#Ghfhp ehu#5346#-37#bp 1
To: *Gdq#Jryhu*
Cc: Udhz |q#Vrorp rq
Subject: UH-#Ndhrxud#Vlw

Kia Ora Dan

Unfortunately I am not able to attend, but I hope you have a great hui.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 16 December 2013 3:29 p.m.
To:
Cc:
Subject: RE: Kaikoura Visit

Thanks
That is appreciated and we will see you then.

What is the physical address of your Marae?

will you be attending this meeting? Otherwise we could try and catch up with you also if it works out timing wise.

Thanks
Dan

From:
Sent: Monday, 16 December 2013 1:13 p.m.
To: Dan Govier
Cc:
Subject: RE: Kaikoura Visit

Yes 9.30 will be fine at our end thanks Dan.

perhaps you and Mum would like to attend this meeting also?

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Sunday, 15 December 2013 3:41 p.m.
To:
Cc:
Subject: RE: Kaikoura Visit

Tēnā koe

Thanks for the prompt reply on my earlier email to

I appreciate you being available on Wednesday, we will look forward to meeting you at your marae. How would 9-30 am suit?

I see you have copied a few people in to this email also, we are hoping to meet with Te Rūnanga o Ngāi Tahu on the Tuesday afternoon before we travel north, again this will be just an informal chat introducing Schlumberger and the proposed survey. Once more details are finalised in regards to the survey we will have more definite information to come back and discuss with Te Rūnanga o Kaikoura.

We are also hoping to catch up with other groups while we are in Kaikoura, especially Whale Watch Kaikoura so I will be in touch with

Thanks for your further contact details also.

Nga mihi,
Dan

From:
Sent: Sunday, 15 December 2013 10.29 a.m.
To: 'dan@eosltd.co.nz'
Cc:

Subject: FW: Kaikoura Visit

Tēnā koe Dan

Gina passed your email on to me to respond. Thanks for making contact and yes I am available to meet this coming Wednesday and will be in our office at Takahanga Marae in Kaikōura. Let me know what time would be suitable for you, to discuss the overall proposal and your draft MMIA with us. You have my email address and please note my other contact details below.

1|

Te Rūnanga o Kaikōura Inc

From:
Sent: Saturday, 14 December 2013 8:56 p.m.
To:
Subject: Fwd: Kaikoura Visit

Hi am forwardg this on to u for response

Sent from my iPhone

Begin forwarded message:

> **From:** Dan Govier <dan@eosltd.co.nz>
> **Date:** 14 December 2013 8:16:45 pm NZDT

To: [redacted]
Subject: Kaikoura Visit

Tēnā koe [redacted]

I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we would like to take the opportunity to come down to Kaikoura and introduce Schlumberger and the proposed seismic survey programme to you.

The final survey details are not yet confirmed; but we would like to have an initial informal chat with you over a cup of tea or coffee and then we would look to come back early in the new year once NZ Petroleum & Minerals have made a decision on the prospecting permit and the survey details are finalised.

Would you be available to meet with us on Wednesday 18th December? We will hopefully meet with a few of the other locals while we are in town as we are planning to be in Kaikoura for the day.

Sorry this is such short notice but the Christmas/New Year period is quickly approaching and we would like to visit as soon as we can.

If you require any further information in regards to this email or the proposed visit please get in touch.

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
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P.O. Box 2065
Nelson 7041

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Dan Govier

From: Dqg|#Fdxgdwv
Sent: P rqgd|#6#Fheuxdu|#5347#15=39#bp 1
To: Gdq#Tryhu
Cc: Nhqqhwk#Mi|dq
Subject: UH=#Idw#Frdw#Lvkhulhv#Dvvhvvp hqw

Hi Dan,

Thanks for the meet and greet with Ken.

I think Figure 9 in NIEC/PB doc is the main chart to respect in regards of the bulk fishing activity [in parallel to coast] , and the respectful' run-in and run-out lines that will take place in the project survey!
Combined with tuna trollers that will be coming through on an ad hoc basis this time of year, and not always attentive in wheelhouse? As well as, they shut-down and just drift, on occasions.

The larger fishers of scampi, Alfonsino, and Ling, will be fine and work well with support vessels, along with the majority of surface liners.
I hope this has covered further bases.
Regards

Director

Star Group Of Companies
27-32 Dunlop Road
P.O Box 12028,
Napier, 4144

New-Zealand.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 3 February 2014 5:28 a.m.
To:
Subject: East Coast Fisheries Assessment

Hi ,
Nice to meet you officially up in Napier last week and good to have a chat.

As discussed please find attached the fisheries assessment that MPI prepared that covers the last five years fishing activity within Schlumberger's permit area.

If you have any comments on this please let me know.

Cheers
Dan

Dan Govier

From: Ol}#P hœvk
Sent: Iubgd|/*:#Iheuxdu|#5347#k=38#dlp 1
To: €Gdq#Jrylnu*
Subject: UH=#Wh#Dwdz d#Frqwdfw#ghwdlv

Kia ora Dan,

Contact details as follows:

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 6 February 2014 8:28 p.m.
To:
Subject: Te Atiawa Contact details

Kia ora
We are trying to organise a visit to see Te Atiawa in Picton relating to the Schlumberger seismic survey. You said you could provide me with some contact details, is this possible please?

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: #VJ#Sdlqh
Sent: Vdwxugd|#55#Iheuxdu|#5347#4:56#dp 1
To: Gdq#Jryhu
Cc: Eoxp lgh#Vhqqhvvd#igh#K,
Subject: Uh#Ursrvhg#Vhlvp I#Vxuyh|

Kia ora Dan,

As previously advised on the phone, I have now spoken with the Board regarding this matter. The Boad believes it would be prudent to engage with you regarding the proposed seismic survey.

To this end, I have copied in our Resource Management Officer. ill liaise with you, in due course, to progress this engagement.

Nga mihi

----- Original Message -----
From: Dan Govier
To:
Sent: Friday, February 07, 2014 10:25 AM
Subject: Proposed Seismic Survey

Tēnā kōrua,

I was given your contact details by

I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we would like to take the opportunity to come to Picton and introduce Schlumberger and the proposed seismic survey programme to you.

Would you be available to meet with us on Tuesday 18th of February?

We are going to be in Wellington on the Monday and will then make our way down to Kaikoura on Tuesday after hopefully meeting with you both.

If you are available is it possible to meet first thing Tuesday morning, say 8-30am or 9am?

If you require any further information in regards to this email or the proposed visit please get in touch.

Nga mihi
Dan

Dan Govier

From: Uhvrxufh#P dqdjhp hqw##Wh#Dwdz d
Sent: Iulgd|#7#P dufk#5347#4<#1p 1
To: Gdq#Jryhu
Subject: UH#Ursrvhg#Vhlvp lf#Vxuyh|

Ka pai Dan. Thanks for responding.

The Trust will welcome the opportunity to look at the report and make further comment, if applicable.

Nga mihi

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 13 March 2014 5:03 p.m.
To: Resource Management | Te Atiawa
Subject: RE: Proposed Seismic Survey

Kia ora

Thanks for both of your emails below. Sorry I have been late in replying to you on this it has been a very busy time for me so I apologise.

I appreciate your email and comments that you have provided on behalf of Te Atiawa Trust below and I have passed these on to Schlumberger who will be undertaking the seismic survey.

A lot of what you have raised is further explained and discussed in the Marine Mammal Impact Assessment in regards to mitigation measures that are in place and consideration to the wider marine environment when undertaking the proposed seismic survey. This report is currently in the process of being finalised at the moment.

Once this document is finalised we can provide you with a copy and then if you have any further questions or concerns I will be more than happy to discuss or try to clarify any issues.

Thank you once again for your considered response,

Nga mihi,
Dan

From: Resource Management | Te Atiawa [mailto.
Sent: Thursday, 13 March 2014 10:08 a.m.
To: Dan Govier
Subject: FW: Proposed Seismic Survey

Morena Dan

I'm wondering if you received this advice from Te Atiawa Trust and, if so, what further steps / outcomes might follow, if any?

I look forward to hearing from you.

Nga mihi

From: Resource Management | Te Atiawa
Sent: Tuesday, 25 February 2014 12:22 p.m.
To: 'Dan Govier'
Subject: FW: Proposed Seismic Survey

Kia ora ano Dan

Further to yesterday's email exchanges: See below for a contextual comment on behalf of Te Atiawa Trust. Please note, that this response is being provided in what amounts to a vacuum of information about what is being specifically proposed / intended, and the nature of the target background marine environment, so the comment are essential principles-based and crafted by me as an employed RM professional with a responsibility for kaitiakitanga outcomes.

As kaitiaki Te Atiawa carries abiding responsibilities for the marine ecosystem, notably in its rohe. It also, understandably, has a level of concern when intervention, at whatever level, is proposed that has the possibility of causing adverse effects. This includes the current situation, in terms of the marine related stake-holding of Te Atiawa. I confirm that Te Atiawa does not hold mana whenua / mana moana status for the areas in question.

Seismic survey work involves a contemporary science discipline that operationally transcends traditional cultural knowledge, so Te Atiawa is essentially reliant on the Department of Conservation (DOC) to convey what amounts 'best practice'. It is expected that any seismic work undertaken will be carried out in accordance with DOC's recommendations. Historic analysis and consequent levels of practices have largely been based upon the potential effects on whales and their hapu, as they do communicate by acoustic means, so the seismic shocks my well have specific impact. However, the inevitable range of occurring mammals will be wider than this, and obviously extends outside of the acoustic sensitivity circumstances, e.g. NZ sea lions. That raises the question of; EVEN WIDER IMPACTS. What might they be? Assumptions are seemingly limited to whales, etc, to cetaceans.

Traditionally, humans have been captured by the non-human-charisma of whales and their hapu and not so with other marine species, and this amounts to, seemingly, irrational bias in their perceived contextual importance in the / an ecosystem. So, the question is: Are there any other potential impacts on the myriad of species that comprise the entire ecosystem within the area to be surveyed? That really does need to be honestly and categorically answered and acted on, as and if required. All players with an interest, including tangata whenua iwi / kaitiaki, and Te Atiawa with its commercial stake-holding, need information about this in order to make any sort of an informed comment.

From the point of view of Te Atiawa, whatever the activity and whatever the measures that are put in place to account for anticipated impacts, there must be a 'whole of eco-system approach' to the management challenge; that is seen as simply being responsible. Given the current state of the ocean environment, the depleting fish stocks, the related ecosystem imbalance and other anthropogenic-based impacts, like solid and liquid waste discharge into the ocean environment, the receiving environment is under continued stress and every additional intervention, however minor, amounts to further cumulative levels of stress / imbalance.

Ideally, all parties who take benefit from the ocean's resources should offset that intervention with at least an equal positive contribution, which has scientific validation. As well as acknowledging the fundamental importance of ecosystem health and balance to the future of humans and their fellow travellers, this would also contribute positively to the popular corporate notion of social-

license that large corporates seek to achieve from their host communities. Given the current environmental status quo, It should be that the environment is improved through deliberate and appropriate offsetting, as opposed to being adversely effected or just maintained. There is no price on the value of this notionally perpetual ecosystem and no justification for net adverse impacts thereon.

You client is urged to act with total responsibility – happy to korero.

Nga mihi

[redacted]er – Te Atiawa Manawhenua Ki Te Tau Ihu Trust.

From: Resource Management | Te Atiawa
Sent: Monday, 24 February 2014 11:26 a.m.
To: 'Dan Govier'
Subject: RE: Proposed Seismic Survey

Ka pai Dan

Expect to hear from me tomorrow and we can take it from there.

Nga mihi

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 24 February 2014 11:18 a.m.
To: Resource Management | Te Atiawa
Subject: RE: Proposed Seismic Survey

Kia ora
That sounds like a very good way forward thanks.

It is difficult with the client (Schlumberger) now back in Australia, that's why we contacted Glenice prior to them arriving in the country to try and arrange a meeting as part of our travels. I am certainly happy to discuss some details of the proposed survey over the phone and answer any questions or concerns you may have and provide you with some further details of the survey and survey area.

I will look forward to your email with further details

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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From: Resource Management | Te Atiawa [mailto:
Sent: Monday, 24 February 2014 11:13 a.m.
To: Dan Govier
Subject: RE: Proposed Seismic Survey

Kia ora ano Dan

My, that was quick out of the blocks.

From Te Atiawa Trust's position, it is seen as establishing a conduit to communicate. I've been delegated the responsibility to put forward the Trust's views. The Trust advises that the area in questions in outside of Te Atiawa rohe, i.e. Te Atiawa does not hold mana whenua status. However, that said, the Trust's marine interests are within the East Coast and Pegasus Basin areas under consideration, so the Trust has a definite stake-holding and wishes to have input. The connection does not have to be a complicated one. I can email you a commentary around the Trust's position, which has been derived from very similar historic circumstances. Then, practically, and if necessary, we can discuss the matter on the phone.

How does that sound?

Nga mihi

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 24 February 2014 10:56 a.m.
To: Resource Management | Te Atiawa
Subject: RE: Proposed Seismic Survey

Kia ora
Thanks for email. I am currently checking with my client who is based in Perth and are now back in Australia following our consultation visits.

I will come back to you soon with a way forward.

Is it possible to hold a meeting during the week or would you want the visit to coincide with a board meeting?

Nga mihi
Dan

From: Resource Management | Te Atiawa [mailto:
Sent: Monday, 24 February 2014 10:52 a.m.
To: Dan Govier
Subject: RE: Proposed Seismic Survey

Morena Dan

See the email-string, below. Are you able to update me on prospects for connection, please?

Nga mihi

From: [redacted]
Sent: Saturday, 22 February 2014 11:23 a.m.
To: Dan Govier
Cc: Resource Management | Te Atiawa; Vennessa Ede (H)
Subject: Re: Proposed Seismic Survey

Kia ora Dan,

As previously advised on the phone, I have now spoken with the Board regarding this matter. The Boad believes it would be prudent to engage with you regarding the proposed seismic survey.

To this end, I have copied in our Resource Management Officer, [redacted] liaise with you, in due course, to progress this engagement.

Nga mihi

----- Original Message -----
From: Dan Govier
To: [redacted]
Sent: Friday, February 07, 2014 10:25 AM
Subject: Proposed Seismic Survey

Tēnā kōrua,

I was given your contact details by [redacted]

I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we would like to take the opportunity to come to Picton and introduce Schlumberger and the proposed seismic survey programme to you.

Would you be available to meet with us on Tuesday 18th of February?

We are going to be in Wellington on the Monday and will then make our way down to Kaikoura on Tuesday after hopefully meeting with you both.

If you are available is it possible to meet first thing Tuesday morning, say 8-30am or 9am?

If you require any further information in regards to this email or the proposed visit please get in touch.

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Uhvrxufh#P dqdjhp hqw##Wh#Dwdz d
Sent: Iulgd|/#54#P dufk#5347#k=75#dp 1
To: Gdq#Tryhu
Subject: UH=#Vfkoxp ehujhu#Vhlvp lf#Vxuyh|#Dsuld#5347

Morena Dan

Thanks for the information sheet – interesting.

Also interested to look at the MMIA.

Nga mihi

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 20 March 2014 1:43 p.m.
To: [redacted]
Subject: Schlumberger Seismic Survey April 2014

Tēnā koutou,

Please find attached an information sheet for the proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

If you have any questions or concerns relating to the attached information sheet or the proposed seismic survey please let me know.

The MMIA is still being finalised, so once this is complete I will send you a copy.

Nga mihi

Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: P dub#Eduwdww
Sent: Iulgd|#57#fqxdu|#5347#1:66#s1p 1
To: Gdq#Jryhu
Subject: UH#Vfkoxp ehujhu#Vhlvp lf#Vxuyh|#Ylw

Thanks for making contact Dan, and apologies for the slow response.

I've booked us a room for 10am Friday and checked the availability of others with an interest in the kaupapa. While I'm yet to get confirmation of attendees, the time looks good, so I'm happy that we stick with it, and I'll let you know who will be present on the day.

Ngā mihi, nā

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 20 January 2014 7:58 p.m.
To:
Subject: Schlumberger Seismic Survey Visit

Tēnā kōrua

I hope you both had a great Christmas and New Years and got to recharge the batteries.

Just thought I would touch base with you in regards to Schlumberger's proposed seismic survey. Schlumberger are coming back to NZ at the end of this month to meet with a few people in Wellington and lower North Island, and I have recommended if you are available that we come down and see you.

Are you both available on Friday 31st of January?

If you could please let me know how you are placed we will schedule it in and will pop down to meet with you if it works, to introduce Schlumberger and the details of the proposed 2D seismic survey.

Nga mihi,
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Grqqd#Eolyhoo
Sent: P rqgd|/#9#Ghfhp ehu#5346#1-84#s1p 1
To: Gdq#Jrylhu
Cc: Mlp hv#Fd|jlo#P dulk#Eduwbuw
Subject: UH#Vfkoxp ehujhu#Vhlvp lf#Vxuyh|

Kia ora Dan

Despite our best efforts to try to accommodate a meeting, unfortunately we are not able to make it happen at such short notice. You should continue to have the discussions with Papatipu Rūnanga in the meantime and hopefully we will touch base again in the New Year.

Have a safe xmas holiday
Ngā mihi

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Friday, 13 December 2013 9:29 p.m.
To:
Cc:
Subject: Schlumberger Seismic Survey

Tēnā ko

I visited your office with NZ Oil & Gas in early September this year as part of the consultation process for their Endurance 3D Seismic Survey they are undertaking off the coast of Moeraki, in which I was their environmental consultant and prepared their Marine Mammal Impact Assessment.

I have been engaged by a company called Schlumberger as their environmental consultant for a proposed 2D seismic survey in the East Coast and Pegasus Basin, where I will be preparing the Marine Mammal Impact Assessment and involved in the consultation and engagement process.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we would like to take the opportunity to come down to Christchurch and introduce Schlumberger and the proposed 2D seismic survey to you all. The final survey details are not yet confirmed; but we would like to have an initial meeting with you and then we would look to come back early in the new year once NZ Petroleum & Minerals have made a decision on the prospecting permit and the survey details are finalised.

Would you be available to meet with us at your office on Tuesday 17th December in the afternoon? Any time from 1pm onwards would work well if that is possible.

Sorry this is such short notice but the Christmas/New Year period is quickly approaching and we would like to visit as soon as we can.

I understand s been informed of the prospecting permit application, but if he is available to meet with us on the Tuesday afternoon as well that would be great.

If you require any further information in regards to this email or the proposed visit please get in touch.

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Mdvrq#Nhuhkl
Sent: Wkxugd|/#1<#Ghfhp ehu#5346#15=49#s1p 1
To: Ol}#P hqlvk:#gdqC hrvog1fr1q}*
Cc: Qhovrq#Jdqj l#qhovrq1dqj lC {wdlfr1q},#Jd#Vp lk
Subject: UH:#R l#shup l#ru#vhlvp lf#qyhvwjdwrq

Kia ora koutou,

Happy to pick this up in the new year and as timing would have it .it's raining. Hahaha

Ra has been copied into this email.

Merry xmas all

Nga mihi

Rangitāne o Wairarapa Inc.
Mandated Iwi Authority

ROTORUA NEW ZEALAND 2025

From:
Sent: Thursday, 19 December 2013 11:57 a.m.
To: 'dan@eosltd.co.nz'
Cc:
Subject: FW: Oil permit for seismic investigation

Oops wrong email address for Dan!

From:
Sent: Thursday, 19 December 2013 11:56 a.m.
To:
Cc: 'dan@esoltd.co.nz'
Subject: Oil permit for seismic investigation

Tena koutou katoa,

I wish you both a Merry Christmas and wonderful new year and roll on the good weather in Wairarapa. Anyway this email is to introduce you Dan who is copied into this email. Dan is and Environmental Consultant working with Pepanz and a Seismic exploration company based in Perth. Sorry I could not quite get their name but I am sure Dan will elaborate for us. The area that the application is for includes both Wellington and Wairarapa so I suggested to Dan I would establish this email so he could open a conversation with you both and your Natural Resources staff. Nelson I don't seem to have email.

Anyway I am keen to talk you both early in the new year a good project to liaise on.

Natural Resources Advisor
Taranaki Whanui

Dan Govier

From: Qhovrq#Jdqj l
Sent: Wxhvgd|/54#Mdqxdu|5347#;64#lp l
To: *Gdq#Jryhu*#Ol}#P hoivk*#Mdvrq#Nuhkl*
Subject: UH#Vhlvp lf#Vxuyh|#Glvfxvvlrq

All systems go at KKW, Dan

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 20 January 2014 7:50 p.m.
To: [redacted]
Subject: RE: Seismic Survey Discussion

Hi all,
Hope you all enjoyed the long weekend.

If I could please confirm the meeting with you all on Wednesday 29th of January at the Kahungunu ki Wairarapa boardroom in Masterton at 2-30 pm that would be greatly appreciated.

I will look forward to seeing you then.

There will be two of us attending.

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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From: [redacted]
Sent: Wednesday, 15 January 2014 4:10 p.m.
To: [redacted]
Subject: RE: Seismic Survey Discussion

Yes Dan, Time OK and flexible at our end.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Wednesday, 15 January 2014 4:07 p.m.
To: [redacted]
Subject: RE: Seismic Survey Discussion

Kia ora
Thanks very much, I will check with Schlumberger and see if they can get over here for then.

If we can confirm that date, how would 2-30 pm sound?

Nga mihi
Dan

From:
Sent: Wednesday, 15 January 2014 4:01 p.m.
To:
Subject: RE: Seismic Survey Discussion

Kia ora Dan

I am available on Wednesday 29th January. We can meet at our boardroom, Kahungunu ki Wairarapa, facing Dixon Street carpark, large building sign facing the street. It is actually the rear of 187-189 Queen Street, Masterton Trust Lands Trust building. This is in Masterton. I'm not available Thursday or Friday.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Wednesday, 15 January 2014 11:26 a.m.
To:
Subject: RE: Seismic Survey Discussion

Thanks for getting back to me with the days you are available.

Just confirming Liz, you are available for Wednesday 29th January?

I need to check out schedules at this end, but we could probably do the afternoon of Wednesday 29th if that works? I will come back soon to confirm.

Thanks
Dan

From:
Sent: Wednesday, 15 January 2014 10:38 a.m.
To:
Subject: RE: Seismic Survey Discussion

Kia ora koutou,

I am available on both Monday 28th and Tuesday 29th not Friday of that week.

From:
Sent: Tuesday, 14 January 2014 12:56 p.m.
To:
Subject: RE: Seismic Survey Discussion

Kia ora koutou,

Unfortunately I am away until the week of the 27th. I am available Tues 28th 9am to 12 noon, Wed 29th from 10.30am or Fri 31 from 1.30pm

Rangitāne o Wairarapa Inc.
Mandated Iwi Authority

smokefree ROTORUA NEW ZEALAND 2025

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Tuesday, 14 January 2014 9:54 a.m.
To:
Subject: Seismic Survey Discussion

Tēnā koutou

I hope you all had a great Christmas and a happy New Year.

Just following up on our emails at the end of last year, I would like to arrange a meeting with you all to discuss a proposed seismic survey to be undertaken by Schlumberger. We will introduce the company to you to provide some background and also the proposed seismic survey in regards to location and timing etc. As yet the prospecting permit is still being processed and a decision is still to be made on the survey to go ahead, but as promised we wanted to come and catch up with you in the New Year.

How would you be placed for a meeting on Thursday 23rd or 24th of January? I think Liz mentioned maybe catching up in Masterton is this the best place for you all?

If you could please let me know whether you would be able to meet on either of those dates that would be greatly appreciated. Schlumberger staff will fly in from Perth for this meeting so if we can try to arrange a date this week that would be appreciated to allow me to make a schedule up for the trip as we will also travel up to Napier on the same trip.

Nga mihi
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Mdvrq#Nhuhkl
Sent: P rqgd|/#3#Iheuxdu|#5347#15=35#s1p 1
To: Gdq#Jryhu#Qhovrq#Jdqj l#Dl}#P hcdvk
Cc: up driilfhuC udqj ldqh1fr1q}
Subject: UH#R l#shup l#ru#vhlvp lf#qyhrwdj dwrq

Dan

Is the deadline today? If so, can I request an extension to respond? 20 days from today I believe.

I've also included I :r email is above). She is with Rangitane o Tamaki Nui a Rua. Can you please also forward to her all the electronic documentation that you are sending us.

Regards

Rangitāne o Wairarapa Inc.
Mandated Iwi Authority

ROTERROR NEW ZEALAND 2025

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 23 December 2013 3:05 p.m.
To:
Subject: RE: Oil permit for seismic investigation

Tēnā koutou

Firstly thanks : the introduction to Nelson and Jason.

As ıentioned in her email, I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.

Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed. The final survey details are not yet confirmed or approved; but I just wanted to make contact with you before Christmas and then we would look to come and see you in the new year where we can discuss the proposed project and answer any questions or concerns you may have.

I hope you have a very good and relaxing Christmas and I will be in touch soon.

Nga mihi
Dan

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Nelson 7041

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From:]
Sent: Thursday. 19 December 2013 5:55 p.m.
To: dan@eosltd.co.nz
Cc:
Subject: RE: Oil permit for seismic investigation

Kia ora Korua

Thanks for the season's greetings. Please accept mine to you. Let's catch up early next year. There are a number of things of interest – oil exploration, local govt. reform, consolidating our space and so on.

From:]
Sent: Thursday, 19 December 2013 11:57 a.m.
To: 'dan@eosltd.co.nz'
Cc:
Subject: FW: Oil permit for seismic investigation

Oops wrong email address for Dan!

From:
Sent: Thursday, 19 December 2013 11:56 a.m.
To:
Cc: 'dan@esoltd.co.nz'
Subject: Oil permit for seismic investigation

Tena koutou katoa,

I wish you both a Merry Christmas and wonderful new year and roll on the good weather in Wairarapa. Anyway this email is to introduce you Dan who is copied into this email. Dan is and Environmental Consultant working with Pepanz and a Seismic exploration company based in Perth. Sorry I could not quite get their name but I am sure Dan will elaborate for us. The area that the application is for includes both Wellington and Wairarapa so I suggested to Dan I would establish this email so he could open a conversation with you both and your Natural Resources staff. Nelson I don't seem to have email.

Anyway I am keen to talk you both early in the new year a good project to liaise on.

Natural Resources Advisor
Taranaki Whanui

Dan Govier

From: Ndxdk]Q jdsrud
Sent: P rqgd|#19#Shfhp ehu#5346#5=67#s1p 1
To: Gdg#Tryhu
Subject: UH=#Ndhrxud#Vlw

Look forward to catching up in the new year.

Kaikoura - An Earthcheck Gold Certified Community – www.kaikoura.co.nz

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Please consider the environment before printing this email.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 16 December 2013 3:33 p.m.
To: a
Subject: RE: Kaikoura Visit

Yes I am sorry for such short notice, it is a shame we will miss you but totally understand with how busy you are and the very short notice we provided. The managers from Schlumberger are arriving into the country first thing tomorrow morning as we wanted to try and meet up with the Runanga and a few of the locals before Christmas. We will try to provide more notice in the new year and I will look forward to meeting with you then.

Thanks
Dan

Dan Govier
Environmental Consultant
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www.eosltd.co.nz
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Nelson 7041

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From:
Sent: Monday, 16 December 2013 3:29 p.m.
To: Dan Govier
Subject: RE: Kaikoura Visit

Sorry but seems we will be missing each other, keen to catch-up on your next visit and the more notice you can give me the better.

Regards

Ltd | www.whalewatch.co.nz

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From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday. 16 December 2013 3:05 p.m.
To: |
Subject: Re: Kaikoura Visit

Ok understood. We will probably have to leave about 3-30 to 4pm on wed as we are on a 7pm flight out

Cheers
Dan

On 16/12/2013, at 2:51 pm,

> I'm in Christchurch Tuesday evening and can't leave any earlier as I have a meeting to Chair at 5pm here in Kaikoura, what time do you leave Kaikoura on Weds?
>
> Watch Kaikoura Ltd | www.whalewatch.co.nz
>
> *Kaikoura - An Earthcheck Gold Certified Community – www.kaikoura.co.nz*
> ***Whakaarohia a Papatūānuku i mua i te tānga mai o tēnei ī-mera.***
> *Please consider the environment before printing this email.*
> ***CAUTION**: This communication is confidential and may be legally privileged or subject to copyright. If it is not addressed to you, please immediately contact us at our cost and do not use, disclose, copy, distribute or retain any of it without our authority.*
>
> ---
>
> **From:** Dan Govier [mailto:dan@eosltd.co.nz]
> **Sent:** Monday, 16 December 2013 2:01 p.m.
> **To:**
> **Subject:** Re: Kaikoura Visit
>
> Kia ora
>
> That is a shame we will miss you on Wednesday. We are in Christchurch tue afternoon, would that work at all for us to catch up with you any better?
>
> Otherwise we will touch base early in the new year
>
> Nga mihi
>
> Dan
>
> On 16/12/2013, at 10:21 am, te:
>
> > Kia Ora Dan
> >
> > Unfortunately I will be in Christchurch on Wednesday so will be unable to catch-up with you on that day but I do look forward to meeting you at some later stage.
> >
> > Ngā mihi

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Sunday, 15 December 2013 3:41 p.m.
To:
Cc:
Subject: RE: Kaikoura Visit

Tēnā koe

Thanks for the prompt reply on my earlier email to

I appreciate you being available on Wednesday, we will look forward to meeting you at your marae. How would 9-30 am suit?

I see you have copied a few people in to this email also, we are hoping to meet with Te Rūnanga o Ngāi Tahu on the Tuesday afternoon before we travel north, again this will be just an informal chat introducing Schlumberger and the proposed survey. Once more details are finalised in regards to the survey we will have more definite information to come back and discuss with Te Rūnanga o Kaikoura.

We are also hoping to catch up with other groups while we are in Kaikoura, especially Whale Watch Kaikoura so I will be in touch with Kauahi.

Thanks for your further contact details also.

Nga mihi,
Dan

From
Sent: Sunday, 15 December 2013 10:29 a.m.
To: 'dan@eosltd.co.nz'
Cc:

Subject: FW: Kaikoura Visit

Tēnā koe Dan

Gina passed your email on to me to respond. Thanks for making contact and yes I am available to meet this coming Wednesday and will be in our office at Takahanga Marae in Kaikōura. Let me know what time would be suitable for you, to discuss the overall proposal and your draft MMIA with us. You have my email address and please note my other contact details below.

Takahanga Marae | PO Box 39 |
Kaikōura 7300|
<image001.png>

From: [redacted].nz]
Sent: Saturday, 14 December 2013 8:56 p.m.
To: [redacted]
Subject: Fwd: Kaikoura Visit

Hi am forwardg this on to u for response

Sent from my iPhone

Begin forwarded message:

> **From:** Dan Govier <dan@eosltd.co.nz>
> **Date:** 14 December 2013 8:16:45 pm NZDT
> **To:** [redacted]
> **Subject: Kaikoura Visit**
>
> Tēnā koe
>
> I am an environmental consultant based in Nelson and have been engaged by a company called Schlumberger to prepare a Marine Mammal Impact Assessment and be involved with the consultation and engagement process for a proposed 2D seismic survey in the East Coast and Pegasus Basins.
>
> Schlumberger have applied for a prospecting permit from NZ Petroleum & Minerals which is still currently being processed; however, we would like to take the opportunity to come down to Kaikoura and introduce Schlumberger and the proposed seismic survey programme to you.
>
> The final survey details are not yet confirmed; but we would like to have an initial informal chat with you over a cup of tea or coffee and then we would look to come back early in the new year once NZ Petroleum & Minerals have made a decision on the prospecting permit and the survey details are finalised.
>
> Would you be available to meet with us on Wednesday 18th December? We will hopefully meet with a few of the other locals while we are in town as we are planning to be in Kaikoura for the day.
>
> Sorry this is such short notice but the Christmas/New Year period is quickly approaching and we would like to visit as soon as we can.
>
> If you require any further information in regards to this email or the proposed visit please get in touch.
>
> Nga mihi
> Dan
> <image002.jpg>

Dan Govier

From: Ndxdk#Qjdsrud
Sent: Wxhvgd|/#4#Iheuxdu|#5347#7=77#s1p 1
To: Gdq#Jryhu
Cc: Sls#Jlo
Subject: UH=#Ndhrxud#Jvlw

Done. See you next week.

le Watch Kaikoura Ltd | www.whalewatch.co.nz

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Whakaarohia a Papatūānuku i mua i te tānga mai o tēnei ī-mera.
Please consider the environment before printing this email.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Tuesday, 11 February 2014 4:19 p.m.
To:
Cc:
Subject: RE: Kaikoura Visit

Kia ora
I now have all our travel arrangements organised for our Kaikoura visit.
Could I please book in 1pm on Tuesday 18th with you please?

We will be driving south in the morning so will come and see you after lunch if that works.
Thanks
Dan

Dan Govier
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P.O. Box 2065
Nelson 7041

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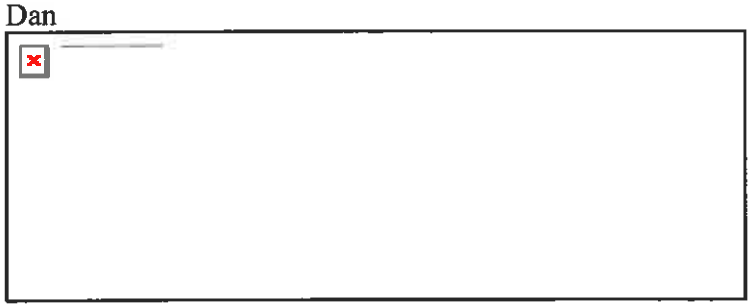
From:
Sent: Monday, 10 February 2014 12:57 p.m.
To: dan@eosltd.co.nz
Cc:
Subject: Re: Kaikoura Visit
Afternoon of the 18th will work, let me know what time suits so I can lock it in.
Regards
Whale Watch Kaikoura Ltd

-------- Original message --------

From: Dan Govier <dan@eosltd.co.nz>
Date:
To: .nz>
Subject: Kaikoura Visit

Kia ora
We are coming back to Kaikoura at this stage on Tuesday 18th and Wednesday 19th of February next week. At this stage we have the Tuesday afternoon free and was checking to see what your schedule was and whether you are around to meet with us for the proposed Schlumberger seismic survey?

We are hopefully having a meeting with Runanga o Kaikoura on the Wednesday morning.
Nga mihi,
Dan



Dan Govier

From: Ndxdk1#Qjdsrud
Sent: Wkxwgd|/#53#P dufk#5347#3=73#s1p 1
To: Gdq#Dryhu
Cc: urjhuC zkddnz dwfk1fr1q}
Subject: UH=#Vfkoxp ehujhu#Vhlvp lf#Vxuyh|#Dsuo#5347

Thanks for the update Dan.

| Whale Watch Kaikoura Ltd | **www.whalewatch.co.nz**

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Whakaarohia a Papatūānuku i mua i te tānga mai o tēnei ī-mera.
Please consider the environment before printing this email.

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Thursday, 20 March 2014 1:34 p.m.
To:
Subject: Schlumberger Seismic Survey April 2014

Kia ora

Please find attached an information sheet for the proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

If you have any questions or concerns relating to the attached information sheet or the proposed seismic survey please let me know.

We are still finalising the MMIA so once this is complete we will send you a copy.

Nga mihi
Dan

Dan Govier
Environmental Consultant
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www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

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Dan Govier

From: Vdud#Frrn
Sent: P rqgd|/#57#P dufk#5347#5=79#s1p 1
To: *Gdq#Jryhu*
Subject: UH=#Vfkoxp ehujhu#Vhlvp lf#Vxuyh|

Hi Dan,
Thanks for that.
Kind regards,

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 24 March 2014 3:05 p.m.
To:
Subject: Schlumberger Seismic Survey

Hi
Thanks for returning my phone call.

As discussed, please find attached an information sheet for the proposed 2D seismic survey to be undertaken by Schlumberger.

The survey is proposed to commence at the start of April 2014 in the East Coast and Pegasus Basins.

No survey lines will come within the Horizons CMA.

The seismic survey vessel *Aquila Explorer* will be used and will be accompanied by the support vessel *Amaltal Mariner*.

The survey duration is anticipated to be between 40-50 days.

If you have any questions or concerns relating to the attached information sheet or the proposed seismic survey please let me know.

Thanks
Dan

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+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

ENVIRONMENTAL OFFSHORE SERVICES LIMITED

Dan Govier

From: Jxv#Vhlgd
Sent: Iulgd|#5;#P dufk#5347#4=7;#s1p 1
To: Z lddq#Dudgjh
Cc: Gdyh#Dxqgtxlwe#gdqC hrvog1fr1g}
Subject: Frp p hqw#rq#SDP #v|vwhp #ru#IFSE

Dear Mr Willian Arlidge,

After having carefully examined the equipment specifications and the specialist consultant report provided by the PAM system supplier (Vanishing Point) and, considering that I've worked with VP's PAM systems on different occasions, I can atest that the system planned to be used onboard the Aquilla Explorer for the East Coast and Pegasus Basins (ECPB) 2D MSSs is suitable for detecting New Zealand endemic and vagrant marine mammal species.

The system basic configuration, transducers, pre-amps, filters and software are appropriate and can be adjusted, customised and optimised by the PAM operator to detect "Species of Concern" and other marine mammals most likely to occur in the survey geographic area.

The system is inherently capable of detecting vocalising and or echo-locating marine mammals beyond 2.1km but effectiveness may be limited by a number of factors such as:

1. Environmental variables:

- background noise, SNR
- depth; seabed topography, composition and its acoustic properties
- absorption losses, scattering losses

2. Types of vocalisation or echolocation:

- directional echolocation
- marine mammal calls frequency range and source level

Please do not hesitate to contact me if additional information or clarification is required.

Kind regards,

PAM Technician / Operator

APPENDIX 3

Technical Details of the PAM System

BLUE PLANET MARINE

Specifications of BPM PAM equipment

Hardware

Blue Planet Marine can provide various customised passive acoustic monitoring systems suitable for detecting and monitoring cetaceans during seismic survey. The full specifications of this system are not included in this document, however can be supplied on request.

The towed hydrophone streamers are based on a well-established design by Ecologic in the United Kingdom. This design, which is a modern iteration of systems originally developed on a pioneering project funded by Shell UK to develop PAM for mitigation in the mid 1990s, has proven highly robust and reliable. It provides flexibility allowing the inclusion of various combinations of hydrophones and other sensors and can, if necessary, be disassembled and repaired in the field. Seismic PAM hydrophones operate in an environment in which the risk of hydrophone loss or damage is significant and options for external assistance are limited. While spare equipment is always provided, the use of a system that can be repaired in the field is, a distinct advantage. The systems that BPM would use for the survey will have a 340 m tow cable and an 80 m deck cable.

The variety of cetacean species likely to be encountered during seismic survey mitigation produce vocalisations over an extremely broad frequency range, from the infrasonic 15-30Hz calls of large baleen whales to the 130kHz pulses of harbour porpoise and Hectors dolphin. To be able to capture all of these, while reducing unwanted noise the PAM system uses two different hydrophone/pre-amp pairs with widely overlapping frequency sensitivity: a low/medium frequency pair and a high frequency pair. These hydrophone pairs can be monitored, filtered and sampled independently.

Filtering and amplification hardware is custom-built by Magrec to meet the specification required for cetacean monitoring. Important features include: adjustable low frequency filters from 0Hz to 3.2kHzs which can be applied to reduce low frequency noise allowing the available dynamic range to be conserved for capturing marine mammal vocalisations within the frequency bands used each species. The Magrec preamp also provides an output with a fixed 20kHz low cut filter to optimise detection of the very high frequency vocalisations of porpoise, Hectors dolphins, beaked whales and Kogia. Additional, highly configurable digital band-pass and band-stop filtering is provided by on board signal processing within the specialised USB sound card.

Audio and low-ultrasonic frequency bands (up to 96 kHz) are digitised using a USB sound card. Ultra high frequency click detection (which is particularly useful for porpoise, Hector's dolphins, Kogia, etc.) is achieved by using a National Instruments Digital Acquisition card with a sampling rate of 1.2 mega samples s-1.

Systems like this have been used from a wide variety of platforms ranging from sailing yachts to ocean-going ice breakers and in waters from the tropics to the Antarctic. However, the need to monitor acoustically for mitigation has been a driver for much of the system's development. Seismic survey mitigation monitoring has been conducted from guard vessels and from the main seismic survey vessel itself. Operation from the seismic vessel has proven most straightforward and would be favoured in most situations.

Software

The system is optimised for use with PAMGUARD. A software suite specifically designed for detecting, classifying and localising a wide variety of marine mammals during seismic surveys. Much of the funding for the development came from the oil exploration industry. Ecologic was part of the team that initiated the PAMGUARD project and remains closely associated with its development. The hardware described here, has been developed in parallel with the PAMGUARD software.

PAMGUARD is an extremely flexible program with a range of modules that can be combined to provide customised configurations to suit particular applications. It includes modules for detecting both transient vocalisations (clicks) and tonal calls (e.g. whistles and moans). Cetacean click vocalisations range from the medium frequency clicks of sperm whales that can be detected at ranges of several miles, through the powerful broadband clicks produced by most delphinids to the specialised narrow band pulses of beaked whales, harbour porpoises and Hector's dolphins. High frequency tonal sounds include the whistle vocalisations produced by delphinids while low frequency tonals are produced by baleen whales. When data from two or more hydrophone elements are available PAMGUARD can calculate bearings to these vocalizations and provide locations by target motion analysis.

PAMGUARD also includes routines for measuring and removing background noise, and for vetoing particularly intense sounds such as Airgun pules.

In addition PAMGUARD collects data directly from certain instruments. For example, it measures and displays the depth of the hydrophone streamer and takes NMEA data (such as GPS locations) from either the ship's NMEA data line or from the stand-alone GPS units provided with the equipment.

The ship's track, hydrophone locations, mitigation zones, airgun locations and locational information for acoustic detections are all plotted on a real-time map.

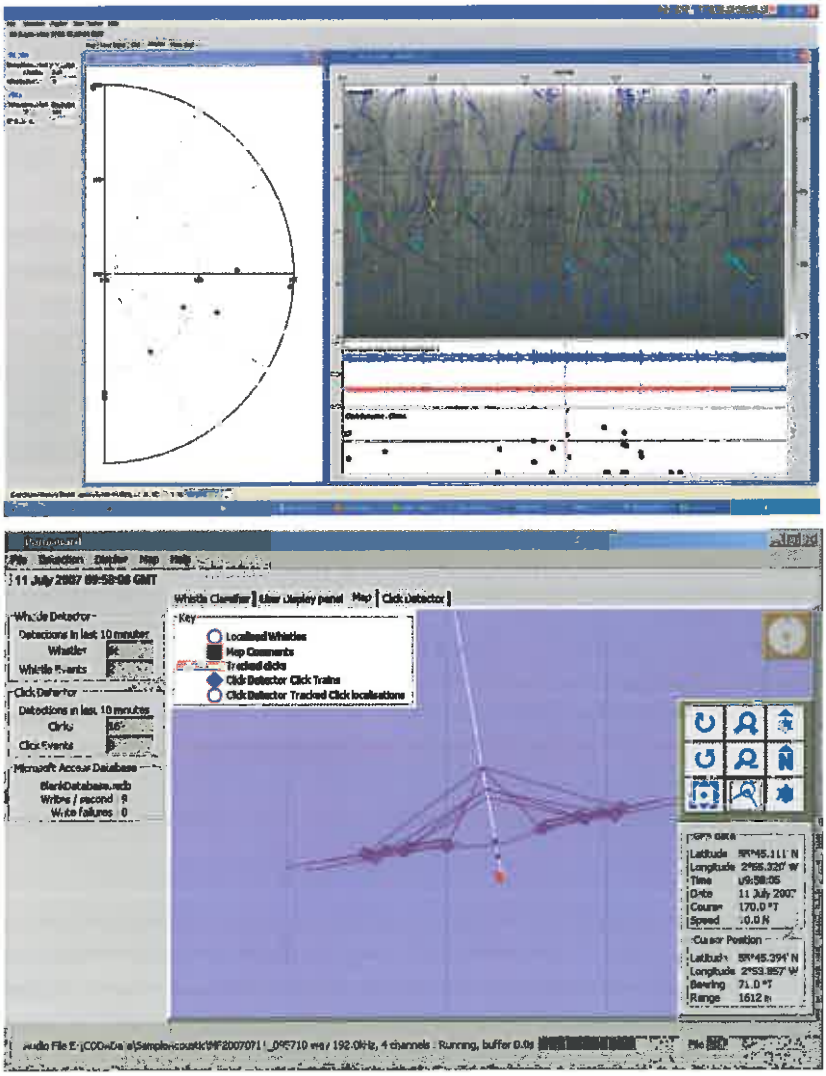

Figure 1 Screen shot from PAMGUARD Whistle and Click Detection and Mapping and Localisation Modules typical of a Seismic Mitigation configuration

Species Detection

The frequency range, call type and vocal behaviour of cetaceans varies enormously between species and this affects the degree to which PAM provides additional detection power, especially in the noisy environment of a seismic survey. This system has proven very effective in detecting small odontocetes and sperm whales, increasing detection reliability by an order of magnitude during trials (funded by Shell) conducted off the UK. PAM is particularly effective for the detection of sperm whales as they can be heard at significant ranges (several miles) and are consistently vocal for a large proportion of the time. Smaller odontocetes such as dolphins, killer whales, pilot whales and other "black fish" can be detected at useful ranges from both their whistle and click vocalisations but they often move so quickly that target motion may be difficult. The effective range for harbour porpoise (~400 m) is limited by the high rate of absorption of their ultra-high frequency clicks. This is usually within proscribed mitigation ranges so that any reliable detection should lead to action. Towed hydrophones of this type have been very effective in picking up vocalisations from beaked whales during surveys and the narrow bandwidth and characteristic upsweep in their clicks greatly assists with their classification. However, beaked whales clicks are highly directional and vocal output can be sparse and intermittent so overall detection probability may remain low.

The value of PAM in mitigating the effects of seismic operations with baleen whales has yet to be fully explored. These whales generally vocalise at low frequencies, increasing vulnerability to masking by vessel and flow noise. Further, although some baleen whale vocalisations are very powerful, they appear to be less consistently vocal than most odontocetes. Many of their vocalisations appear to be breeding calls and may be produced seasonally and either solely or predominantly by males.

Standard Seismic Mitigation Acoustic Monitoring System	
Towed Hydrophone	
Acoustic Channels	2 x Medium Frequency Benthos AQ4. **–201 dBV re 1Pa (+/-** 1.5 dB 1-15kHz) with Magrec HP02 broad band preamps (LF cut filter @ 100Hz or 50Hz as required) Near-flat Sensitivity 50Hz- 15kHz with good sensitivity to higher frequencies 2 x High Frequency Magrec HP03 units, comprising a spherical ceramic and HP02 preamp (Low cut filter set at 2kHz) Near flat sensitivity 2kHz- 150kHz +/-6 dB 500Hz to 180kHz
Depth Sensor	Keller 4-20Ma 100m range Automatically read and displayed within PAMUARD
Streamlined housing	5m, 3 cm diameter polyurethane tube. Filled with Isopar M
Cable	340m multiple screened twisted pair, with strain relief and Kellum's grip towing eye, Length deployed may vary to suit application
Connectors	19 pin Ceep IP68 waterproof
Deck cable	~75m 19pin Ceep to breakout box
Topside Amplifier Filter Unit	
Unit	Magrec HP/27ST
Supply Voltage	10-35 V DC
Supply current	200mA at 12 V
Input	Balanced input
Gain	0,10,20,30,40,50 dB

Standard Seismic Mitigation Acoustic Monitoring System	
High Pass Filter	-6db/octave selectable 0, 40, 80, 400,1.6k, 3.2k
Output	2 X Balanced output via 3 pin XLR
Ultra HF Output	2 X Balanced output via 3 pin XLR (with 20kHz high pass filter for porpoise detection)
Headphone	Dual output via ¼" jack
Overall Bandwidth	10Hz-200kHz +/–3dB
GPS	
Input	Serial to USB adapter to interface with ship's NMEA supply
Backup	Standalone USB unit provided as independent backup
Computers	
	Up to date Laptop Computers
Digitisers	
Digitiser	NI USB 6251 high speed Digital Acquisition (if required for porpoise detection)
Sound Card	High quality sound card 192kHz sampling rate e.g. Motu Ultralite Mk3 Hybrid, Or RME Fireface 400
Software	
General	PAMGUARD with appropriate configurations
Porpoise Detection	Rainbow Click / Logger

APPENDIX 4

Marine Mammal Mitigation Plan for the ECPB 2D MSS

Marine Mammal Mitigation Plan:

Schlumberger Seaco Inc. East Coast and Pegasus Basin Multiclient 2D Marine Seismic Survey

BPM-14-SLB-East Coast and Pegasus Basin Multiclient 2D MSS-MMMP-v1.2

28/03/2014

BLUE PLANET MARINE

Document Distribution List

Date: 28/03/2014

Title: Marine Mammal Mitigation Plan: Schlumberger Seaco Inc. East Coast and Pegasus Basin Multiclient 2D Marine Seismic Survey

Company/Organisation	Position or Location & name of individual	Copy No.
Schlumberger	Bruce Clulow, Operations Manager	1
Schlumberger	Ken Jayan, Multiclient Operations Supervisor	2
EOS Ltd	Dan Govier, Environmental Consultant	3
BPM	Simon Childerhouse, Senior Research Scientist	4
BPM	Rob Slade, Operations Manager	5

Document Revision Record

Rev.	Date	Description	Prepared	Reviewed	Approved
1.0	26/03/2014	Version 1	SC	LD	SC
1.1	27/03/2014	Revision 1 – comments incorporated	SC	DG	SC
1.2	28/03/2014	Revision 2 – DOC comments incorporated	SC	LD	SC

Document Reference Number: BPM-14-SLB-East Coast and Pegasus Basin Multiclient 2D MSS-MMMP-v1.2

Prepared by: Simon Childerhouse

Last updated: 28 March 2014

www.blueplanetmarine.com

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List of Addenda

1. Introduction

This document has been developed by Blue Planet Marine (BPM) for Schlumberger Seaco Inc. (Schlumberger) in order to meet the requirements for a Marine Mammal Mitigation Plan (MMMP) for the East Coast and Pegasus Basin Multiclient 2D Marine Seismic Survey (the survey). Schlumberger, a leading geophysical services company, is to undertake a 2D marine seismic survey (MSS) of approximately 5,000 lineal in the East Coast and Pegasus Basins (ECPB). The ECPB Survey Area will be located within the 51,800 km^2 Petroleum Prospecting Permit (PPP) 56061 and will be bound by the ECPB Operational Area; (Figure 1).

This MMMP outlines the procedures to be followed by observers and crew in order to guide survey operations. It should be read in conjunction with the *2013 Code of Conduct for Minimising Disturbance to Marine Mammals from Seismic Survey Operations* (the Code) and the Schlumberger Marine Mammal Impact Assessment (MMIA) developed by Environmental Offshore Services Ltd (EOS) specifically for this survey. The Code is the primary tool for describing mitigation and reporting required for seismic surveys consistent with NZ legislation. It should be the primary reference for MMO and PAM operators during a survey. This MMMP provides additional and supplemental information useful in the completion of MMO and PAM roles.

2. The Schlumberger Seaco Inc. East Coast and Pegasus Basin Multiclient 2D Marine Seismic Survey

EOS was engaged by Schlumberger to prepare a MMIA for an approximate 5,000 km survey on the East Coast of the North Island and Pegasus Basin, scheduled to commence in April 2014. The survey area will be largely located within the 51,800 km^2 Petroleum Prospecting Permit (PPP) 56061 and will be bound by the ECPB Operational Area (Figure 1). Information provided in the draft MMIA for the ECPB survey area has been used by BPM in the development of this MMMP.

The survey area will be bound by the ECPB Operational Area; allowing for the operation of line turns, acoustic source testing and soft start initiation (Figure 1). It is anticipated that the survey will take approximately 40-50 days to complete, depending on weather constraints and marine mammal encounters. The actual commencement date of the survey is dependent on the seismic vessel, *Aquila Explorer*, completing prior surveys. The current schedule anticipates a commencement date of approximately April 2014, though this could be delayed.

The survey will acquire approximately 5,000 lineal km of 2D seismic data in order to provide a general understanding of the geological structure within PEP 56061. It will also identify more prospective areas for further investigation utilising a 3D MSS.

A few sections of the ECPB Operational Area are within the Coastal Marine Area (CMA) administered by Greater Wellington Regional Council (GWRC), Horizons Regional Council and Hawkes Bay Regional Council, however most of the proposed survey lines stay within the EEZ. **The Code is not mandatory within the CMA, however, Schlumberger will adhere to it within the entire ECPB Operational Area.**

The ECPB 2D MSS will use the seismic vessel Aquila Explorer and will tow one solid streamer, 8 km in length which will be at a depth of 8 m at the front and slanted down to 30 m at the end of the streamer. The acoustic source will have an effective volume of 6,300 in^3 and will be comprised of four sub-arrays with 11 acoustic sources on the two outside sub-arrays and 9 acoustic sources on the inside two, located at a depth of 10 m below the sea surface and approximately 130 m behind the survey vessel. The depth of the sub-arrays will ensure the volume used enables the survey to be run effectively in regards to data acquisition, but also to minimise the potential environmental disturbance. In the case

of dropouts during acquisition, the source array may operate at a slightly lower capacity for a short period of time.

The acoustic source will have an operating pressure of 2,000 psi and fired at a sourcepoint interval of 25 m apart, where for a typical boat speed of 4.2 – 4.5 knots (kts), relates to a sourcepoint activation every 11 – 11.5 seconds. Given the volume of the acoustic source being used, the survey is classified as a **Level 1** survey under the Code. The mitigation procedures **set** out in this MMMP will adhere to the requirements of a Level 1 survey as stipulated in the Code.

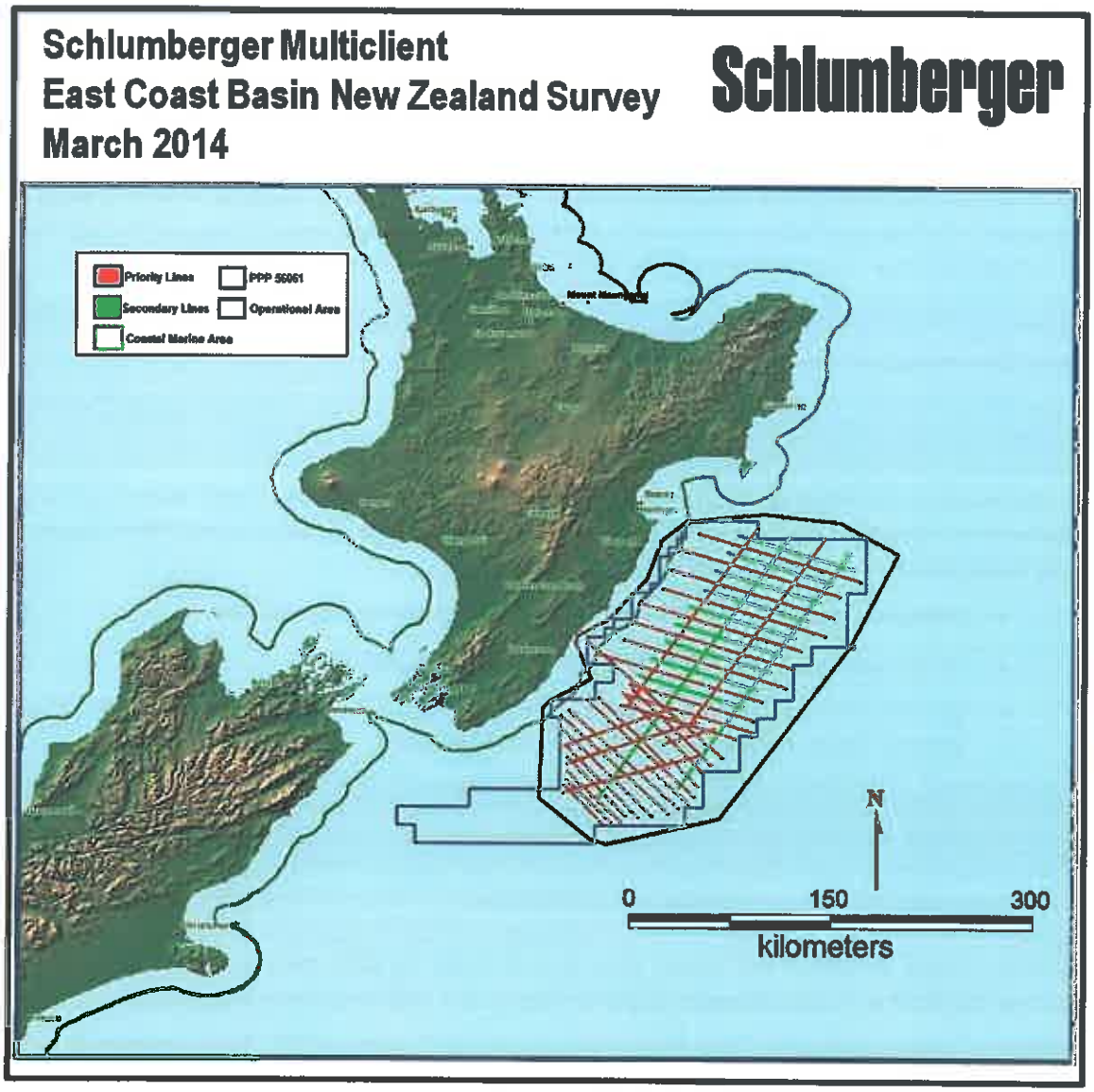


Figure 1: Location of the Schlumberger East Coast and Pegasus Basin Multiclient 2D Marine Seismic Survey.

(Figure reproduced courtesy of EOS 2014. Observers to refer to the VADAR system for the coordinates of the survey Operational Area.)

3. Record Keeping and Reporting

The observers (MMOs and PAM operators) are responsible for maintaining records of all marine mammal sightings/detections and mitigation measures taken throughout each survey period. Observers are also required to monitor and record seismic operations, the power output of the acoustic source while in operation, observer effort and sighting conditions. These and other reporting requirements are detailed in Appendix 2 of the Code.

Observers are to accurately determine distances/bearings and plot positions of marine mammals whenever possible throughout the duration of sightings. Positions of marine mammals should be plotted in relation to the vessel throughout a detection. GPS, sextant, reticle binoculars, compass, measuring sticks, angle boards, or any other appropriate tools should be used to accurately determine distances/bearings and plot positions of marine mammals.

The operator will ensure that information relating to the activation of an acoustic source and the power output levels employed throughout survey operations is readily available (e.g. in a place of convenience for the qualified observers while conducting their normal duties) to support the activities of the qualified observers in real time by providing a display screen for acoustic source operations.

Please review Appendix 2 of the Code carefully. Note that you are required to record the power levels (and timing) of at least one random soft start per swing[1]

Note: the Code is mandatory within the NZ EEZ, as such record keeping should be of a high standard as it may form the basis of compliance or enforcement action by the authorities.

All data must be recorded in a standardised Department of Conservation (DOC) Reporting Form. Datasheets are available from www.doc.govt.nz/notifications and are in Excel format. With regard to these forms please note the following advice from DOC:

- Always save the forms in MS Excel 2003 version, with macros enabled;
- Do not attempt to use the forms on a Macintosh device; and
- Do not cut/paste within the document (copy/paste should be okay, but cutting and pasting causes problems with formulas and validation).

It is recommended that observers test the functionality of the datasheets prior to mobilisation and become familiar with their use. In particular, note that macros must be enabled.

All raw datasheets shall be submitted by the qualified observer directly to the Director-General (refer Appendix 5 of the Code for postal and email addresses) within 14 days of a completed MMO/PAM operator rotation or end of the survey. Prior to submission to DOC, these data sheets are to be reviewed by the BPM Project Manager so please ensure that sufficient time is made for that.

There are a number of situations that require immediate notification to DOC. These are listed in Table 2, in Section 6. Where uncertainty or ambiguity in application of the Code arises, clarity can be sought from the Director-General.

It is recommended that observers provide the client with a daily summary detailing marine mammal sightings, mitigation measures taken and instances of non-compliances.

[1] Note: Text in blue boxes are recommendations or further explanations to observers from BPM and/or DOC.

The Team leader is responsible for compiling an end of survey summary report based on the data collected throughout each survey. The contents of this report are summarised in Appendix 2 of the Code.

3.1 Contact details for the Department of Conservation

During the survey, the first point of contact within DOC is Ian Angus
If a response is required urgently then telephone but in all other circumstances use email. Should Ian Angus be unavailable, please phone 0800DOCHOT (0800-362-468) and state the following:

1) You wish to provide information to the Marine Species and Threats team, National Office;
2) The name of the MMO/PAM operator, the seismic survey and boat you are currently on;
3) The time and date;
4) The issue/enquiry they wish to pass on to Ian Angus; and
5) Where you can be contacted with a reply (if appropriate).

3.1.1 Communication protocol

The communication protocol to be followed for reporting to DOC is as follows:

For **general reporting of non-urgent issues** to DOC the communication protocol is:

- MMO Team Leader to contact BPM Project Manager ashore (Rob Slade);
- BPM to contact Schlumberger (Bruce Clulow);
- Schlumberger to contact EOS (Dan Govier); and
- EOS to contact DOC (Ian Angus or other).

For **urgent communications**, any qualified MMO can contact DOC directly either by email or by phone under the following conditions:

- Qualified MMO undertaking direct communication with DOC must inform the MMO Team Leader, Party Chief (or nominated Schlumberger person) and the Client Reps of the issue and intention to contact DOC, and keep these people informed of discussions and associated events;
- The BPM Project Manager and onshore Schlumberger Project Manager (Bruce Clulow) must be kept informed;
- If the contact is by email, then the Team Leader should consider making a phone call advising DOC of the situation; and
- All direct contacts to DOC via phone must be followed up by an email to DOC and Schlumberger at the earliest opportunity to provide written confirmation of the message.

4. Mitigation Measures Required Under the Code

The survey is classified as a Level 1 survey under the Code. Within the operational area, the marine mammal impact mitigation measures required can be divided into three principal components:

1) The use of dedicated observers (i.e. MMOs and PAM operators);
2) The mitigation measures to be applied; and

3) The mitigation actions to be implemented, should a marine mammal be detected.

Note: Based on results of Sound Transmission Loss Modelling, Schlumberger is required to implement a mitigation measure amended from that outlined in the Code. **As outlined in the MMIA (section 2.3.1), the mitigation zone for SOC (both with and without calves) has been increased from 1.0/1.5 km to 2.1 km and the mitigation zone for 'other marine mammals' has been increased from 200 m to 350 m**. This MMMP is consistent with the Code and MMIA.

4.1 Dedicated observers (MMOs and PAM operators)

As this is a Level 1 survey, there will be two MMOs and two PAM operators on board the *Aquila Explorer* for the duration of the survey. The training and experience of the observers will meet the requirements stipulated in Section 3.4 of the Code. There will be at least one MMO (during daylight hours) and one PAM operator on watch at all times while the acoustic source is in the water in the operational area. Observers may stand down from active observational duties while the acoustic source is in the water but inactive for extended periods. Note: an "extended period" does not apply to when the acoustic source may be off during line turns (refer below).

It is recommended that:

- MMOs conduct daylight observations from half an hour before sunrise to half an hour after sunset;

- Fatigue and effective watch-keeping be managed by limiting watches to a maximum of 4 hours; and

- The maximum on-duty shift duration must not exceed 12 hours in any 24-hour period.

The primary role of the observers is to detect and identify marine mammals and guide the crew through any mitigation procedures that may be required. Any qualified observer on duty has the authority to delay the start of operations or shut down an active survey according to the provisions of the Code. In order to work effectively, clear lines of communication are required and all personnel must understand their roles and responsibilities with respect to mitigation.

It is recommended that:

- Where possible, both MMOs are on watch during pre-start observations and soft starts;

- While on transit to the prospect the observers deliver a presentation to crew members detailing observer roles and mitigation requirements;

- The observers hold briefings with key personnel prior to the commencement of seismic operations; and

- The observers provide posters detailing mitigation procedures and communications protocols and display these in the instrument room, at the PAM station and on the Bridge (refer Addenda 2 and Addenda 3 of this document).

Undertaking work-related tasks, such as completing reporting requirements, while monitoring equipment is allowed during duty watch, but PAM operators must not be distracted by non-work activities such as listening to music or watching TV/DVDs etc.

4.1.1 Safety drills

Attendance at a safety drill at least once during each rotation is typically mandatory (e.g. the vessel HSE plan will specify the number). Although not specified in the Code, safety of personnel takes priority over mitigation. Safety drills may be conducted when the acoustic source is active. In this case,

endeavours should be made to arrange rosters such that observers attend alternate drills, thus enabling mitigation to be maintained. In all cases, observers must comply with the mandatory safety code of the vessel.

4.1.2 PAM not operational

Section 4.1.2 of the Code states: "*At all times while the acoustic source is in the water, at least one qualified MMO (during daylight hours) and at least one qualified PAM operator will maintain watches for marine mammals*".

The Code defines PAM as "*calibrated hydrophone arrays with full system redundancy*". BPM has provided full redundancy for this survey by providing two full sets of PAM equipment plus an additional backup PAM hydrophone cable. However, there may be occasions where PAM is not operational.

The Code was first implemented in 2012. In 2013 it was updated. One update relates to times when PAM is not operational. Section 4.1.2 of the Code states that:

"*If the PAM system has malfunctioned or become damaged, operations may continue for 20 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM gear must be repaired to solve the problem, operations may continue for an additional 2 hours without PAM monitoring as long as all of the following conditions are met:*

- *It is daylight hours and the sea state is less than or equal to Beaufort 4*
- *No marine mammals were detected solely by PAM in the relevant mitigation zones in the previous 2 hours*
- *Two MMOs maintain watch at all times during operations when PAM is not operational*
- *DOC is notified via email as soon as practicable with the time and location in which operations began without an active PAM system*
- *Operations with an active source, but without an active PAM system, do not exceed a cumulative total of 4 hours in any 24 hour period.*"

It is recommended that MMOs and PAM operators familiarise themselves with this revision to the Code, including the conditions. For clarity, the period that a survey may operate without PAM is a maximum of 2 hours 20 minutes and only when the conditions identified in Section 4.1.2 of the 2013 code are satisfied. Once this time is exceeded, the source must be shut down until PAM is operational again.

4.2 Crew observations

As per section 3.8.6 of the Code:

'If a crew member onboard any vessel involved in survey operations (including chase or support vessels) observes what may be a marine mammal, he or she will promptly report the sighting to the qualified MMO, and the MMO will try to identify what was seen and determine their distance from the acoustic source.

In the event that the MMO is not able to view the animal, they will provide a sighting form to the crew member and instruct on how to complete the form. Vessel crew can relay either the form or basic information to the MMO. If the sighting was within the mitigation zones, it is at the discretion of the MMO whether to initiate mitigation action based on the information available. Sightings made by members of the crew will be differentiated from those made by MMOs.'

4.3 Mitigation procedures

The proponent will observe the following mitigation practices:

4.3.1 Operational area

Under the Code, an operational area must be designated outside of which the acoustic source will not be activated. This includes testing of the acoustic source and soft starts. The operational area is defined by the following coordinates (Table 1) and has been loaded into VADAR for real time monitoring of vessel location and marine mammal detections relative to the operational area.

Table 1: ECPB operational area coordinates

Longitude (decimal degrees West)	Latitude (decimal degrees South)
177.333	-39.6667
178.052	-39.5993
178.757	-39.6755
179.299	-39.967
178.854	-40.8349
177.643	-42.4306
176.599	-42.6718
176.441	-42.6136
175.975	-42.2405
176.004	-41.4082
176.083	-41.3334
176.456	-41.1334
176.304	-40.8027
176.328	-40.7423
176.629	-40.5725
176.831	-40.3367
176.962	-40.2118
177.1	-39.847
177.333	-39.6667

4.3.2 Operational capacity

The operational capacity of the acoustic source is notified in the MMIA an outlined in Section 2 of this MMMP. This operational capacity should not be exceeded during the survey, except where unavoidable for source testing and calibration purposes only[2]. All occasions where activated source volume exceeds notified operational capacity must be fully documented in observer reports. It is the

[2] D Lundquist, DOC (25 March 2014): "Please note that if the operational capacity is exceeded at any other time (including soft starts), this is a non-compliance incident and should be reported as such."

responsibility of the operator to immediately notify the qualified observers if operational capacity is exceeded at any stage[3].

4.3.3 Sighting conditions

Good sighting conditions means in daylight hours, during visibility of more than 1.5 km, and in a sea state of less than or equal to Beaufort 3.

Poor sighting conditions means either at night, or during daylight visibility of 1.5 km or less, or in a sea state of greater than or equal to Beaufort 4.

Beaufort 3

- Gentle breeze: 7–10 kts
- Wave height: 0.5–1 m
- Large wavelets. Crests begin to break; scattered whitecaps

BEAUFORT FORCE 3
WIND SPEED: 7-10 KNOTS

SEA: WAVE HEIGHT .6-1M (2-3FT), LARGE WAVELETS CRESTS BEGIN TO BREAK, ANY FOAM HAS GLASSY APPEARANCE, SCATTERED WHITECAPS

Beaufort 4

- Moderate breeze: 11-16 kts
- Wave height: 1–2 m
- Small waves with breaking crests. Fairly frequent whitecaps.

BEAUFORT FORCE 4
WIND SPEED: 11-16 KNOTS

SEA: WAVE HEIGHT 1-1.5M (3.5-5FT), SMALL WAVES BECOMING LONGER, FAIRLY FREQUENT WHITE HORSES

4.3.4 Pre-start observations

A Level 1 acoustic source can only be activated if it is within the specified operational area, and no marine mammals have been observed or detected in the relevant mitigation zones as outlined in Section 4.5.

[3] D Lundquist, DOC (25 March 2014): "qualified observer should be able to monitor this via a dedicated screen as described in section 3 above"

The source cannot be activated during daylight hours unless:

- At least one qualified MMO has continuously made visual observations all around the source for the presence of marine mammals, from the bridge (or preferably an even higher vantage point) using binoculars and the naked eye, and no marine mammals (other than fur seals) have been observed in the relevant mitigation zone for at least 30 minutes, and no fur seals have been observed in the relevant mitigation zones for at least 10 minutes; and
- Passive Acoustic Monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation and no vocalising cetaceans have been detected in the relevant mitigation zones.

It is recommended that MMOs and PAM operators are notified at least 45 minutes prior to activation of the source to ensure that the 30 min of pre-start observations can be conducted.

The source cannot be activated during night-time hours or poor sighting conditions unless:

- Passive Acoustic Monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation, and
- The qualified observer has not detected vocalising cetaceans in the relevant mitigation zones.

Note: If a marine mammal is observed to move into a relevant mitigation zone during pre-start observations and then observed to move out again there is no requirement to delay soft start (providing that at least 30 minutes of pre-start observations have been completed). The important criterion is that there are no marine mammals inside the relevant mitigation zones when the acoustic source is activated at the beginning of soft start and that at least 30 minutes of pre-start observations had been undertaken immediately prior.

Another update to the Code in 2013 relates to commencement of operations in a new location in the survey programme for the first time (Section 4.1.3). When arriving at a new location, the initial acoustic source activation must not be undertaken at night or during poor sighting conditions unless either:

- MMOs have undertaken observations within 20 nautical miles of the planned start up position for at least the last 2 hours of good sighting conditions preceding proposed operations, and no marine mammals have been detected; or
- Where there have been less than 2 hours of good sighting conditions preceding proposed operations (within 20 nautical miles of the planned start up position), the source may be activated if[4]:
    - PAM monitoring has been conducted for 2 hours immediately preceding proposed operations, and
    - Two MMOs have conducted visual monitoring in the 2 hours immediately preceding proposed operations, and

[4] D Lundquist, DOC (25 March 2014): "Please note that this option may only be used if there have not been two hours of good sighting conditions preceding operations. It cannot be used if there were 2 or more hours of good sighting conditions and marine mammals were sighted (i.e., the second option may only be used if weather conditions prevented the first condition being met, not if marine mammal presence prevented the first condition being met)"

- No Species of Concern have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the 2 hours immediately preceding proposed operations, and
- No fur seals have been sighted during visual monitoring in the relevant mitigation zone in the 10 minutes immediately preceding proposed operations, and
- No other marine mammals have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the 30 minutes immediately preceding proposed operations.

It is recommended that MMOs and PAM operators familiarise themselves with this revision to the Code including the conditions.

4.3.5 Soft starts

The soft start procedure will be followed every time the source is activated. That is: the gradual increase of the source's power to the operational power requirement over a period of at least 20 minutes and no more than 40 minutes, starting with the lowest power acoustic source in the array. The MMIA for the survey (section 2.2.1.3) describes the soft start procedures to be conducted as:

"A soft start 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 capacity defined in this MMIA (6,300 in^3) is not to be exceeded during the soft start period."

Soft starts will also be scheduled so as to minimise the interval between reaching full power and commencing data acquisition.

The only exception to the requirement to use the soft start procedure is when the acoustic source is being reactivated after a single break in firing of less than 10 minutes (not related to an observation of marine mammal), immediately following normal operations at full power (see Section 3.8.10 of the Code). However, it is not permissible to repeat the 10-minute break exception from soft start requirements by sporadic activation of acoustic sources at full or reduced power within that time.

Note: for each swing, at least one random sample of a soft-start should be recorded in the standard form and submitted to DOC for every rotation (see Appendix 2 of the Code).

4.3.6 Line turns

As noted in the MMIA (Section 3.2), acquisition will continue during line turns and the acoustic source will continue at full power during this time.

4.4 Species of Concern

The full list of Species of Concern (SOC) as defined by the Code is shown in Addenda 1 below.

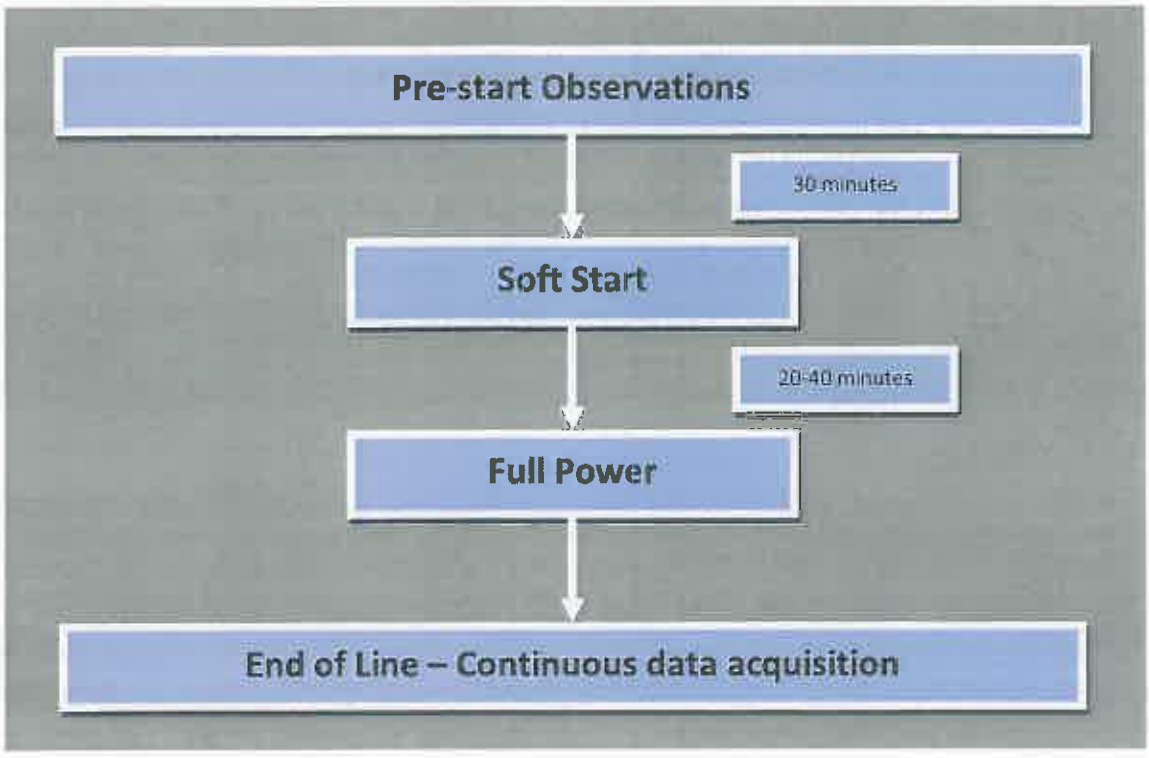


Figure 2: Seismic operations mitigation procedure.

4.5 Mitigation zones

The Code stipulates standard mitigation zones for Level 1 surveys. However, based on assessment of the acoustic source to be used and the nature of the survey area, a revised (i.e. larger) mitigation zone has been specified for SOC (without calves). Details are outlined in the MMIA (section 5.1.2.1) and a summary (MMIA, Section 2.3.1) is provided below:

"The Code of Conduct also requires that Sound Transmission Loss Modelling (STLM) is undertaken when operating a MSS in an AEI to validate the mitigation zones in the Code of Conduct. The STLM is based on the specific configuration of the ECPB 2D MSS acoustic array and the environmental conditions (i.e. bathymetry (which includes all the canyons and trenches within the modelled area), substrate, water temperature and underlying geology) within the ECPB Operational Area. The Code of Conduct states that if Sound Exposure Levels (SEL's) are predicted to exceed 171 dB re 1μPa^2.s (behaviour criteria) corresponding to the relevant mitigation zones for Species of Concern or 186 dB re 1μPa^2.s (injury criteria) at 200 m, consideration will be given to either extending the radius of the mitigation zones or limiting acoustic source power accordingly.

The STLM is discussed in more detail in [MMIA] Section 5.1.2.1 however the results are briefly summarised here as all the mitigation zones have been increased following the STLM. As a result the revised mitigation zones need to be incorporated into the operational procedures for the ECPB 2D MSS within this section.

STLM showed that 100% of SEL's greater than 186 dB re 1μPa2.s were within 330 m of the acoustic source and 100% of SEL's were below 171 dB re 1μPa2.s at 2.05 km from the acoustic source. Therefore, due to SEL's of 171 dB re 1μPa2.s and 186 dB re 1μPa2.s being greater than the standard mitigation zones stated in the Code of Conduct, the mitigation zones will be increased for the ECPB 2D MSS throughout the entire ECPB Operational Area.

The STLM was modelled at worst case, in the shallowest part of the ECPB Operational Area and the SEL's decrease as the depth increases further offshore (MMIA Section 5.1.2.1). The increased mitigation zones will be incorporated throughout the ECPB Operational Area, so as to take a conservative approach for the duration of the MSS, as most of the ECPB Operational Area have SEL's lower than the worst case scenario modelled and what the increased mitigation zones have been based on.

The mitigation zone for Species of Concern with and without calve present will be increased to 2.1 km following the STLM indicating this distance is compliant with the behaviour criteria requirements within the Code of Conduct. Whereas the mitigation zone for 'other marine mammals' will be increased to 350 m following the STLM results."

Therefore the mitigation zones for this survey are (

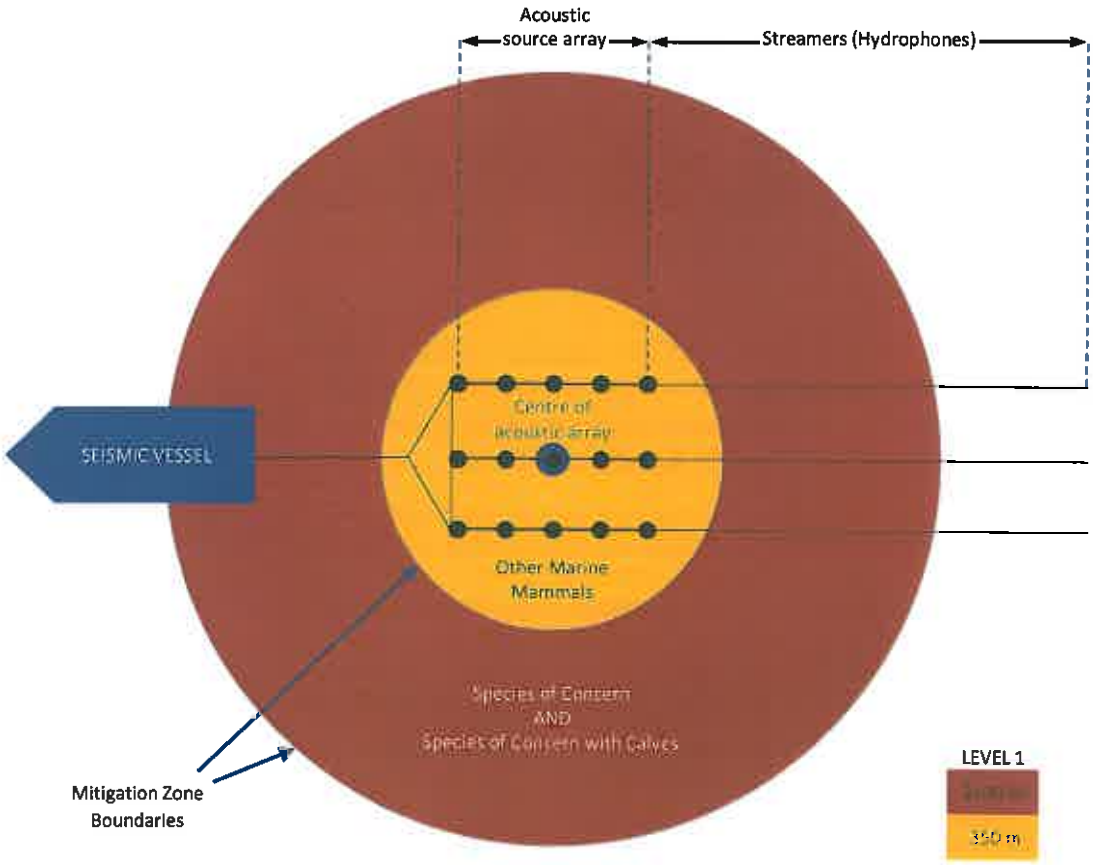


Figure 3):

1) 2.1 km from the centre of the acoustic source for SOC **with** calves;
2) 2.1 km from the centre of the acoustic source for SOC **without** calves; and
3) 350 m from the centre of the acoustic source for all other marine mammals.

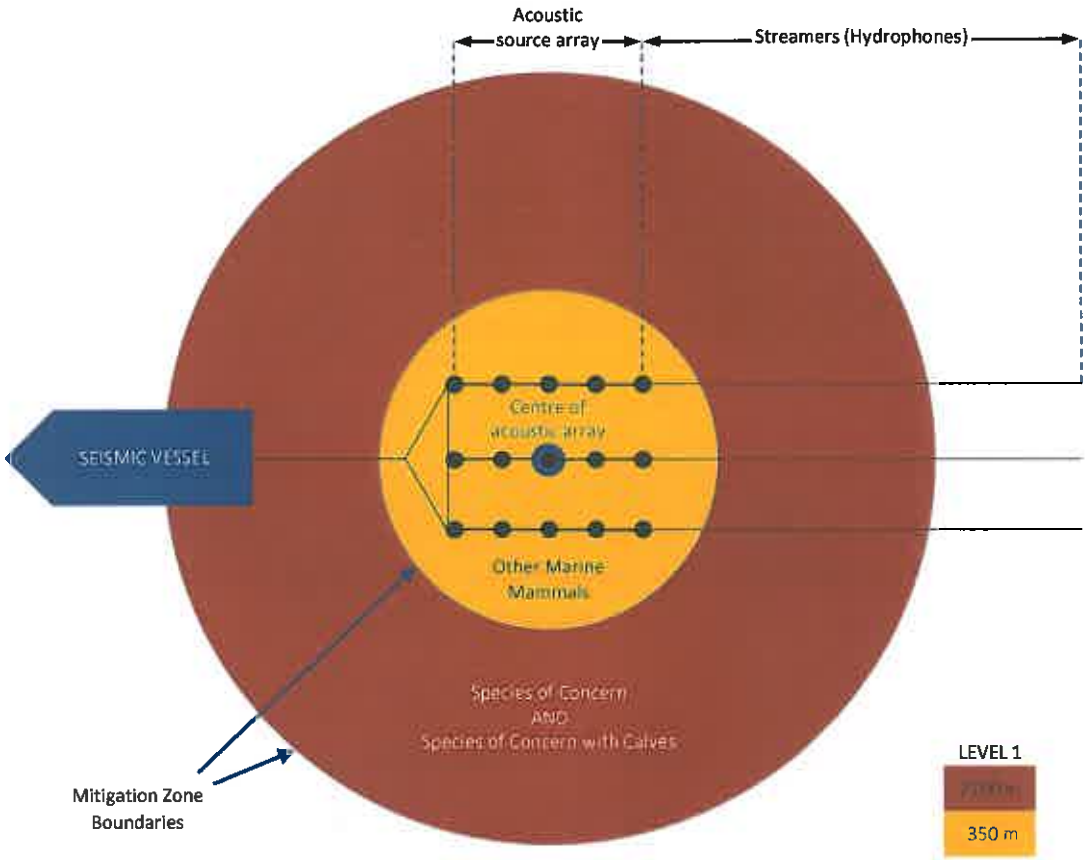


Figure 3: Mitigation Zone Boundaries for the Schlumberger East Coast and Pegasus Basin Multiclient 2D Marine Seismic Survey.

NOTE: The mitigation zone for SOC is larger than that identified in the Code and MMOs must be familiar with this.

4.5.1 PAM and calves

PAM cannot distinguish calves from adults, the Code therefore requires the proponent to apply the precautionary principle and the 2.1 km mitigation zone for any cetacean SOC detected by PAM.

PAM operators must be familiar with this requirement

4.6 Mitigation actions

In the event that marine mammals are detected by the observer within the designated mitigation zones of **2.1 km** and **350 m**, the observer will either delay the start of operations or shut down the source. These mitigation actions will apply to:

4.6.1 Species of Concern with calves

If during pre-start observations or when the acoustic source is active (including soft starts) the observer (MMO or PAM operator) detects at least one cetacean SOC with a calf within 2.1 km of the source, start up will be delayed, or the source will be shut down and not reactivated until:

1) The observer confirms the group has moved to a point that is more than 2.1 km from the source; or

2) Despite continuous observation, 30 minutes has elapsed since the last detection of the group within 2.1 km of the source, and the mitigation zone remains clear.

In regard to cetacean SOC with a calf note that the requirements above apply to the entire group containing that calf. An explanatory note from DOC[5] " *Yes, whole group has to be seen to move beyond zone, or not be seen for 30 mins*", and "*The intent of this provision is that since a group of marine mammals containing one calf has potential to contain more (and at distance it may be hard to follow movement of the cow/calf pair), the same precaution should apply to all the individuals*".

Due to the limited detection range of current PAM technology for ultra-high frequency cetaceans[6] (<300 m), any such bioacoustic detections will require an immediate shutdown of an active survey or will delay the start of operations, regardless of signal strength, or whether distance or bearing from the acoustic source has been determined. Shutdown of an activated acoustic source will not be required if visual observations by a qualified MMO confirm that the acoustic detection was of a species falling into the category of 'Other Marine Mammals'.

It is also recommended that observers monitor the area immediately beyond the 2.1 km mitigation zone. If SOC are approaching this zone, observers notify the seismic operator that a shutdown may be required.

4.6.2 Species of Concern without calves

If during pre-start observations or when the acoustic source is active (including soft starts) the observer (MMO or PAM operator) detects a SOC (without calves) within 2.1 km of the source, start up will be delayed, or the source will be shut down and not reactivated until:

1) The observer confirms the SOC has moved to a point that is more than 2.1km from the source; or

2) Despite continuous observation, 30 minutes has elapsed since the last detection of the SOC within 2.1 km of the source, and the mitigation zone remains clear.

It is a requirement that due to the range limitations of PAM, all acoustic detections of cetaceans using ultra high frequency vocalisations (e.g. Maui's or Hector's dolphins) trigger an immediate shutdown of an active survey or delay the start of operations unless a MMO confirms that vocalisations do not emanate from such a SOC. This is because the maximum effective detection range of ultra-high frequency vocalisations from the PAM equipment under these general operational conditions (i.e. background noise levels) is in the order of 300-400 m.

4.6.3 Other Marine Mammals

If, during pre-start observations prior to initiation of a Level 1 acoustic source soft start, a qualified observer detects a marine mammal within 350 m of the source, start up will be delayed until:

- A qualified observer confirms the marine mammal has moved to a point that is more than 350 m from the source, or
- Despite continuous observation, 10 minutes has passed since the last detection of a New Zealand fur seal within 350 m of the source and 30 minutes has elapsed since the last

[5] Email to BPM from Mr Tara Ross-Watt, DOC Senior Adviser - International and Marine; 17 December 2012.
[6] For the purposes of the Code, ultra-high frequencies are defined as those between 30 and 180 kHz - e.g. Maui's or Hector's dolphins.

detection of any other marine mammal within 350 m of the source, and the mitigation zone remains clear.

If all mammals detected within the relevant mitigation zones are observed moving beyond the respective areas, there will be no further delays to initiation of soft start.

Note: The presence of "Other Marine Mammals" within 350 m of the source will not result in a shutdown if the source is active, it can only result in a delay to start up of the source.

MMOs should pay particular attention to the reactions and behaviour of NZ fur seals in close proximity to the source, with particular attention paid to their behaviour when the acoustic source is fired. The aim is to build knowledge of the effects of seismic noise on the behaviour of this species.

4.6.4 Mitigation posters and summary

Refer to Addenda 2 of this MMMP for posters detailing mitigation action procedures.

5. Further Mitigation Measures

The following additional mitigation measures will be implemented during this survey and are over and above those identified in the Code. They have been agreed by DOC following discussions between Schlumberger and DOC.

1) **Autopsy of any stranded marine mammals during the survey**

   While conducting the ECPB 2D MSS, Schlumberger will have Massey University perform a necropsy on any marine mammals that may be found dead and cannot be attributed to shark attacks or vessel collisions, inshore of the ECPB Operational Area, along the Hawkes Bay, Wairarapa, Wellington, Marlborough, Kaikoura and north Canterbury coastline and bound by Mahia Peninsula, Tory Channel and Banks Peninsula during the ECPB 2D MSS and for a period two weeks after the ECPB 2D MSS is completed. MMOs should report any dead marine mammals seen in the operational area to DOC immediately.

2) **MMOs to maintain observations when outside the operational area**

   The *Aquila Explorer* will travel to the ECPB Operational Area from its previous seismic survey. On transit to the ECPB Operational Area, an MMO will be on the bridge to observe for any marine mammals that would add to the knowledge and distribution of marine mammals around NZ.

   Any marine mammal observations outside the ECPB Operational Area will be recorded in the 'Off Survey' forms developed by DOC. Any Maui's dolphins observed will be reported immediately to DOC.

6. Notifications to DOC

A written report will be submitted to the Director-General of DOC at the earliest opportunity, but no longer than 60 days after completion of survey.

If a situation arises that requires a more direct line of communication from the observers to DOC, then the MMO Team Leader is to first inform the Party Chief of the issue and intended action. The following table summarises the situations when DOC (in effect, the Director-General) should be notified

immediately. During this survey, the first point of contact within DOC is Ian Angus or If a response is required urgently then telephone, but in all other circumstances use email. Should Ian Angus be unavailable, please phone 0800DOCHOT and state the information as outline in Section 3.1.

Table 2: Events that require DOC to be notified.

Situation	Timing of notification	Comments
The PAM system becomes non-operational	Immediate	This refers to when both primary and backup systems are non-operational
Any instances of non-compliance with the Code	Immediate	This is a standard requirement under the Code and includes instances where the operational capacity notified in the MMIA is exceeded – refer section 4.3.2 of this MMMP.
Observation of any dead marine mammals seen in the operational area	Immediate	MMOs should report to DOC immediately any dead marine mammals seen in the survey operational area
If PAM is being repaired, and operations continue without active PAM for maximum of 2 hours 20 mins per event	As soon as practicable	DOC is notified via email as soon as practicable with the time and location in which operations began without an active PAM system (Code 4.1.2)

Addenda 1: Species of Concern as defined in the Code

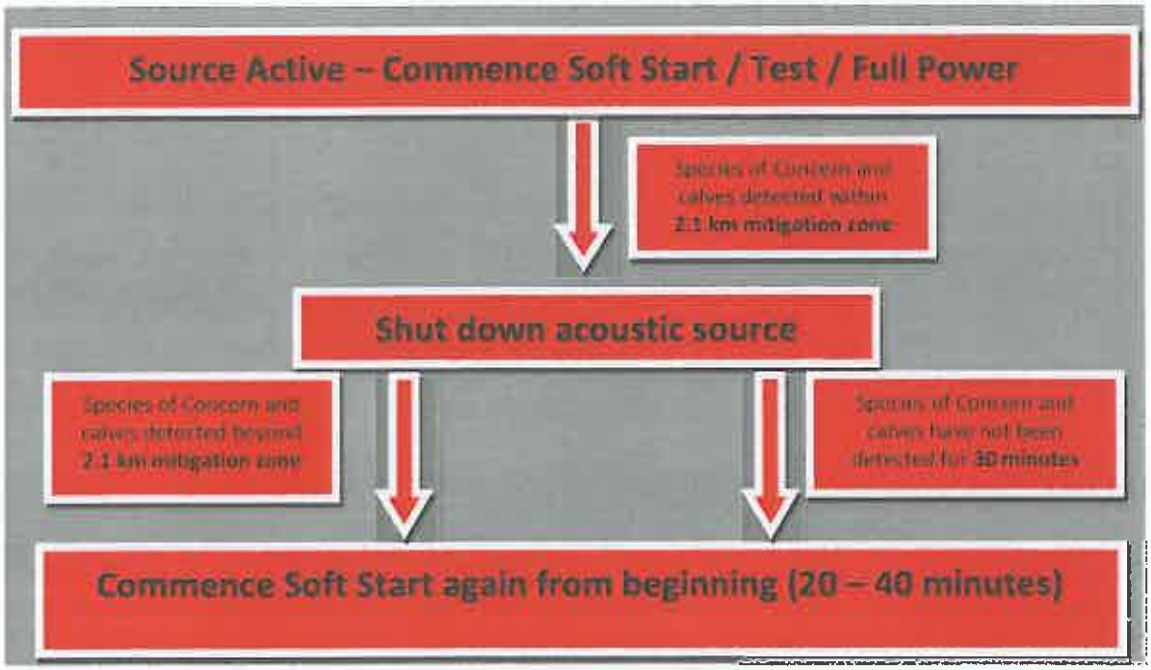
Common name	Latin name
Andrew's beaked whale	*Mesoplodon bowdoini*
Antarctic minke whale	*Balaenoptera bonarensis*
Arnoux's beaked whale	*Berardius arnuxii*
Blainville's beaked whale	*Mesoplodon densirostris*
Blue whale	*Balaenoptera musculus*
Bottlenose dolphin	*Tursiops truncatus*
Bryde's whale	*Balaenoptera edeni*
Cuvier's beaked whale	*Ziphius cavirostris*
Dwarf Minke whale	*Balaenoptera acutorostrata subsp*
Dwarf sperm whale	*Kogia simus*
False killer whale	*Pseudorca crassidens*
Fin whale	*Balaenoptera physalus*
Ginkgo-toothed whale	*Mesoplodon ginkgodens*
Gray's beaked whale	*Mesoplodon grayi*
Hector's beaked whale	*Mesoplodon hectori*
Hector's dolphin	*Cephalorhynchus hectori*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Maui's dolphin	*Cephalorhynchus hectori maui*
Melon-headed whale	*Peponocephala electra*
New Zealand sea lion	*Phocarctos hookeri*
Pygmy/Peruvian beaked whale	*Mesoplodon peruvianus*
Pygmy blue whale	*Balaenoptera musculus brevicauda*
Pygmy killer whale	*Feresa attenuata*
Pygmy right whale	*Caperea marginata*
Pygmy sperm whale	*Kogia breviceps*
Sei whale	*Balaenoptera borealis*
Shepherd's beaked whale	*Tasmacetus shepherdi*
Short-finned pilot whale	*Globicephala macrorhynchus*

Southern Bottlenose whale	*Hyperoodon planifrons*
Southern right whale	*Eubalaena australis*
Southern right whale dolphin	*Lissodelphis peronii*
Sperm whale	*Physeter macrocephalus*
Strap-toothed whale	*Mesoplodon layardii*
True's beaked whale	*Mesoplodon mirus*

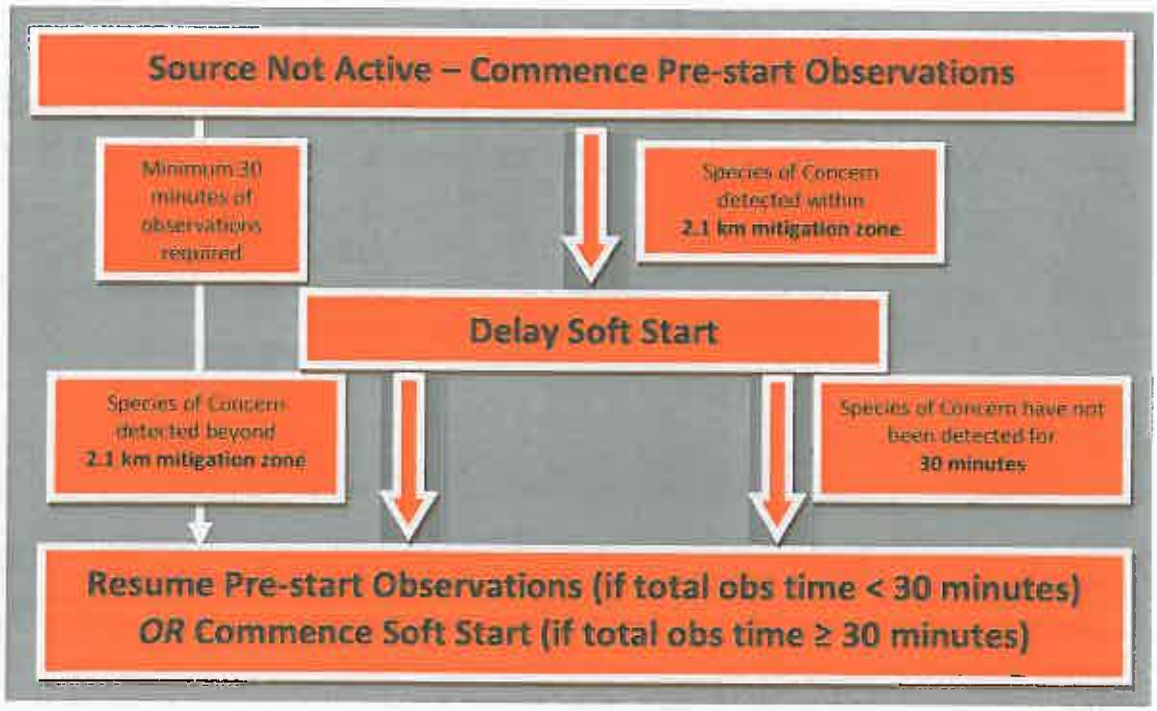
Addenda 2: Mitigation Procedures – Good Sighting Conditions (poster format)

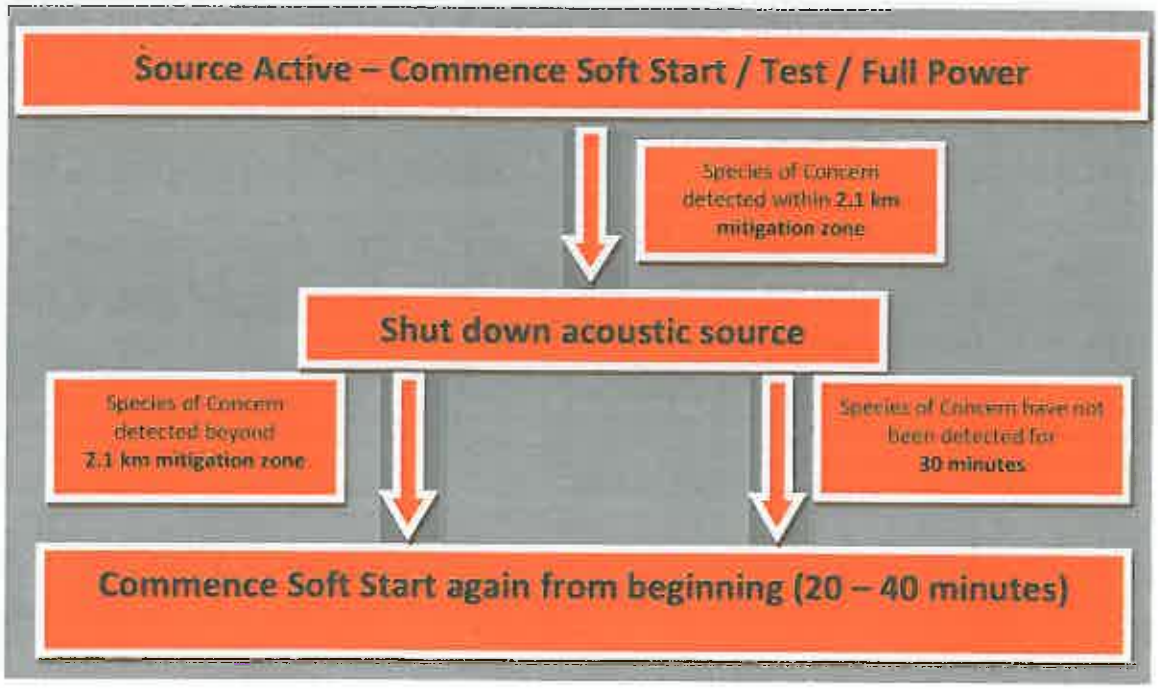
The following posters depict mitigation procedures. It is recommended they be posted in the instrument room, the PAM station and on the bridge. Operational flowcharts are also found in Appendix 4 of the Code.

Species of Concern with Calves within 2.1 km of Acoustic Source



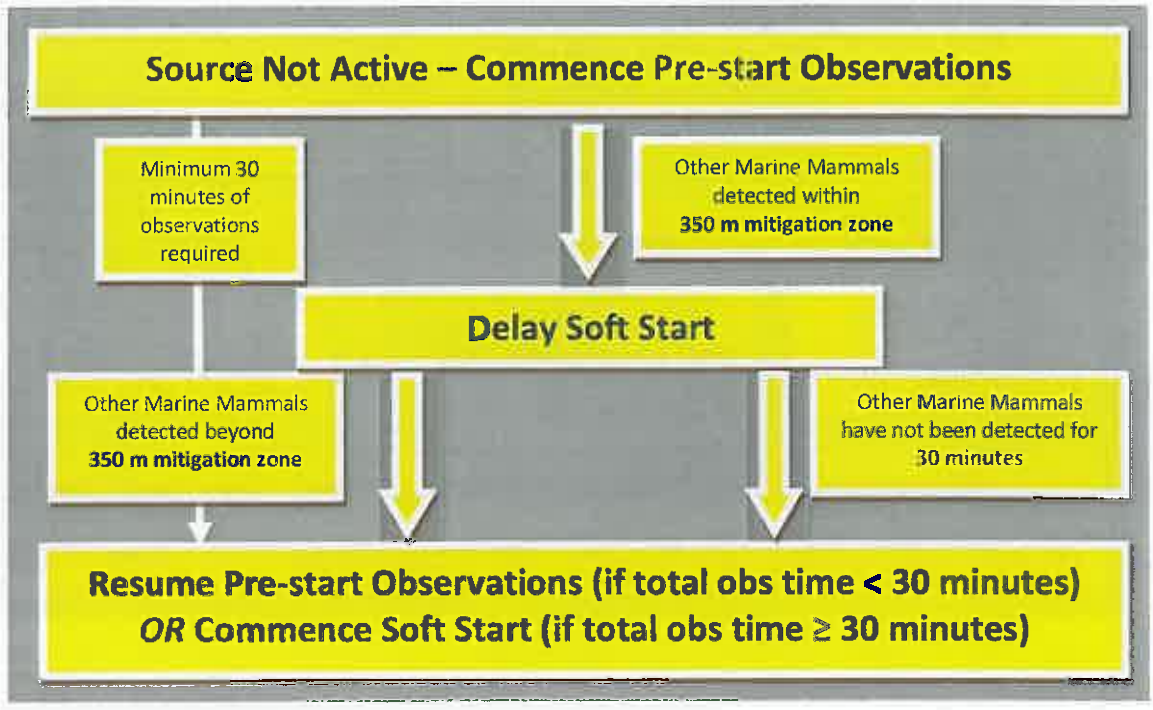
Species of Concern (no Calves) within 2.1 km of Acoustic Source





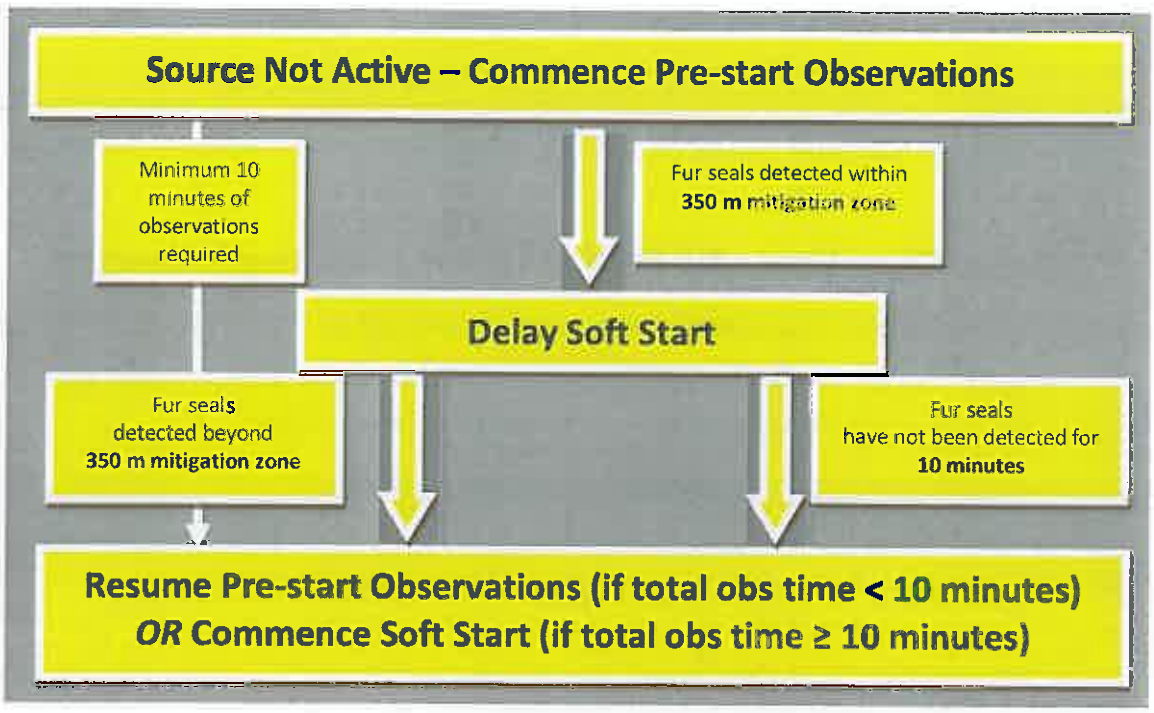
Other Marine Mammals within 350 m of Acoustic Source

(excluding fur seals – see below)



BLUE PLANET MARINE

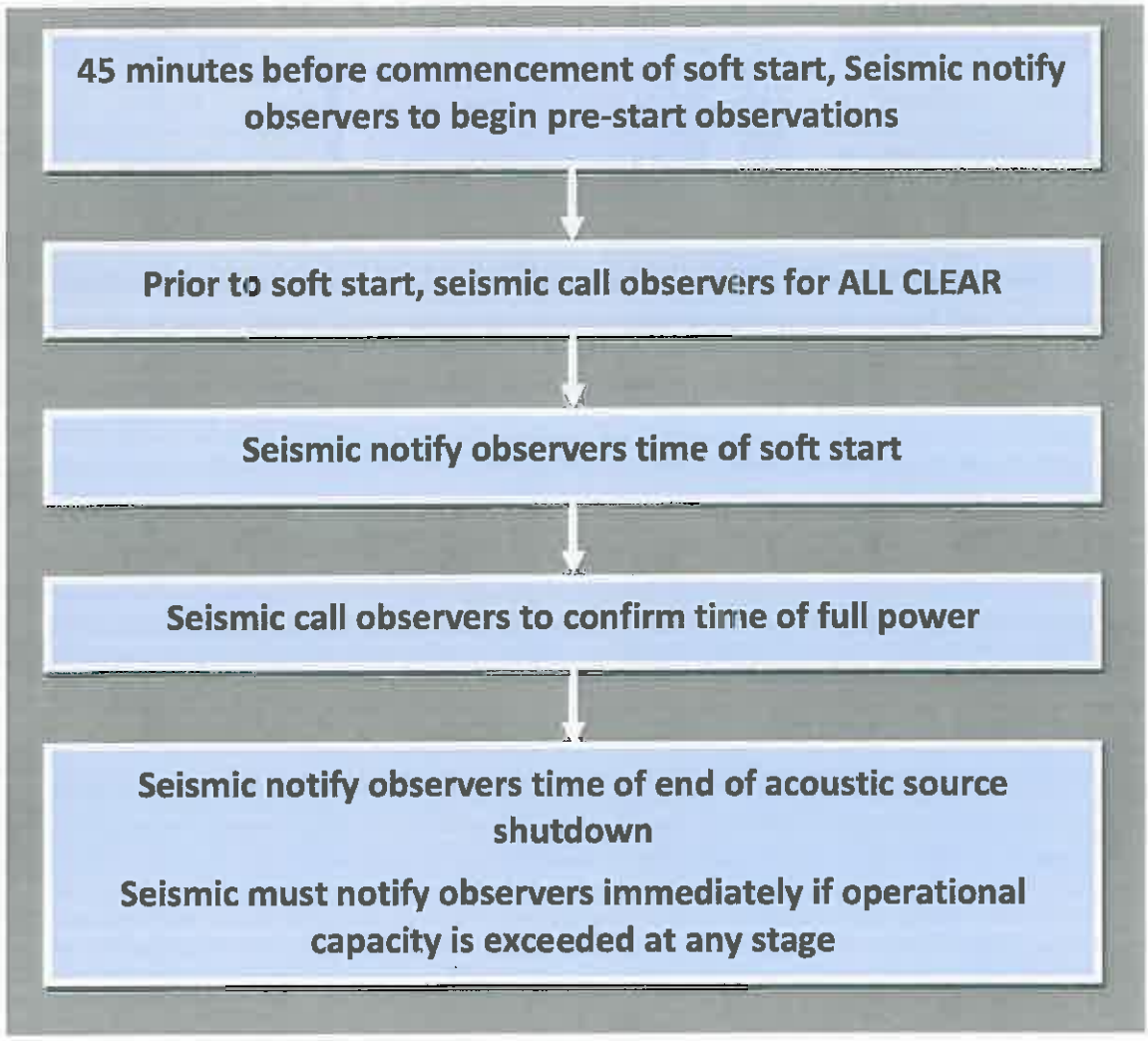
Fur seals within 350 m of Acoustic Source



Addenda 3: Recommended Communication Protocols (poster format)

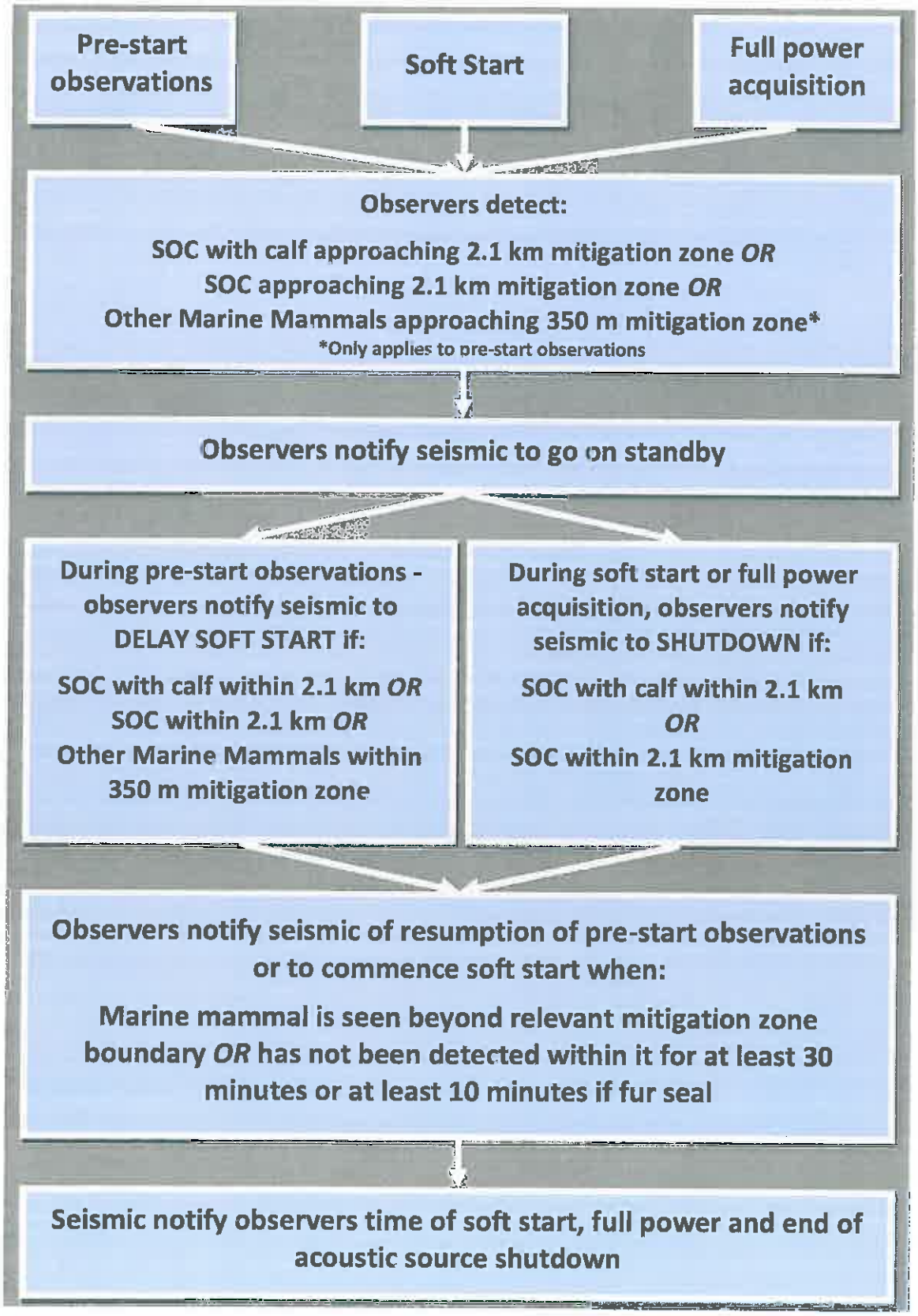
Note: Seismic control room to immediately notify observers (MMO and PAM) of any changes in the status of acoustic source

Normal Operations - No Marine Mammal Sighting/Detection



BLUE PLANET MARINE

Delayed Soft Start or Shutdown – Marine Mammal Sighting/Detection



APPENDIX 5

Sound Transmission Loss Modelling

Curtin University

Centre for Marine Science and Technology

East Coast and Pegasus Multiclient 2D Seismic Survey Underwater Sound Exposure Modelling

Prepared for:

Schlumberger Australia Pty Ltd / Schlumberger Seco Inc.

Prepared by: Matthew Koessler and Alec Duncan

PROJECT CMST 1286
REPORT 2014-15

18th March 2014

Summary

This report describes acoustic propagation modelling that was carried out to predict received sound exposure levels from the East Coast and Pegasus Multiclient 2D seismic survey. The modelling method used to produce these results accurately deals with both the horizontal and vertical directionality of the airgun array, and with water column and seabed variations in depth and range.

Modelling predicted that the maximum sound exposure levels produced by the Aquila 6300 cubic inch array operating within the survey area would be between 189.0 and 187.4 dB re 1 $\mu Pa^2.s$ at a range of 200 m, between 175.8 and 173.2 dB re 1 $\mu Pa^2.s$ at a range of 1 km, and between 173.1 and 170.0 dB re 1 $\mu Pa^2.s$ at a range of 1.5 km, with the higher levels occurring in the shallowest water depths.

The maximum sound exposure levels were predicted to drop below 186 dB re 1 $\mu Pa^2.s$ at ranges between 240 m and 330 m, and below171 dB re 1 $\mu Pa^2.s$ at ranges between 1.4km and 2.05 km, with the longer ranges corresponding to the shallowest water.

Long range modelling results were highly directional due to the combination of airgun array directionality and variable bathymetry, but showed the expected rapid attenuation inshore of the source and slow attenuation offshore.

Contents

List of Figures

1 Introduction

This report describes acoustic propagation modelling which was carried out to predict received sound exposure levels from the 2D Pegasus seismic survey in order to establish whether the survey meets the sound exposure level requirements of the New Zealand Department of Conservation 2012 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations. The Code requires modelling to determine whether received sound exposure levels will exceed 186 dB re 1 $\mu Pa^2.s$ at a range of 200m from the source, or 171 dB re 1 $\mu Pa^2.s$ at ranges of 1km and 1.5km.

The survey spans the offshore area of New Zealand's North Island from Hawkes Bay to Cook Strait. The survey bounding polygon is shown below in Figure 1 and the operational area of the survey is shown in Figure 2.

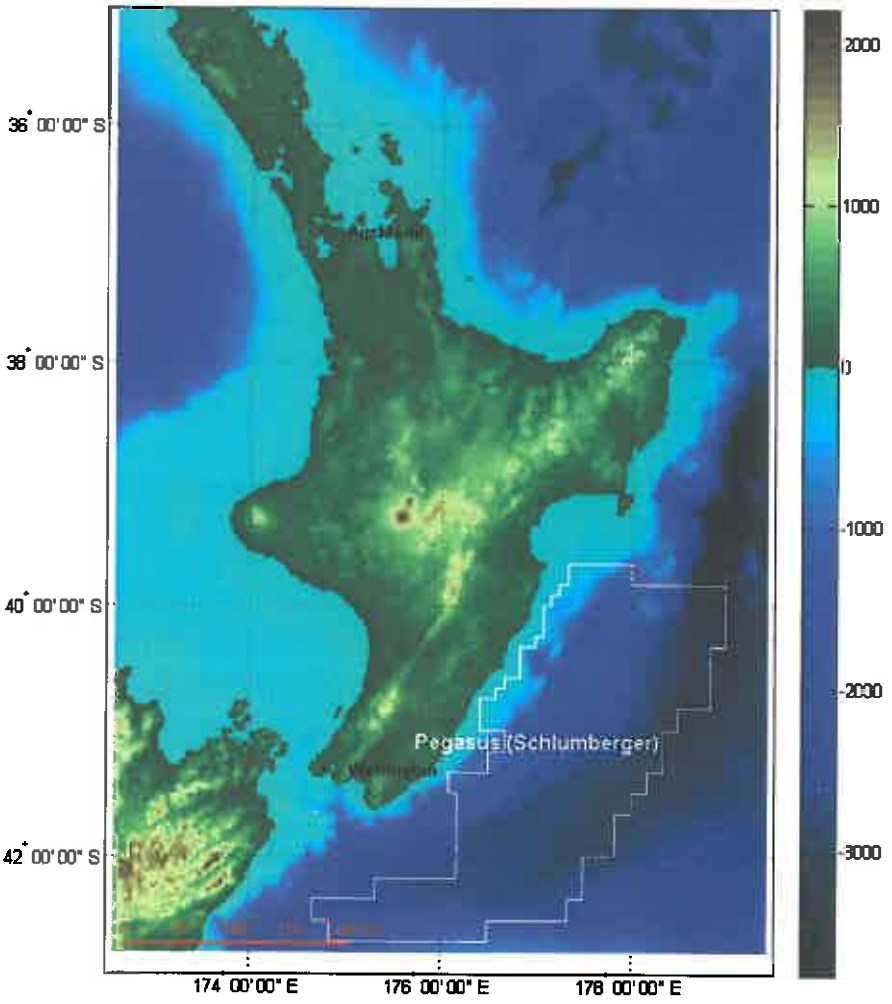


Figure 1. Map the New Zealand North Island showing the survey area, the white polygon shows the bounds of the survey.

The bathymetry within the survey area is complex; this is due to the large geographic footprint of the survey and New Zealand's past and present geologic-tectonic regime. The bathymetry data shown in Figure 1 and Figure 2 were obtained from the NIWA elevation and bathymetry grid (CANZ 2008).

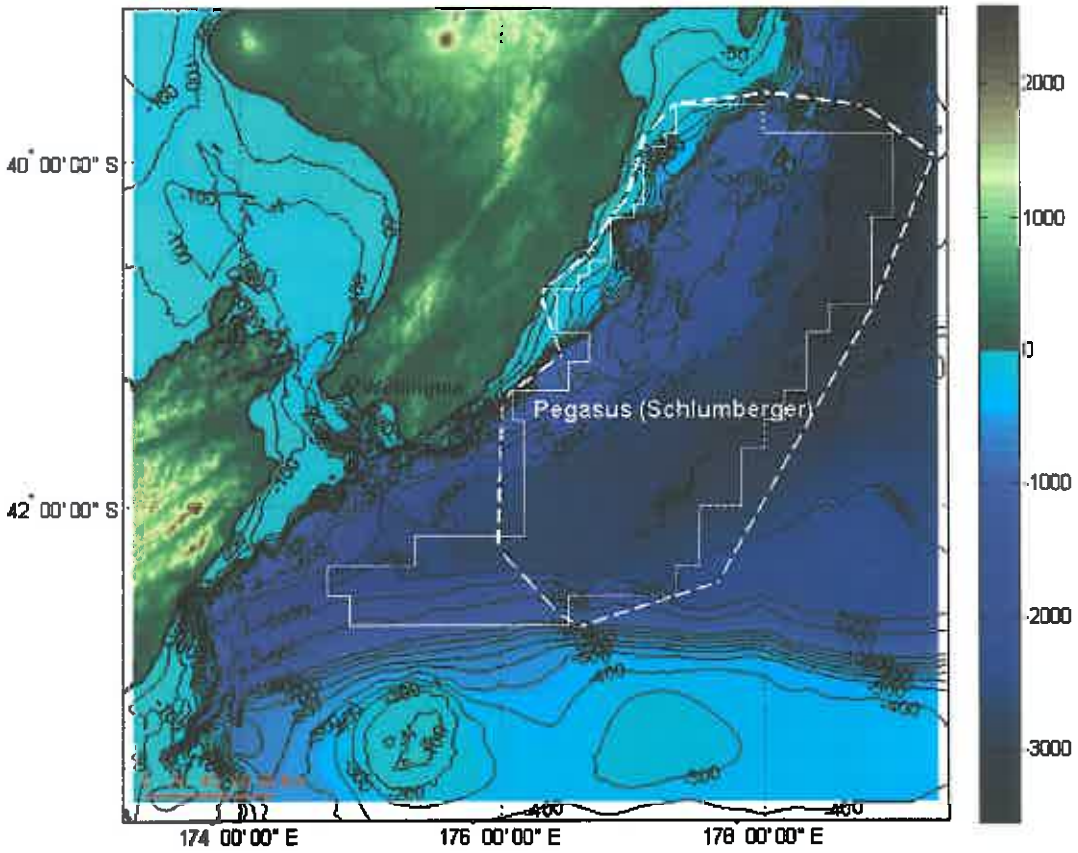


Figure 2. Bounding polygon of the survey (solid white), operational area of the survey (dashed white), and detailed bathymetry.

The offshore environment transitions from the continental shelf through the continental slope to the continental rise, however the active past and present geologic regime around New Zealand introduces some major geographic features into the environment. As such, the offshore region within the Pegasus seismic survey and the surrounding area is spatially complex.

This report details the sound propagation modelling of transmitted signals from the proposed airgun array configuration. Sound exposure levels are then calculated from these signals. The propagation modelling includes the complex environmental factors likely to be found within the survey region. Section 2 describes the methods used to carry out the

modelling and the results are presented in Section 3. Major conclusions are summarised in Section 4.

2 Methods

2.1.1 Source modelling

The airgun array proposed for this survey is the Aquila 6300 cubic inch array shown in Figure 3.

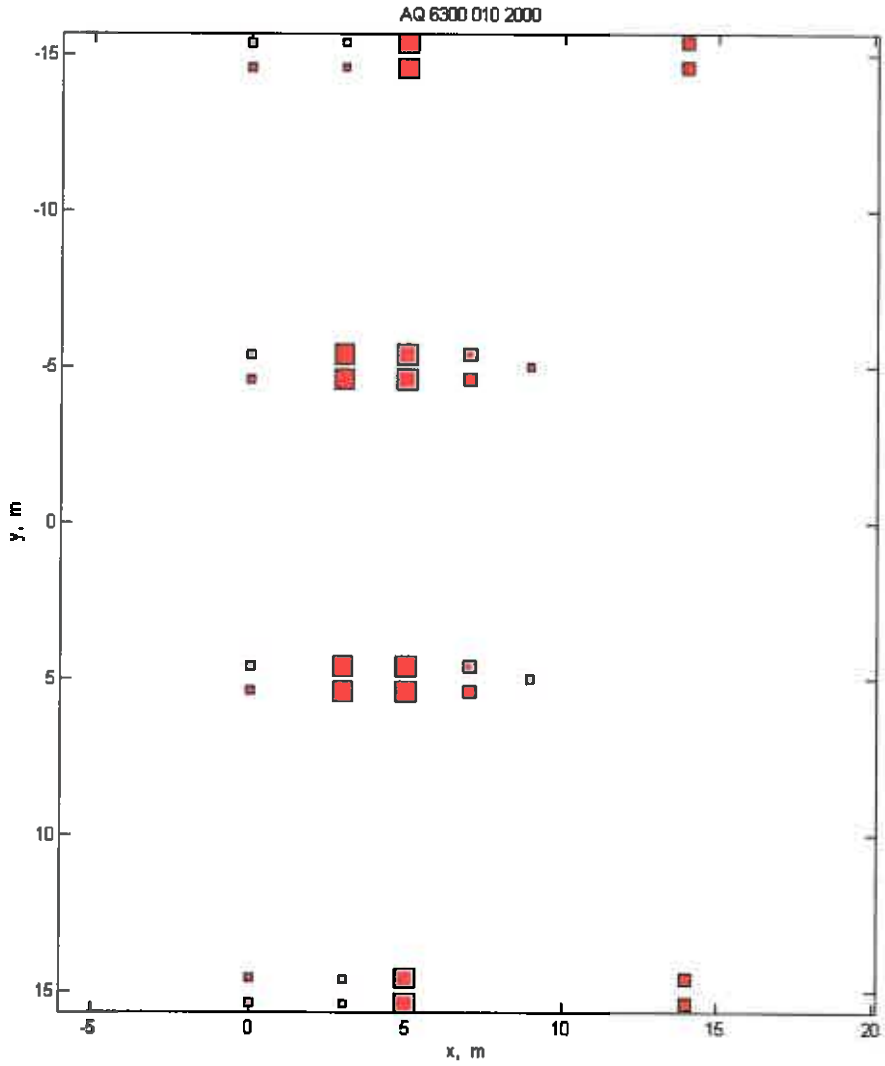


Figure 3. Plan view of the Aquila 6300cui array. Array elements are shown much larger than actual size but are scaled proportional to the cube root of their volume.

2.1.2 Modelling and calibration methods

Acoustic signals required for this work were synthesised using CMST's numerical model for airgun arrays. The procedure implemented for each individual source element is based on the bubble oscillation model described in Johnson (1994) with the following modifications:

- An additional damping factor has been added to obtain a rate of decay for the bubble oscillation consistent with measured data;
- The zero rise time for the initial pressure pulse predicted by the Johnson model has been replaced by a finite rise time chosen to give the best match between the high frequency roll-off of modelled and measured signal spectra;
- For the coupled-element model used in this work, the ambient pressure has been modified to include the acoustic pressure from the other guns in the array and from the surface ghosts of all the guns. Including this coupling gives a better match between the modelled signal and example waveforms provided by seismic contractors, but only has a minor influence on the spectrum of this signal and hence on the modelled received levels.

The model is subjected to two types of calibration:

- The first is historical and was part of the development of the model. It involved the tuning of basic adjustable model parameters (damping factor and rise time) to obtain the best match between modelled and experimentally measured signals, the latter obtained during sea trials with CMST's 20 in^3 air gun. These parameters have also been checked against several waveforms from larger guns obtained from the literature.
- The second form of calibration is carried out each time a new array-geometry is modelled, the results of which are presented below. Here, the modelled gun signals' amplitudes are scaled to match the signal energy for a far-field waveform for the entire array computed for the direction (including ghost) to that of a sample waveform provided by the Client's seismic contractor. When performing this comparison the modelled waveform is subjected to filtering similar to that used by the seismic contractor in generating their sample, or additional filtering is applied

to both data sets to emphasise a section of the bandwidth of the supplied data which CMST regards as being most reliable.

Beam patterns for the calibrated array were built up one azimuth at a time as follows:

- The distances from each gun to a point in the far-field along the required azimuth were calculated. (The far-field is the region sufficiently far from the array that the array can be considered a point source);
- The corresponding time delays were calculated by dividing by the sound speed;
- Computed signals for each gun were delayed by the appropriate time, and then these delayed signals were summed over the guns;
- The energy spectral density of the resulting time domain waveform was then calculated via a Fourier transform;
- During this procedure care was taken to ensure that the resulting spectrum was scaled correctly so that the results were in source energy spectral density units: dB re 1 $\mu Pa^2s/Hz$ @ 1m.

2.1.3 Source modelling results

Figure 4 shows a comparison between the example waveform and spectrum for the vertically downward direction provided by the client and those produced by the CMST airgun model after calibration. There are differences in detail but the general agreement is excellent.

In this case the provided example waveform was for an array depth of 10 m, and so this depth was used for model calibration. The CMST airgun model accounts for the effects of the resulting increase in hydrostatic pressure on the oscillation of the airgun bubbles, and hence on the radiated sound.

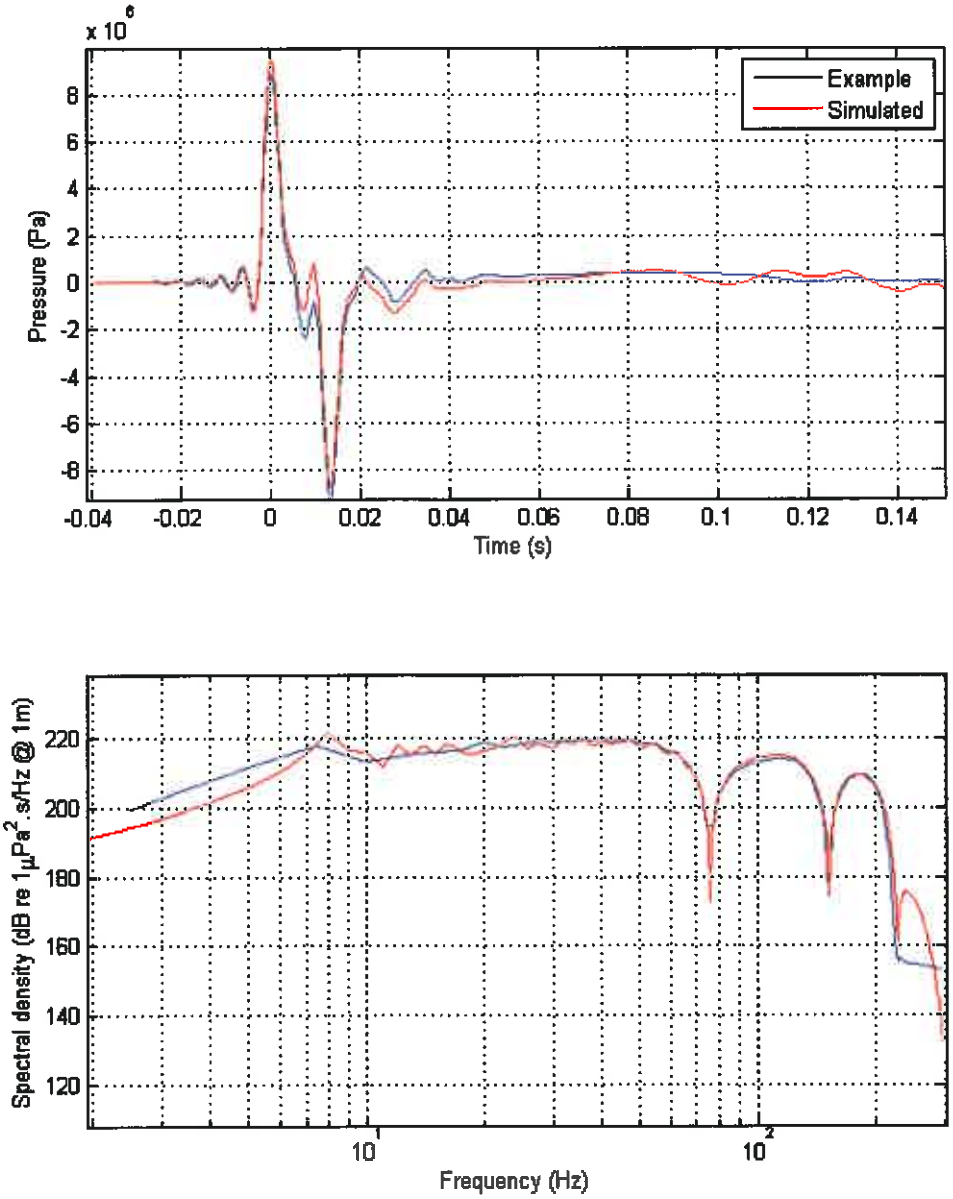


Figure 4. Comparison between the waveforms (top) and spectra (bottom) of the example signal for the vertically downward direction provided by the client (blue) and the signal produced by CMST's airgun array model (red).

Vertical and horizontal cross-sections through the frequency dependent beam pattern of the array are shown in Figure 5. These beam patterns demonstrate the strong angle and frequency dependence of the radiation from the airgun arrays. The horizontal beam pattern shows that in the horizontal plane a large amount of the high frequency energy is radiated in the in-line direction for this airgun configuration. A significant amount of energy is also radiated in the cross-line direction but only to mid frequencies. These beam

patterns are characteristic of an airgun array with wide spacing between elements or in this case wide spacing between sub-arrays.

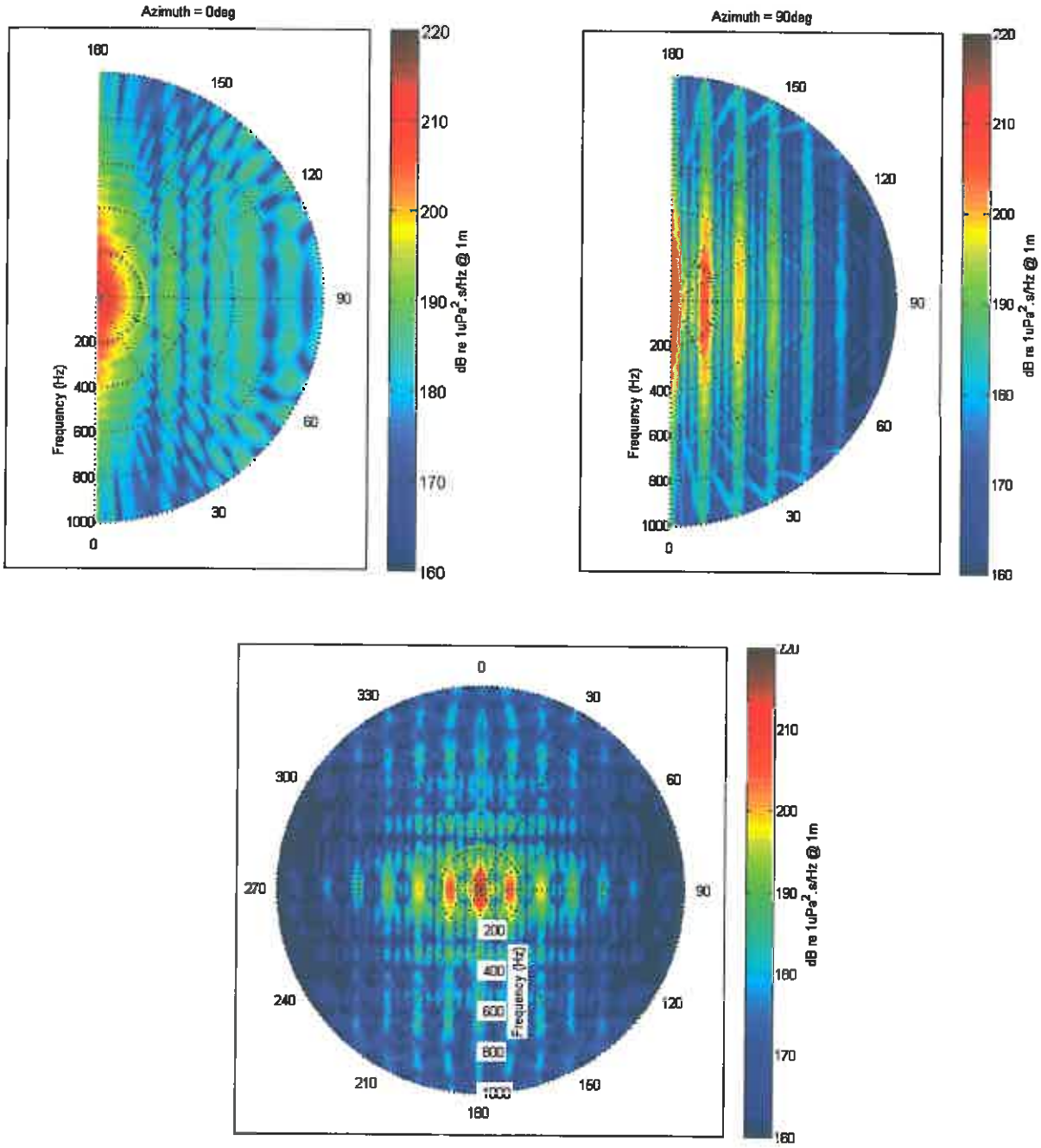


Figure 5. Array far-field beam patterns as a function of orientation and frequency (radial coordinate). The top two plots are for the vertical plane for the in-line direction (left) and cross-line direction (right). Zero elevation angle corresponds to vertically downwards. The bottom plot is for the horizontal plane with 0 degrees azimuth corresponding to the in-line direction.

2.1.4 Propagation modelling

2.1.4.1 Water-column properties

A representative sound velocity profile for the autumn months of the southern hemisphere was used to obtain the best estimate of the environmental conditions at the time of the proposed survey. This was obtained from the nearest grid point of the World Ocean Atlas (NOAA, 2005) and is shown in the two panels of Figure 6. The profile shows a mixed layer down to a depth of about 30 m. Below 30 m there is a reduction in sound speed with increasing depth which continues to a depth of about 1500 m. The profile for deep waters contains a duct between 500 m and 2500 m.

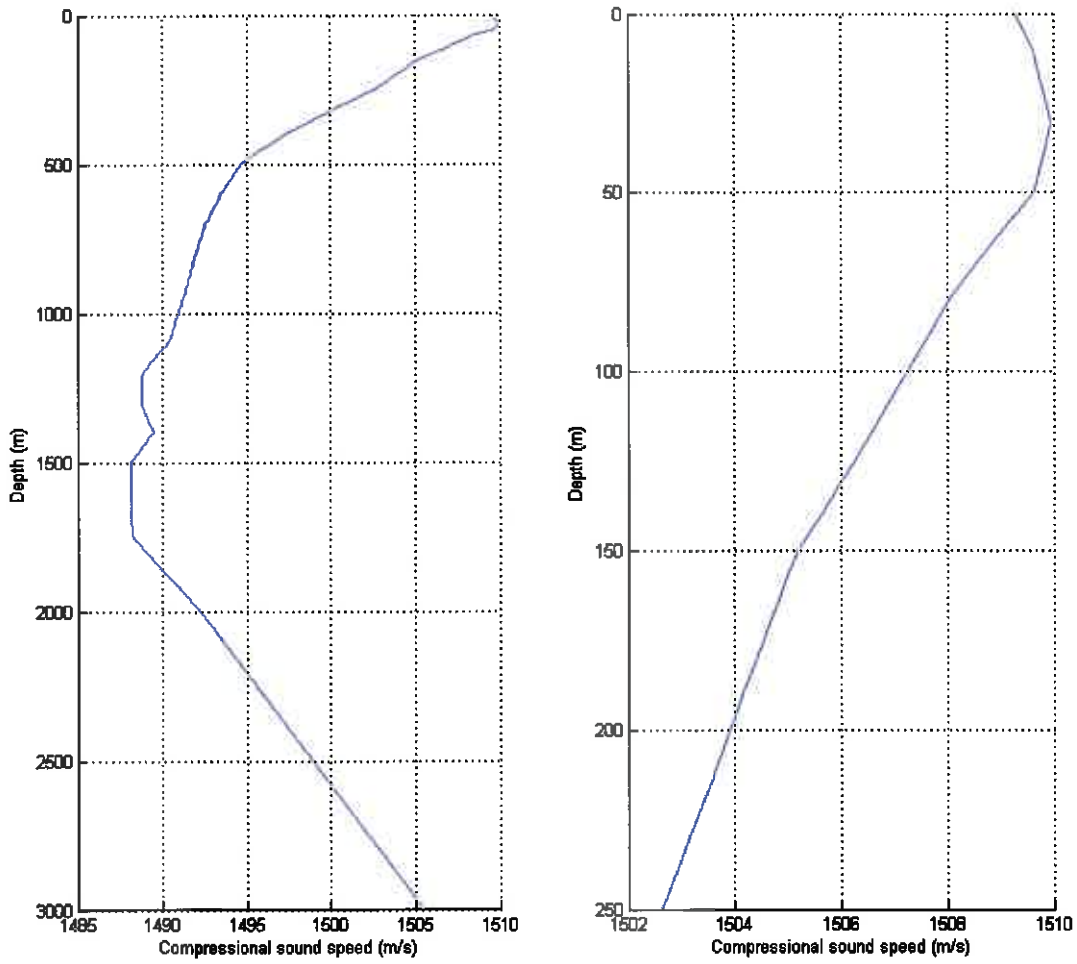


Figure 6. Sound velocity profiles obtained from NOA.
deep waters. *Right:* A sound velocity profile for shallow waters.

2.1.4.2 Regional geoacoustic models & bathymetry

Since the survey spans an area of complex bathymetry, seven geoacoustic regions representing different bottom types were used. These regions are shown in Figure 7. The regions were chosen to represent the probable bottom sediment compositions and sub-bottom layering. The bottom models for each region were based on information from published literature on New Zealand regional seabed geology and the acoustic properties of marine sediments. For all the regions defined, elastic propagation parameters were ignored. When limited information is known about sediments and the average sediment composition consists of sand, silt, and clay, neglecting elastic effects is a reasonable approximation (Jensen, Kuperman, Porter, & Schmidt, 2011). The resulting seabed properties for each geoacoustic region are tabulated below in Table 1.

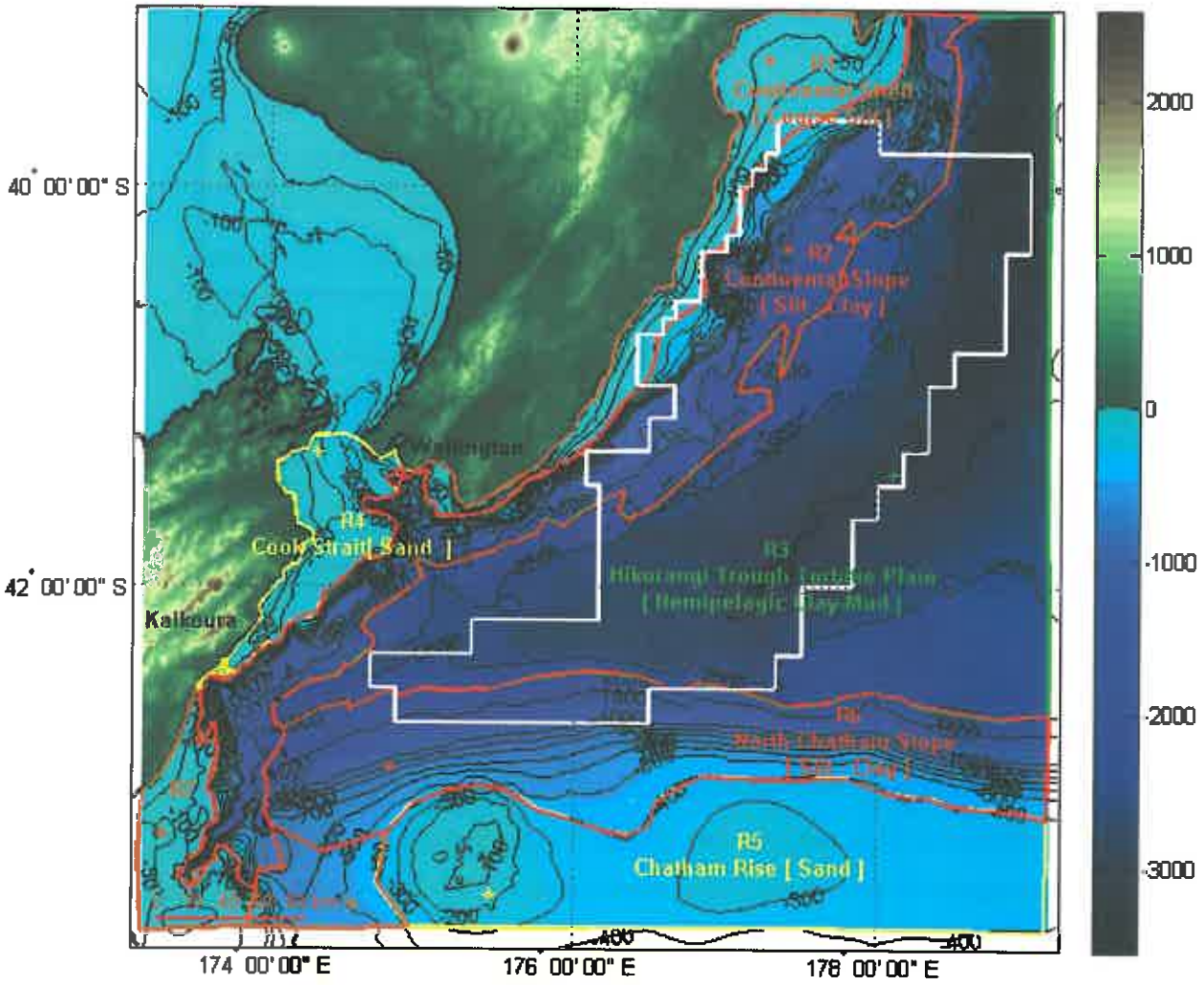


Figure 7. Geoacoustic regions for the Pegasus 2D seismic survey.

Table 1: Geoacoustic Properties for the regions in defined in Figure 7

Layer Sediment Description	Thickness (m)	Density ($kg.m^{-3}$)	Compress-ional wave speed ($m.s^{-1}$)	Compress-ional wave attenuation (dB per wavelength)
R1 Continental Shelf				
Coarse Silt Layer	50	1740 1798	1615 1676	0.4
Coarse Silt Half Space	N/A	1798	1676	0.4
R2 Continental Slope				
Silt – Clay Layer	50	1488 1546	1549 1610	0.1
Silt – Clay Half Space	N/A	1546	1610	0.1
R3 Hikurangi Trough (Turbidite Plain)				
Trubidite Plain Clay - Mud	50	1421 1578	1520 1581	0.1
Clay - Mud Half Space	N/A	1578	1581	0.1
R4 Cook Strait				
Fine Sand Half Space	N/A	1700	1856	0.8
R5 Chatham Rise				
Fine Sand Half Space	N/A	1700	1856	0.8
R6 North Chatham Slope				
Silt – Clay Layer	50	1488 1546	1549 1610	0.1
Silt – Clay Half Space	N/A	1546	1610	0.1
R7 Mernoo Saddle				
Coarse Silt Layer	50	1740 1798	1615 1676	0.4
Coarse Silt Half Space	N/A	1798	1676	0.4

The Northern area of the Pegasus survey spans the tectonically active Hikurangi margin where the Pacific plate subducts beneath the Australian plate (Davey et al., 1986). This tectonic regime creates mountain and river systems on the North Island and these systems output terrigenous sediments to the coastal marine environment (Carter, 1975; Griffiths & Glasby, 1985) . As such, the bottom sediments of the continental shelf and continental slope consist of detrital terrigenous sediment (Carter, 1975; Foster, Foster, & Carter,

1997; Orpin & Orpin, 2004). On the continental shelf, the sediment types range from fine and coarse sand near shore, to coarse silt at the shelf break (K. B. Lewis & Lewis, 1973). The detrital sediments are further transported down the continental slope by turbidity currents and a major submarine channel, the Hikurangi channel (K. Lewis, Lewis, & Pantin, 2002) . Clays and muds are predominantly deposited on the lower area of the margin (K. B. Lewis & Lewis, 1994). In general, sediments become finer away from the continental shelf to the lower areas of the turbidite plains. As such the R1, R2, and R3 regions represent this fining trend from the near shore to offshore areas.

In the Southeast, the survey bounds extend near the edge of Cook Strait. The shallow waters with minimal slope in the Cook Strait collect large amounts of sediments (Churchman et al., 1988; Griffiths & Glasby, 1985). These sediments can range from coarse gravels to sands (Carter & Carter, 1992). However for the purpose of this work an average bottom sediment type of sand was chosen for the R4 region representing Cook Strait.

The Southernmost extent of the Pegasus survey is bounded by the Chatham Rise and the Mernoo Saddle. The water depths over the Chatham Rise decrease from 1500 m to 300 m. Currents which travel up the South Island coast have scoured and redeposited sediments from the crest of the Chatham Rise to areas on its slopes (Carter, 1975; Carter, Carter, & Heath, 1975). The crest of the rise contains relict sand from this scouring process and the North Chatham slope contains a mix of fine sands, silts, and muddy clays (Barnes & Barnes, 1992, 1994). As such, R5 was modelled with a sand bottom and R6 an average sediment type of silt and clay, see Table 1. The region R7 contains both the Northern extent of the Mernoo Saddle and the upper limits of the Pegasus and Kaikoura canyons. The sediment type can vary within the region (Carter, Carter, Carter, & Griggs, 1982; K. Lewis, Lewis, & Barnes, 1999) but the literature supports an average sediment type similar to the R1 region. The bottom sediment type was then modelled as coarse silt.

With the likely bottom sediment types defined for the offshore area, the geoacoustic parameters for the regions R1 – R7 were taken from Hamilton (1980). Grainsize measurement reported in the literature (Barnes & Barnes, 1994; Carter et al., 1982; K. Lewis et al., 1999; K. B. Lewis & Lewis, 1973, 1994), were used to link the sediment type to sound speed parameters tabulated by Hamilton (1980). However, over time sediment can accumulate as layers. The sediment thickness of continental shelf and slope off

Hawkes Bay and the Kaikoura Peninsula has been estimated at an average thickness of 50 m (Carter et al., 1982; K. B. Lewis, 1973). The regions R1, R2, R3, R6 and R7 were modelled with a 50 m thick sediment layer.

For layers of unconsolidated sediments compaction and porosity reduction can change the sound propagation parameters within a layer (Jensen et al., 2011). Therefore, a gradient between the top and the bottom of the sediment layer for the regions R1, R2, R3, R6, and R7 was used. Both the compressional wave speed (Hamilton, 1979) and density (Hamilton, 1976) increased linearly with depth within this gradient layer.

2.1.4.3 Short Range Modelling

2.1.4.3.1 Choice of propagation modelling codes

The short ranges involved in this component of the modelling made it possible to use the range independent propagation modelling code SCOOTER (Michael B. Porter, 2007) for this work. SCOOTER is a wavenumber integration code, which is stable, reliable, and can deal with arbitrarily complicated fluid and/or solid seabed layering. It cannot, however, deal with changes of water depth with range, and is therefore considered a range independent model, but that is unimportant in this particular application.

2.1.4.3.2 Source Locations and Seabed Properties

Three representative sources locations S1, S2, and S3 were chosen to model the short range sound propagation in various water depths and over various bottom types. The locations are shown in Figure 8 . These locations were chosen to model various scenarios where the greatest amount of sound energy would propagate in the ocean

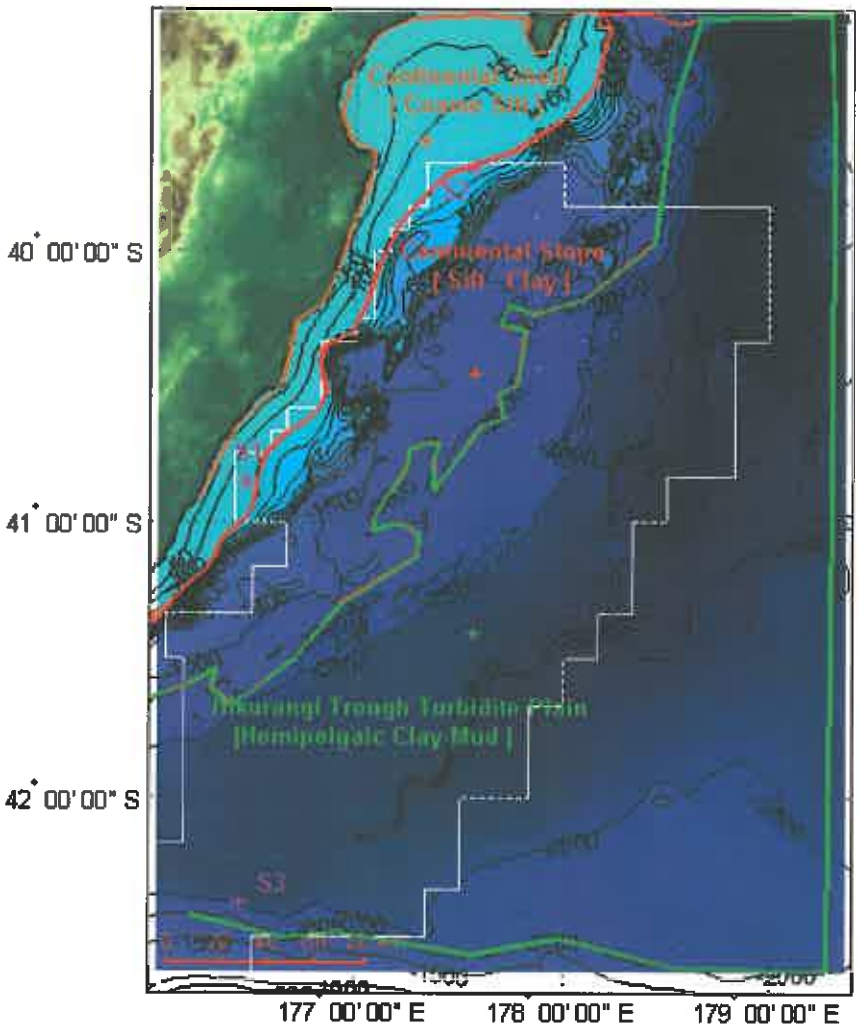


Figure 8. Source locations for short range modelling within the Pegasus survey region (magenta asterisks labelled S1, S2 and S3).

2.1.4.4 Long Range Modelling

2.1.4.4.1 Choice of propagation modelling codes

For longer ranges the effects of varying water depth are important and it was necessary to use a range dependent model. In this case the parabolic equation code RAMGeo (Collins, 1993) was used. This code is well tested and reliable but can only deal with fluid seabeds.

2.1.4.4.2 Source Locations and Seabed Properties

A single source location was chosen to model long range sound propagation. This source location is labelled S4 and is shown below in Figure 10. This location was chosen as being likely to produce the highest sound levels inshore of the survey area. Moreover, the location was chosen to give the maximum expected sound levels received at Kaikoura, located about 250 km away. Kaikoura is classed as a sensitive region as various Cetacean species congregate in the area and whale watching tours are an important part of the local tourism industry.

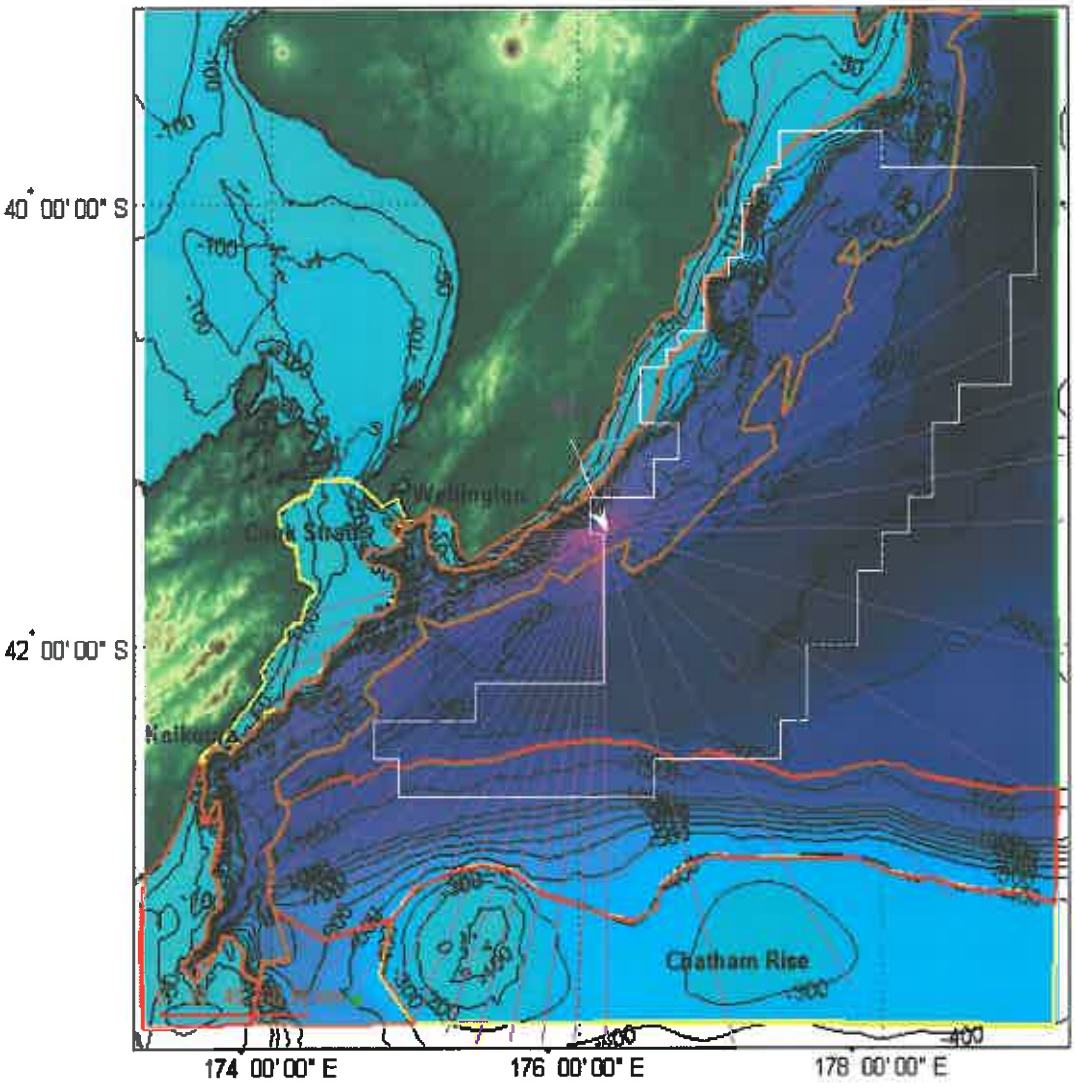


Figure 9. Geoacoustic regions and source location (S4) used for long-range modelling.

2.1.5 Sound exposure level (SEL) calculations

2.1.5.1 Short Range Modelling

At short ranges it is important to include both the horizontal and vertical directionalities of the airgun array, which requires summing the signals from the individual airguns at each receiver location. This process is accurate but very computationally demanding, and it is not feasible to apply it at ranges of more than a few kilometres.

Calculation of received sound exposure levels was carried out using the following procedure:

1. For each source location:
    a. SCOOTER was run at 1 Hz frequency steps from 2 Hz to 1000 Hz for a source depth corresponding to the depth of the airgun array (10 m). The output of SCOOTER at each frequency and receiver location is the ratio of the received pressure to the transmitted pressure. The ratio is a complex number and represents both the amplitude and phase of the received pressure.
2. For each receiver location:
    a. The range from the receiver to each airgun in the array was calculated, and used to interpolate the results produced by the propagation modelling code, in order to produce a transfer function (complex amplitude vs. frequency) corresponding to that receiver - airgun combination.
    b. These transfer functions were inverse Fourier transformed to produce the corresponding impulse response, which was then convolved with the signal from the appropriate airgun to give a received signal due to that gun.
    c. The received signals from all guns in the array were summed to produce a received pressure signal.

The sound exposure level (SEL) at the receiver was calculated by squaring and integrating the pressure signal.

2.1.5.2 Long Range Modelling

For longer ranges the short-range modelling procedure described above was too computationally intensive to be feasible and instead SELs were calculated as a function of range, depth and azimuth from each source location as follows:

- Transmission loss was modelled at 7.5° azimuth increments out to 250 km maximum range using RAMGeo (fluid Parabolic Equation model) for a set of discrete (bin-centre) frequencies at one-third octave intervals from 8 Hz to 1000 Hz. For the Southeast corner of the survey a 3.75° azimuth increment was used. The bathymetry along the track was interpolated from the CANZ (2008) database, and the local acoustic environment was as described previously.
- Frequency-dependent source level was obtained by integrating the horizontal plane source spectrum for the appropriate (relative) azimuth over each frequency band. (Band edges were chosen as the geometric means of adjacent frequencies.) Relative azimuths were calculated based on a survey line direction of 320°T.
- Source level and transmission loss were then combined to compute the received level as a function of range, depth and frequency. This calculation was carried out at 5° azimuth increments. Corresponding transmission loss data were extracted from the closest available transect (in azimuth) used in the propagation modelling.
- Integrated squared acoustic pressure was calculated for each 1/3rd-octave spectral bin. These values were summed and converted to decibels to yield SEL.

3 Results

3.1.1 Short Range Modelling Results

Plots predicted maximum received sound exposure level at any depth as a function of range and azimuth from the source are given in Figure 10 and Figure 11. The maximum range in each plot is 500 m and 3 km respectively. The directionality of received levels in the horizontal plane is due to the directionality of the airgun array, which produces its highest levels in the in-line direction, an azimuth of 0°.

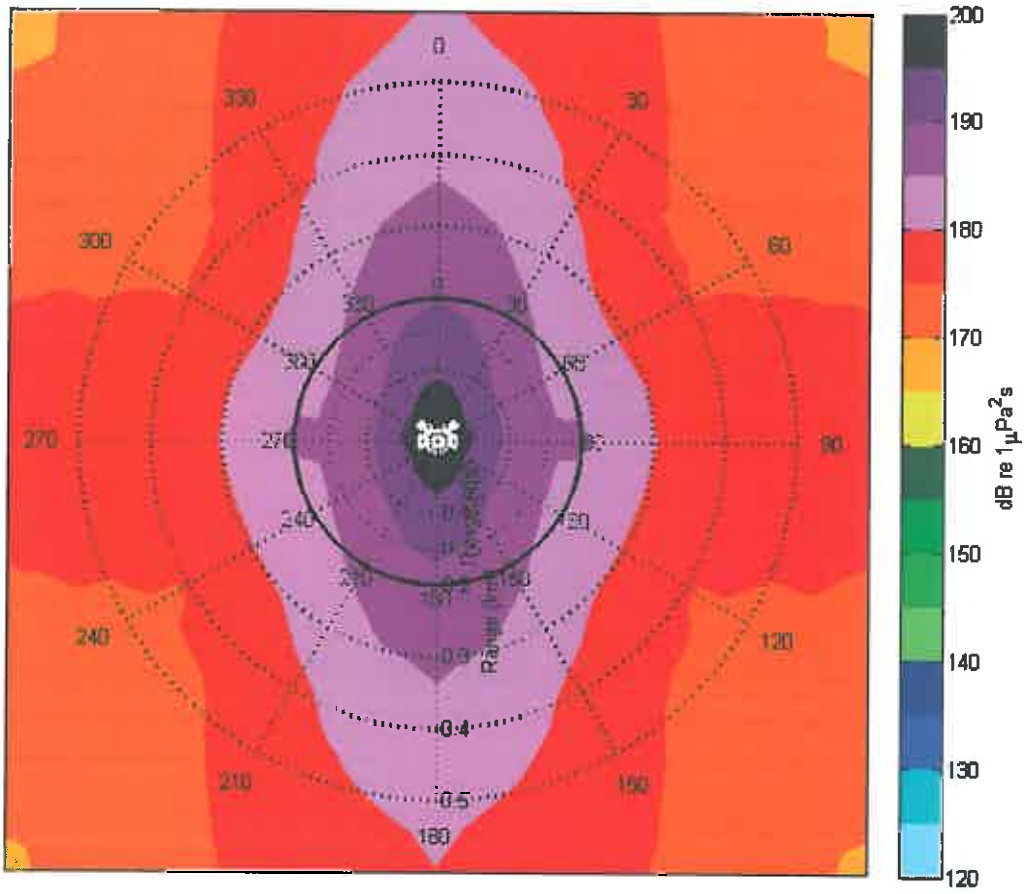


Figure 10. Predicted maximum received SEL at any depth as a function of azimuth and range from the source to a maximum range of 500m. An azimuth of 0° (up) corresponds to the in-line direction. The thick black circle corresponds to the 200m mitigation range.

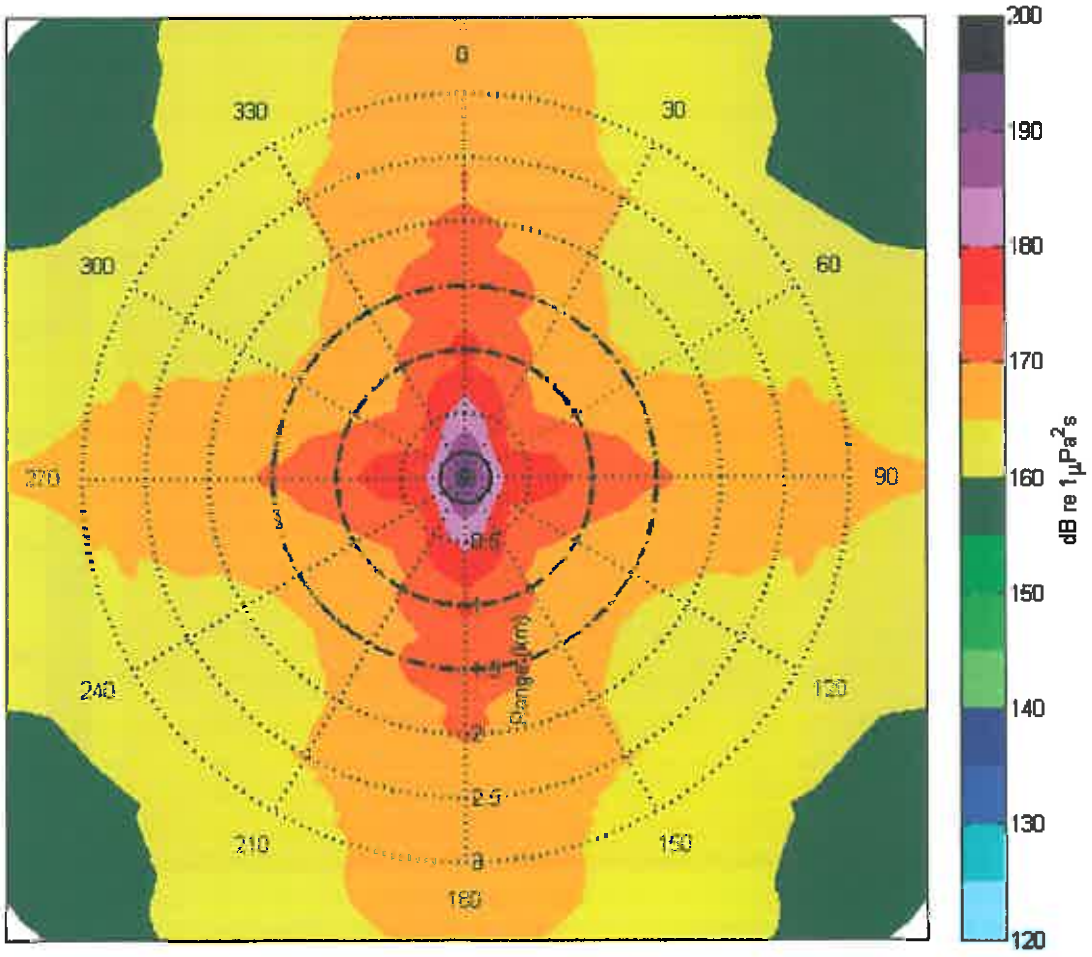


Figure 11. Predicted maximum received SEL at any depth as a function of azimuth and range from the source to a maximum range of 3km. An azimuth of 0° (up) corresponds to the in-line direction. The thick black circle corresponds to mitigation ranges of 200m (solid), 1km (dash), and 1.5km (dash-dot).

Figure 12, Figure 13, and Figure 14 show the maximum received SEL as a function of range from the S1, S2, and S3 source locations. Given the horizontal plane directionality of the array discussed above and shown in Figure 5, the maximum SEL in the water column is expected in the in-line direction. Considering the three source locations (S1, S2, and S3), the maximum sound exposure levels within survey area are predicted to be between 189.0 and 187.4 dB re 1 μPa^2.s at a range of 200 m, between 175.8 and 173.2 dB re 1 μPa^2.s at a range of 1 km, and between 173.1 and 170.0 dB re 1 μPa^2.s at a range of 1.5 km. The higher levels occur in the shallowest waters due to short range reflections from the seabed and the large total volume of the airgun array.

For each source location, Table 2 presents the ranges where the SELwill drop below thresholds of 186 dB re 1 $\mu Pa^2.s$ and 171 dB re 1 $\mu Pa^2.s$. The S1 source is located in shallow waters where the seabed is reflective, and is therefore expected to produce the largest sound exposure levels. Comparing levels from the three source locations shows that this is indeed the case.

Table 2: Ranges at which sound exposure levels drop below thresholds in both shallow and deep waters

	Source Location S1	Source Location S2	Source Location S3
	Range (m)	Range (m)	Range (m)
186 dB re 1 $\mu Pa^2.s$ Threshold	330	300	240
171 dB re 1 $\mu Pa^2.s$ Threshold	2050	1900	1400

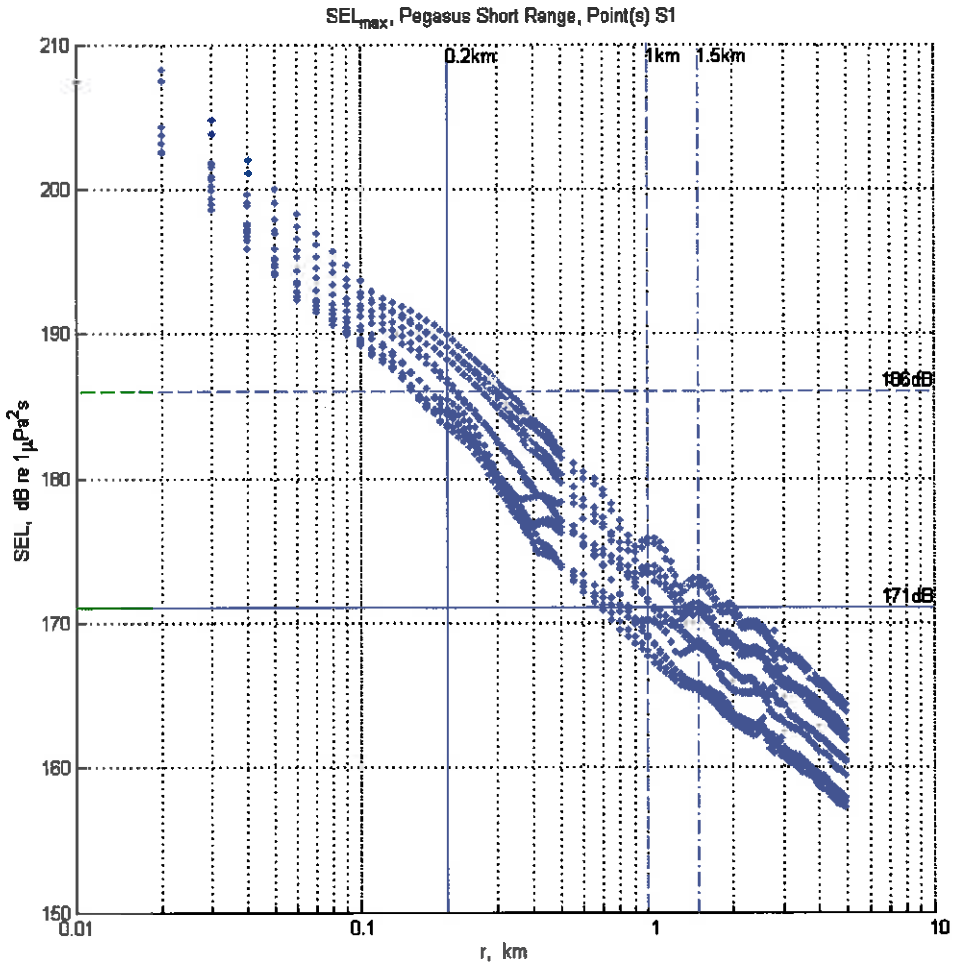


Figure 12. Scatter plot of maximum SEL for source S1.Blue dots are maximum predicted received levels at any depth as a function of range, plotted for all azimuths. Vertical magenta lines show mitigation ranges of 200m (solid), 1km (broken), and 1.5km (dash-dot). Horizontal green lines show mitigation thresholds of 171 dB re 1 µPa^2.s (solid) and 186 re 1 µPa^2.s (broken).

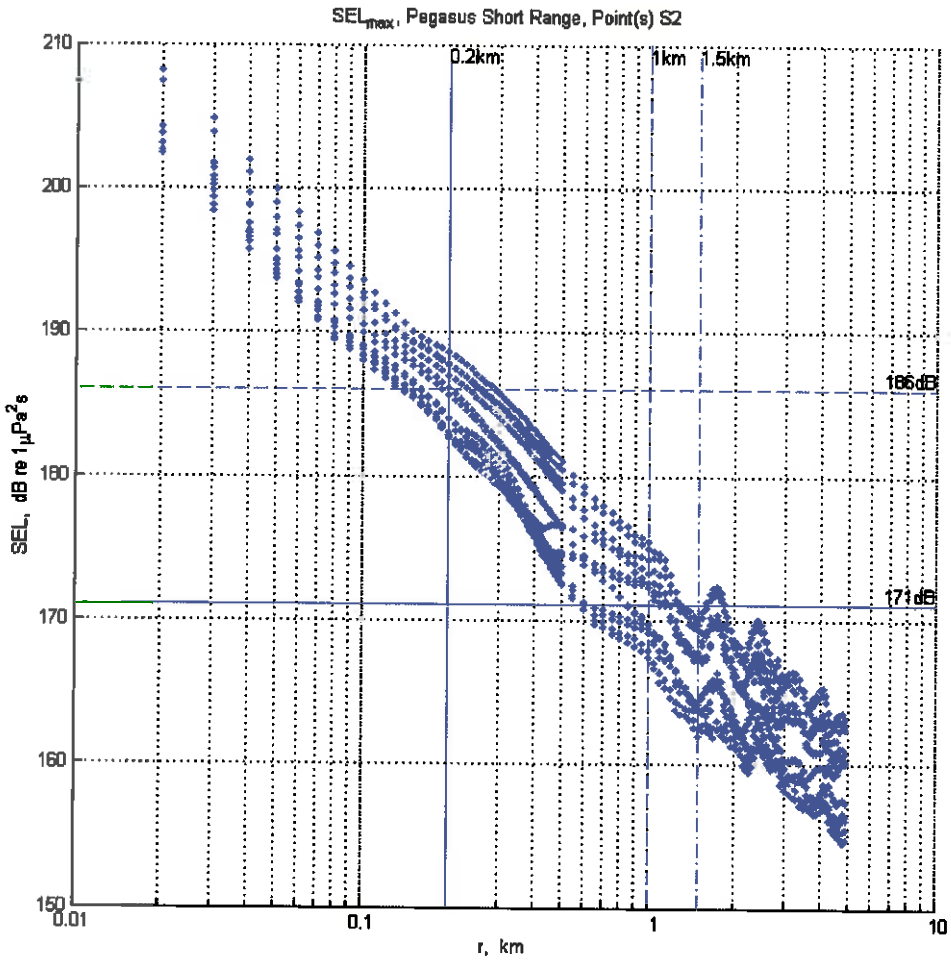


Figure 13. Scatter plot of maximum SEL for source S2. Blue dots are maximum predicted received levels at any depth as a function of range, plotted for all azimuths. Vertical magenta lines show mitigation ranges of 200m (solid), 1km (broken), and 1.5km (dash-dot). Horizontal green lines show mitigation thresholds of 171 dB re 1 μPa^2.s (solid) and 186 re 1 μPa^2.s (broken).

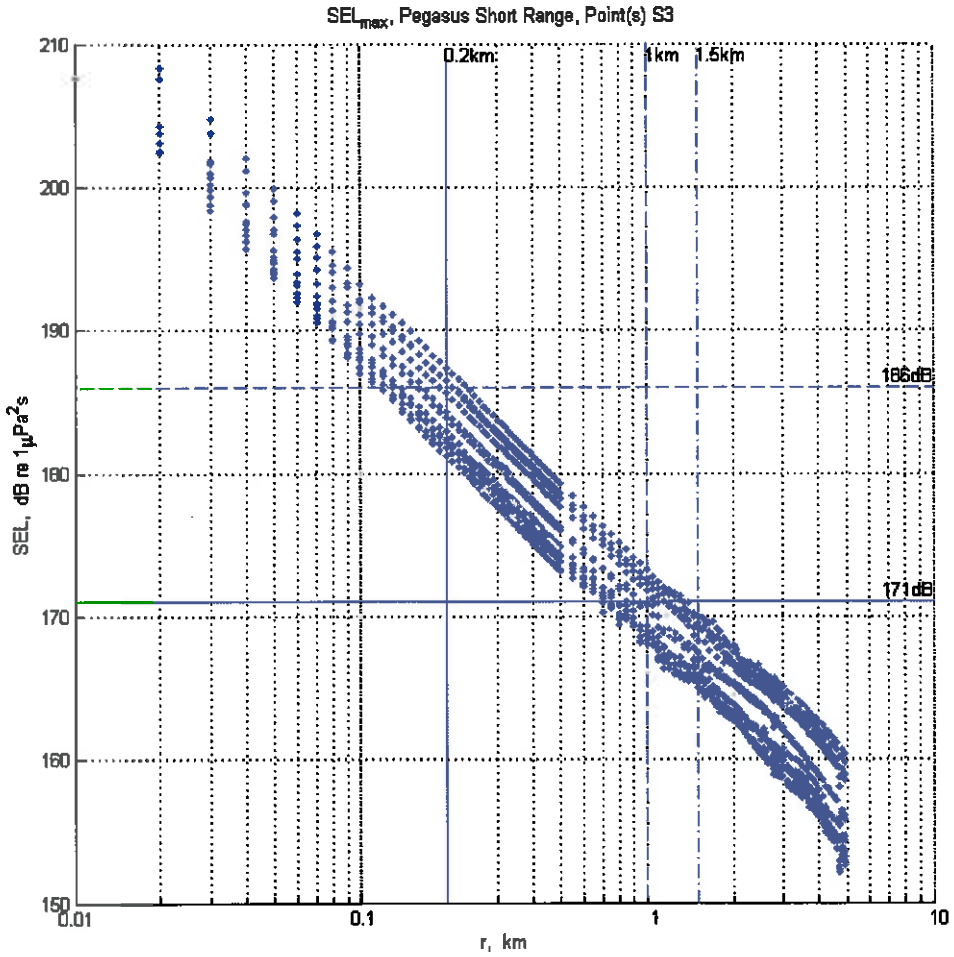


Figure 14. Scatter plot of maximum SEL for source S3. Blue dots are maximum predicted received levels at any depth as a function of range, plotted for all azimuths. Vertical magenta lines show mitigation ranges of 200m (solid), 1km (broken), and 1.5km (dash-dot). Horizontal green lines show mitigation thresholds of 171 dB re 1 µPa^2.s (solid) and 186 re 1 µPa^2.s (broken).

Figure 15 plots the percentage of received shots below standard thresholds as a function of range. The percentage levels are plotted for a source in shallow water (S1) and a source in deep water (S3). For S1 this plot shows that 95% of shots are predicted to be below 186 dB re 1 µPa^2.s at a range of 200 m and 78% of shots are below 171 dB re 1 µPa^2.s at 1km. For S3 this plot shows that more than 95% of shots are predicted to be below 186 dB re 1 µPa^2.s at a range of 200 m and 93% of shots are below171 dB re 1 µPa^2.s at 1km.

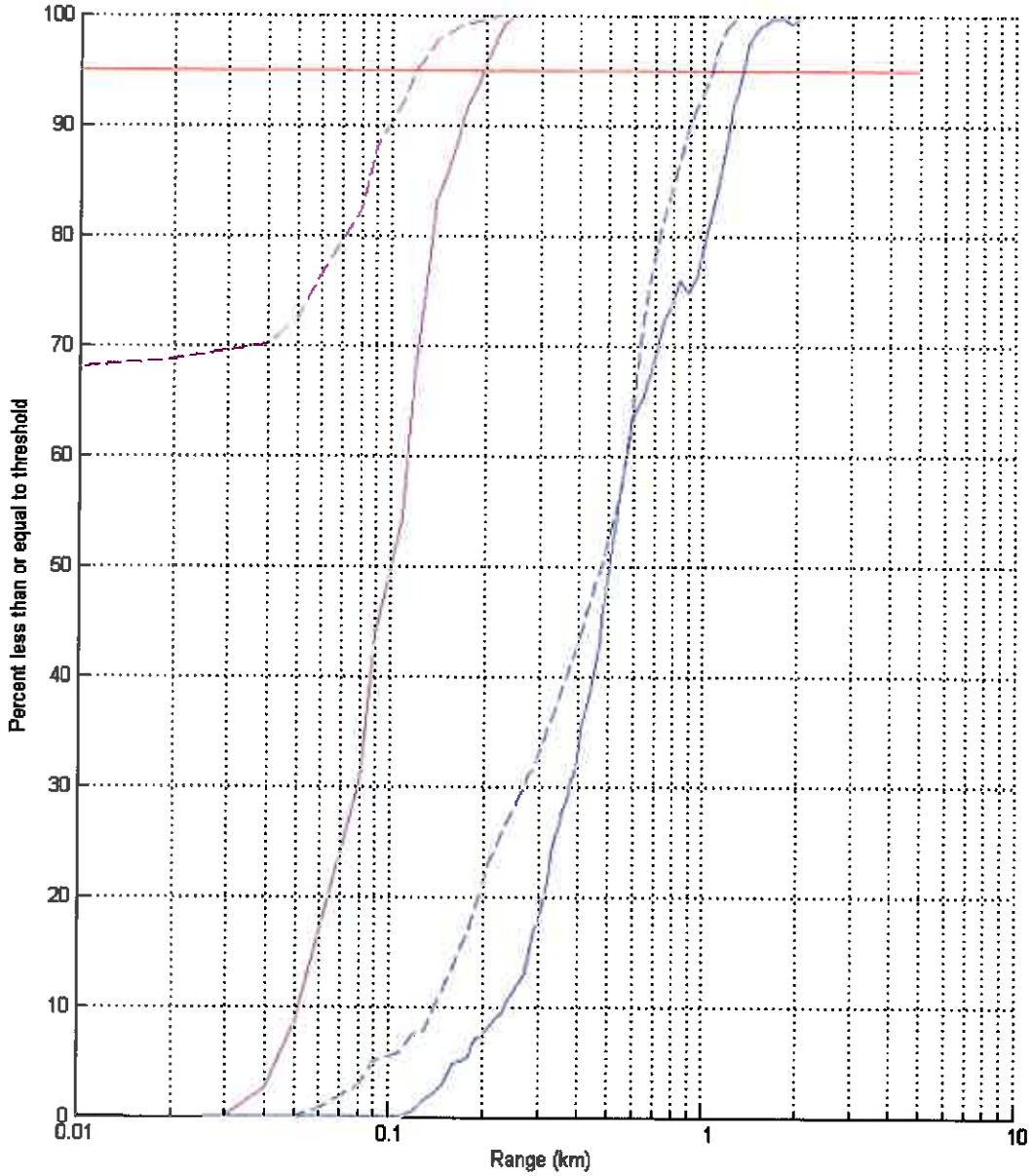


Figure 15. Percentage of received shots below thresholds of 186 dB re 1 $\mu Pa^2.s$ (blue) and 171 dB re 1 $\mu Pa^2.s$ (magenta) as a function of range for sources S1 (solid) and S3 (dash). Percentages are calculated over all azimuths and depths.

3.1.2 Long Range Modelling Results

Figure 16 shows the geographical distribution of received sound exposure levels out to a maximum range of 250 km from the S4 source location. Note that in order to illustrate the lower sound levels that occur at longer ranges a different colour scale has been used for these plots than for the short range results given in the previous section.

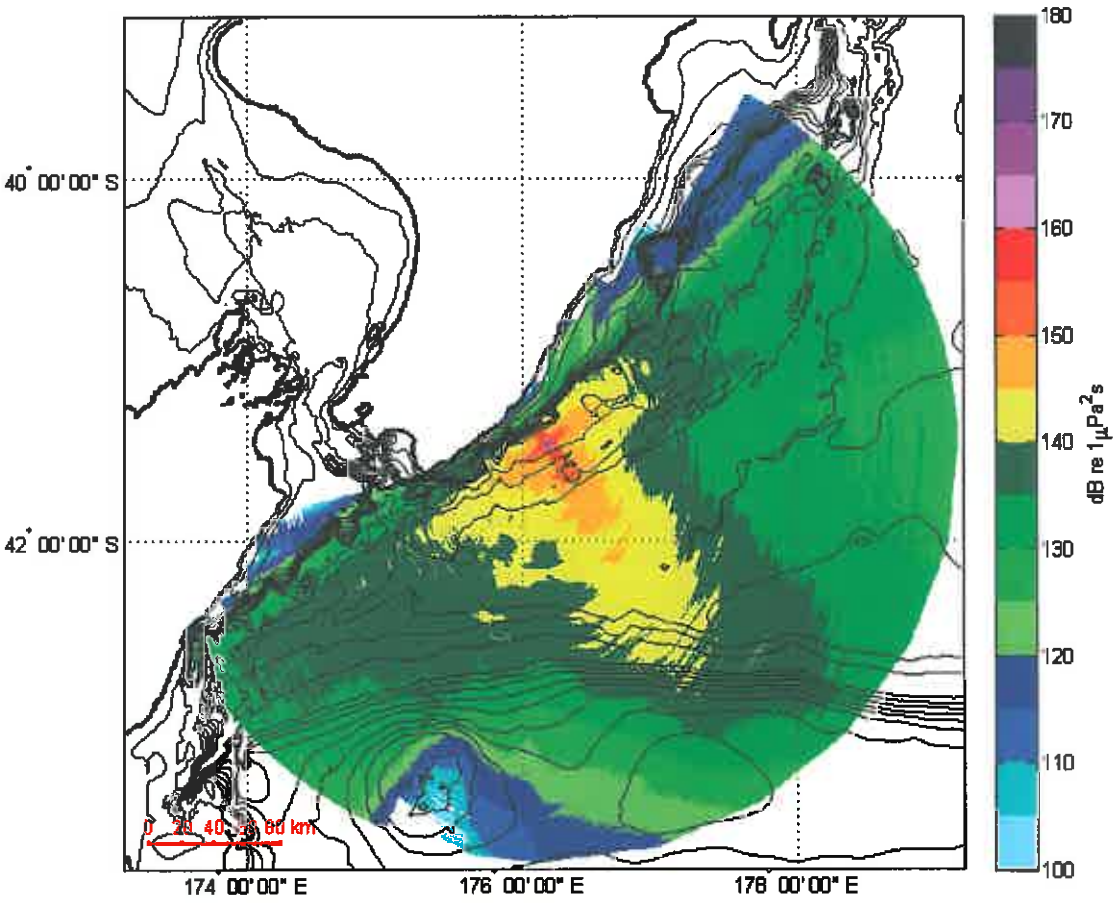


Figure 16. Geographical distribution of modelled sound exposure level for a source at S4. (Maximum level at any depth.) Survey line azimuth is 320°T.

The strong and complicated directionality apparent in these plots is due to a combination of the directionality of the array, which produces maxima in the in-line, and in the cross-line directions. However the cross-line levels are slightly less that the in-line levels. The effect of variable bathymetry causes rapid attenuation upslope from the source and enhances propagation downslope. Upslope from the source, rays steepen on each subsequent seabed reflection, increasing the attenuation rate. Conversely in the

downslope direction rays are flattened on each subsequent seabed reflection, which reduces the number of seabed interactions and therefore the attenuation rate.

These effects are illustrated in Figure 17 which shows a vertical cross-section through the sound field produced by a source at S4. The highest levels are transmitted vertically downward into the seabed. However, due to the total volume and frequency dependent beam pattern of the airgun array, energy is trapped in the ocean interior. The receiver azimuth in Figure 17 is 240°T - 60°T and shows the cross-sectional slice of sound exposure level predicted to reach the Kaikoura area (left side of the plot). The levels predicted at Kaikoura, are between 115 – 125 dB re 1 $\mu Pa^2.s$.

Figure 18 shows a scatter plot of the maximum sound exposure level at any depth as a function of range for all azimuths.

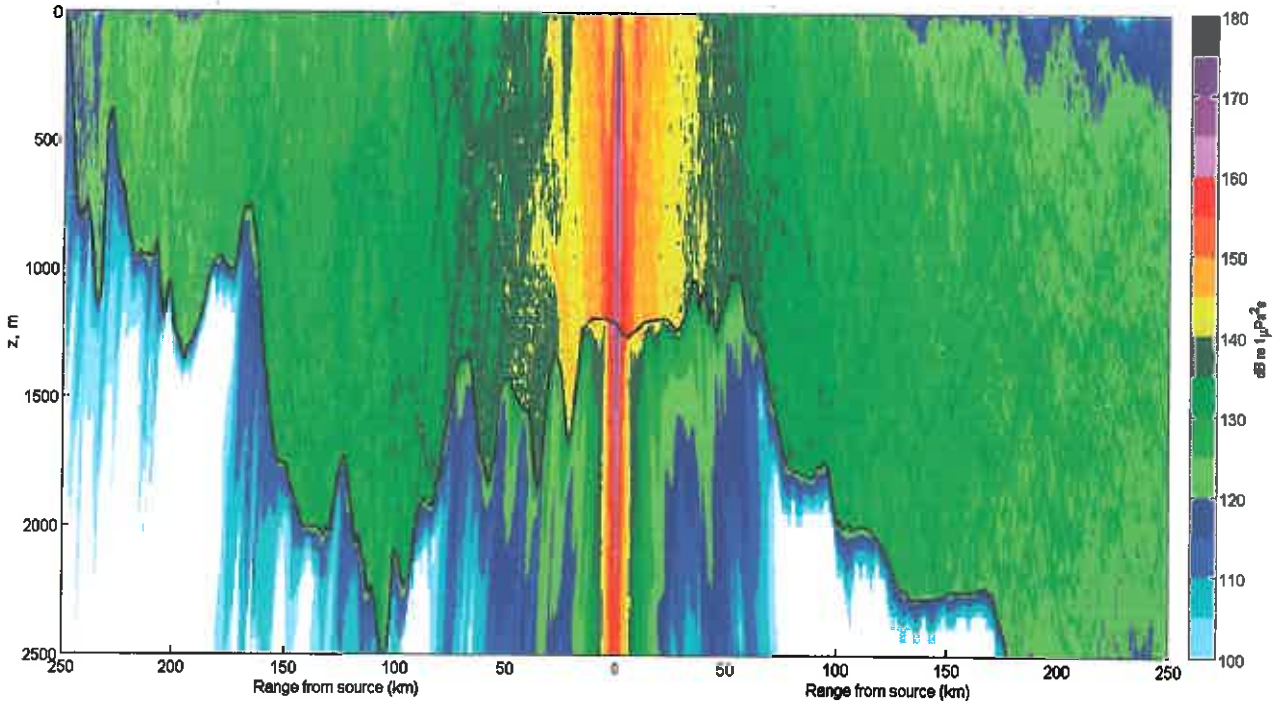


Figure 17. Vertical cross-section through the sound field in the inline direction (240°T - 60°T), centred on S4. Black line is the seabed.

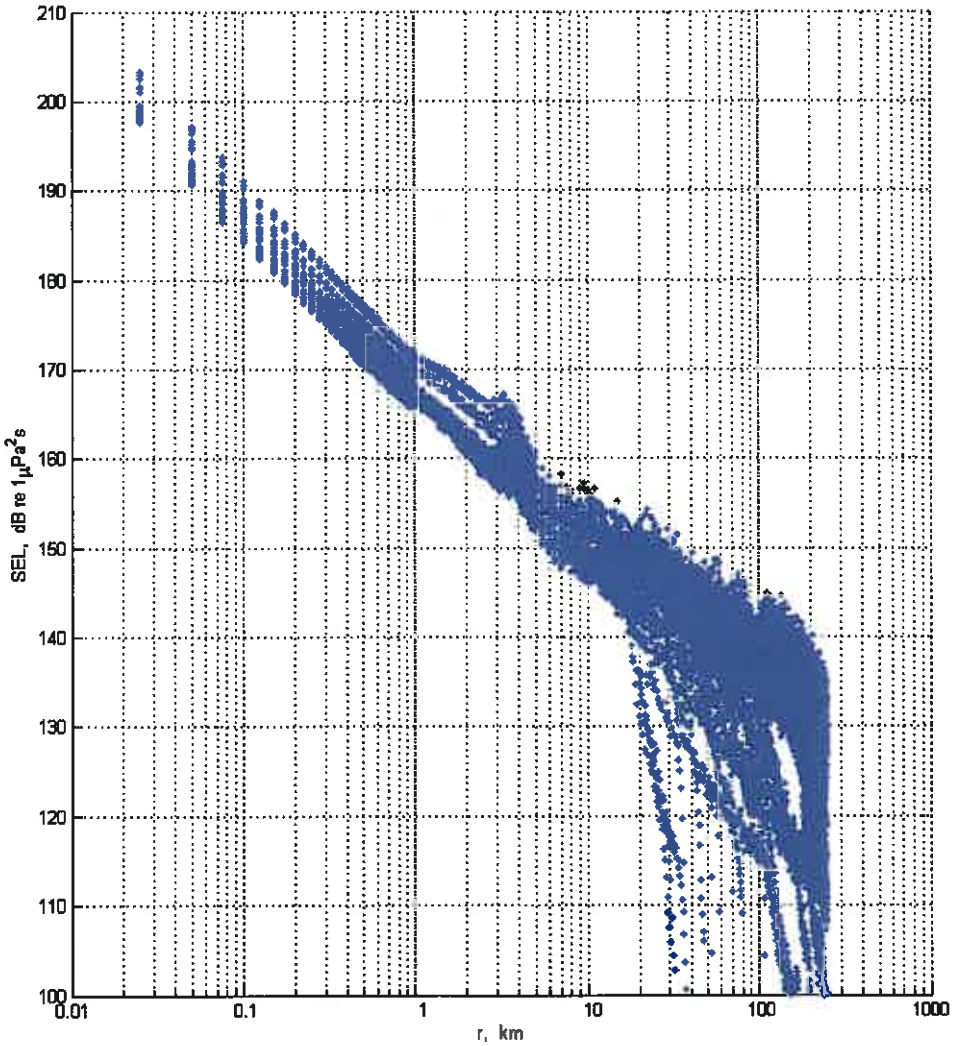


Figure 18. Maximum received sound exposure level at any depth as a function of horizontal range for all modelled azimuths from S4.

4 Conclusions

The modelling method used to produce the short range results is very computationally intensive but accurately deals with both the horizontal and vertical directionality of the airgun array and with variations in water depth. The majority of the sound energy is transmitted downward and is absorbed by the seabed, but some energy is trapped and propagates within the ocean interior.

The short range modelling predicted that the maximum sound exposure levels produced by the Aquila 6300 cubic inch array operating within the East Coast and Pegasus Multiclient 2D survey area would be between 189.0 and 187.4 dB re 1 $\mu Pa^2.s$ at a range of

200 m, between 175.8 and 173.2 dB re 1 $\mu Pa^2.s$ at a range of 1 km, and between 173.1 and 170.0 dB re 1 $\mu Pa^2.s$ at a range of 1.5 km, with the higher levels occurring in the shallowest water depths.

The maximum sound exposure levels were predicted to drop below 186 dB re 1 $\mu Pa^2.s$ at ranges between 240 m and 330 m, and below171 dB re 1 $\mu Pa^2.s$ at ranges between 1.4km and 2.05 km, with the longer ranges corresponding to the shallowest water.

The long range modelling results were highly directional due to the combination of airgun array directionality and bathymetry, but showed rapid attenuation inshore of the source and slow attenuation offshore. The levels predicted off Kaikoura, when the array is at a distance 250 km, are between 115 – 125 dB re 1 $\mu Pa^2.s$.

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