Marine Mammal Impact Assessment

Māui 8 Site Survey, Offshore Taranaki, New Zealand

Shell Todd Oil Services Limited

Marine Mammal Impact Assessment Document

Prepared For

Shell Todd Oil Services Limited

Project

Marine Mammal Impact Assessment
Māui 8 Site Survey, Offshore Taranaki, New Zealand

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Non-Technical Summary

Shell Todd Oil Services Ltd (STOS) plans to undertake a small seismic site survey to detect any potential shallow hazards prior to the drilling of the proposed Māui 8 well. Additionally, a seabed survey will be conducted to detect any potential hazards that would pose threats to the safe anchoring of the rig. The site is in approximately 110 m water depth within New Zealand's Māui natural gas field between the Māui A and Māui B platforms in the South Taranaki Bight, located approximately 40 km off the Taranaki coastline. The nearest major settlement is on the coast at New Plymouth, approximately 80 km north-east of the proposed Māui 8 well location. The survey will be conducted using the seismic research vessel *M. V. Duke*, which is owned and operated by Gardline CGG Pte Ltd (Gardline CGG). It is anticipated that the survey will commence late April to early May and last approximately seven days.

In order to acquire seabed data, the seismic survey will utilise an airgun array with an operational capacity of 220 cu. in. The Department of Conservation (DOC) released the *'2013 Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations'* (hereafter "the 2013 Code") which defines three levels of seismic surveys based on a clear demarcation of the acoustic source capacity. Based on that classification, the seismic activity associated with the Māui 8 survey has been classified as "Level 2", a low scale seismic operation in comparison to larger geophysical investigations. As per the 2013 Code, seismic operators must provide a Marine Mammal Impact Assessment prior to commencement of the survey.

A Marine Mammal Impact Assessment (MMIA) is the process of identifying, quantifying and evaluating the potential impacts of a defined activity (seismic survey), on marine mammals and determining how these will be appropriately managed. The methodology used to evaluate the potential ecological effects includes the following components:

- identify the ecological features that could potentially be affected;
- determine the sensitivity of relevant ecological features;
- identify mitigation inbuilt within the survey;
- initially assess impacts affecting each species;
- from the initial assessment: identify any mitigation, compensation or enhancement that should be incorporated into the survey;
- assess potential residual effects following the incorporation of mitigation, compensation and enhancement; and
- after all mitigation efforts, identify any residual likely significant impacts on marine mammals.

Part of the MMIA assessment is consultation with communities considered to be able to make a useful contribution to the technical assessment, or which may have views on the project or its potential impacts on marine mammals.

The impact assessment is based on robust ecological impact assessment methods whereby each species is assigned a value (comprised of its *conservation status* and *abundance* within a defined zone of influence), with the magnitude of each potential effect also being determined (based on the *severity of the effect* and the *proportion of the population potentially affected*). The assessment results in determination of the significance of

each effect on each species. The results of this are used to determine if any unacceptable effects are likely and/or if further mitigation is required. The assessment includes consideration of both in-combination and cumulative effects from other projects/developments/surveys where synergistic effects could occur.

As mentioned above, the first stage of the MMIA is to identify the species that could potentially be affected. Numerous species of marine mammals have been identified in the offshore Taranaki basin in the past. These include blue whales, humpback whales, bottlenose dolphins, dusky dolphins, common dolphins, long-finned pilot whales, killer whales and New Zealand fur seals. The survey will not coincide with any known major migrations of baleen whales, or breeding/calving periods of any of the species listed as threatened in New Zealand. However, more recent findings suggest that the South Taranaki Bight, some 40km further southwest, is an important foraging ground for blue whales.

The most significant potential impact from this seismic survey is considered to be the introduction of human-produced noise. This impact will be mitigated through a range of standard measures which will be strictly adhered to during the entire duration of the survey, including:

- Two Marine Mammal Observers (MMOs) in daylight hours as per the 2013 Code. They will be responsible for:
    - monitoring seismic activity and ensuring that operations are carried out in a safe manner for marine mammals in the area;
    - conducting pre-start observations before any seismic activity commences;
    - delaying the start of operations for marine mammals within their respective mitigation zones as specified in the 2013 Code;
    - monitoring 'soft starts' during which the power of acoustic array is gradually increased to allow animals to leave the area before operations reach full power;
    - performing shut-downs of operations for marine mammals identified as Species of Concern that come within specific distances of the acoustic source.

To further minimise any potential impacts, additional mitigation measures will be put in place for the duration of the Māui 8 survey, including:

- As recommended in the 2013 Code and supported by STOS as best practice, two Passive Acoustic Monitoring System (PAMS) Operators will be present onboard the seismic vessel throughout the survey to conduct acoustic monitoring for marine mammals. Such acoustic monitoring will provide 24-hour cover, allowing MMOs time off during the hours of darkness and low visibility;
- Two qualified MMOs will be on watch during all pre-start observations during daylight hours and any other key times (heath and safety permitting);
- Immediate notification of the Director-General of DOC if Species of Concern are encountered in unusually high numbers;
- If any Hector's dolphins or Maui's dolphins are sighted at any time during the survey (including transits), the Director-General of DOC will be informed at the first possible instance;
- Calibration of received sound levels at the prescribed mitigation distances will be checked during the survey and the results presented in the final trip report. If the results of these measurements

significantly differ from the noise modelling conducted as a part of this MMIA, the Director-General will be immediately notified;

- At least one MMO is to be on the watch during transits or at any times of increased vessel speed (i.e. above usual survey speed). If any baleen whales are sighted in the vicinity ahead of the vessel and if it is judged by the MMO that the animal/s is/are not responsive (i.e. during times of resting, feeding, socialising), the vessel's course will be altered to avoid collision with the animal/s.

As part of this MMIA, sound transmission loss modelling has been conducted using industry standard software. The modelling results suggested that injury in marine mammals is only likely to occur within 20 m of the airgun array source, (based on peak noise criteria derived by Southall *et al.*, 2007). Moreover, the sound levels during the survey are predicted not to exceed 171 dB re 1 SEL at distances corresponding to the relevant mitigation zones for Species of Concern (1km and 600m), nor will they exceed 186 dB re 1 SEL at a distance of 200 m. Therefore, present mitigation zone distances as detailed in the 2013 Code are deemed to be sufficient for this survey.

Overall, taking into account the low intensity of the acoustic source and relatively short duration of the survey, together with the modelling and mitigations mentioned above, the impact assessment of this survey is considered to be "minor" or "not significant" for all of the species identified.

Contents

1. Introduction 14

1.1 Background Information 14

1.2 Permits and Legislation 14

1.3 Previous Environmental Impact Assessment 14

1.4 Objectives of this Assessment 16

1.5 MMIA Team 17

2. Project Description 18

2.1 Survey Area 18

2.2 Survey Vessel 20

2.3 Survey Parameters 21

2.4 Alternatives Considered 24

3. Assessment Methodology 26

3.1 Method Overview 26

3.2 Consultation 26

3.3 Scoping 28

3.4 Identification of Ecological Receptors and Establishing the Baseline 30

3.5 Valuing Receptors 31

3.6 Identification of Mitigation Inbuilt Within the Survey Design 34

3.7 Impact Magnitude 34

3.8 Significance 36

3.9 Additional Mitigation, Re-Assessment and Identification of Residual Effects 37

4. Noise Propagation Modelling 38

4.1 Introduction 38

4.2 Noise Propagation 38

4.3 Noise Propagation Modelling Method 39

4.4 Modelling Results and Impact Assessment 40

5. Baseline and Evaluation of Receptors 43

5.1 Zone of Influence 43
5.2 The Social and Cultural Environment 45
5.3 The Wider Anthropogenic Environment 45
5.4 The Physical Environment 47
5.4.1 Bathymetry 47
5.4.2 Circulation and Currents 47
5.4.3 Water Density (Temperature and Salinity) 48
5.4.4 Thermocline 48
5.4.5 Seabed Sediments 48
5.5 Designated Marine Conservation Sites 51
5.6 The Biological Environment 55
5.7 Marine Mammals 56
5.7.1 Baleen Whales (Mysticetes) 60
5.7.2 Toothed Whales and Dolphins (Odontocetes) 64
5.7.3 Pinnipeds 72
5.8 Other Marine Mega Fauna 74
5.8.1 Sea Turtles 74
5.8.2 Sharks and Rays 74
5.8.3 Seabirds 74
5.9 Valuation of Receptors 76
6. Inbuilt Mitigation 79
7. Assessment of Potential Effects 81
7.1. Vessel Collision Risk 81
7.2 Physical Disturbance Due to Presence of Vessels 83
7.3 Seismic Sound Effects 85
7.3.1 Physiological Impacts 87
7.3.2 Perceptual (Masking of Vocalisations) 88
7.3.3 Behavioural Disturbance 91

7.3.4 Indirect Effects on Prey Species 93

8. Additional Mitigation **96**

9. In-Combination and Cumulative Effects **97**

9.1 In-Combination Effects 97

9.2 Cumulative Effects 97

10. Monitoring and Reporting **98**

11. References **101**

12. Appendix **115**

Appendix A Consultation 115

Appendix B Noise Prediction Modelling 163

Appendix C Proposed Survey Lines Coordinates 191

Appendix D Marine Mammal Mitigation Plan 196

List of Figures

Figure 1.1 Location of Māui 8 in the offshore Taranaki Basin 15
Figure 2.1 Map of the designated operational area for the Māui 8 site survey 19
Figure 2.2 Schematic showing a marine high resolution seismic (HRS) survey (*source: The Open University, 2014*) 22
Figure 2.3 Map of the Māui 8 survey area with the proposed HRS line plan 23
Figure 4.1 Bathymetry at the Māui 8 site and transects chosen for the propagation modelling 39
Figure 5.1 Map of the Māui 8 survey area indicating the Zone of Influence 44
Figure 5.2 General spatial pattern of trawl fishing activity based on data set 2007-2010 (approximate location of the Māui 8 site is marked with red square) 46
Figure 5.3 General spatial pattern of set net fishing activity based on dataset 2007-2010 (approximate location of the Māui 8 site is marked with red square) 46
Figure 5.4 Taranaki Basin map and bathymetry *(source: NZ Petroleum and Minerals, 2013)* 49
Figure 5.5 New Zealand currents and water masses *(source: Te Ara, 2014)* 50
Figure 5.6 North Island marine reserves and marine mammal sanctuaries (approximate location of the Māui 8 site is marked with red square) *(source: Department of Conservation, NZ)* 53
Figure 5.7 South Island marine reserves and marine mammal sanctuaries (approximate location of the Māui 8 site is marked with red square) *(source: Department of Conservation, NZ)* 54
Figure 5.8 Areas of Ecological Importance for marine mammals *(source: Department of Conservation, NZ)* 55
Figure 5.9 Whale distribution and migration routes in New Zealand waters *(source: Te Ara, 2014)* 61
Figure 5.10 Southern right whale distribution in New Zealand waters *(source: NABIS, 2014)* 63
Figure 5.11 Short-beaked common dolphin distribution in New Zealand waters *(source: NABIS, 2014)* 66
Figure 5.12 Killer whale distribution in New Zealand waters *(source: NABIS, 2014)* 67
Figure 5.13 Bottlenose dolphin distribution in New Zealand waters *(source: NABIS, 2014)* 68
Figure 5.14 Hector's dolphin distribution in New Zealand waters *(source: NABIS, 2014)* 69
Figure 5.15 Sightings of Maui's and/or Hector's dolphins recorded between 1970 and 2013 *(source: DOC, 2014)* 70
Figure 5.16 Dusky dolphin distribution in New Zealand waters *(source: NABIS, 2014)* 72
Figure 5.17 New Zealand fur seal distribution in New Zealand waters *(source: NABIS, 2014)* 73
Figure 7.1 Auditory frequencies used by marine mammals and main frequency range of seismic activity based on Götz *et al.* (2009) and Southall *et al.* (2007) 86
Figure 7.2 Frequency ranges of marine mammals likely to occur in the survey area and their overlap with seismic survey frequency range 90

List of Tables

Table 2.1 Operational area coordinates for the Māui 8 site survey 18
Table 2.2 Survey vessel specifications 20
Table 2.3 HRS equipment for the Māui 8 site survey 22
Table 3.1 Consultations – key issues raised 27
Table 3.2 Receptors scoped out of this assessment 28
Table 3.3 Baseline data sources 31
Table 3.4 Conservation score 32
Table 3.5 Abundance valuation 33
Table 3.6 Valuation of receptors 33
Table 3.7 Impact severity 34
Table 3.8 Proportion of population affected 35
Table 3.9 Impact magnitude 36
Table 3.10 Impact significance matrix 37
Table 3.11 Significance descriptions 37
Table 4.1 Injury impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses) 41
Table 4.2 Behavioural impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses) 41
Table 5.1 Mean monthly sea surface temperatures (SST) at 39.353870°S / 173.338710°E from satellite data (2000-2009) for period March-May. 50
Table 5.2 Marine mammals recorded in the Taranaki Basin 57
Table 5.3 Marine mammals and their likelihood of occurring in the project area at the time of survey 58
Table 5.4 Seabird species most likely to occur in the project area and their conservation status 75
Table 5.5 Receptor valuation 76
Table 7.1 Scope of the assessment 81
Table 7.2 Collision risk assessment 82
Table 7.3 Physical disturbance assessment 84
Table 7.4 Non-auditory and auditory injury and mortality assessment 87
Table 7. 5 Frequencies of acoustic signals produced by marine mammals that are likely to be encountered in the survey area 89
Table 7.6 Masking assessment 91
Table 7.7 Behavioral disturbance assessment 93
Table 7. 8 Indirect impact on prey species assessment 94
Table 7. 9 Other proposed Seismic Surveys 97

List of Abbreviations

AIE	Area of Ecological Importance
BOEM	The Bureau of Ocean Energy Management (USA)
BSEE	The Bureau of Safety and Environmental Enforcement (USA)
cu in	Cubic inch
DOC	The New Zealand Department of Conservation
EcIA	Ecological Impact Assessment
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
GEL	Gardline Environmental Limited
GIS	Geographic Information Systems
GPS	Global Positioning System
HRS	High Resolution Seismic
HYCOM	Hybrid Coordinate Ocean Model
Hz	Hertz
IAGC	International Association of Geophysical Contractors
IEMA	Institute of Environmental Management and Assessment
kHz	Kilohertz
IEEM	Institute of Ecology and Environmental Management
JNCC	Joint Nature Conservation Committee (UK)
km	Kilometres
m	Metres
MMIA	Marine Mammal Impact Assessment
MMO	Marine Mammal Observer
MMS	Marine Mammal Sanctuary
MWD	Marine Wildlife Department
NABIS	National Aquatic Biodiversity Information System

NGO	Non-governmental organisation
NPWS	National Parks and Wildlife Service
NZ	New Zealand
NZMEC	New Zealand Marine Environment Classification
nm	Nautical miles
OGP	International Association of Oil & Gas Producers
PAM(S)	Passive Acoustic Monitoring (System)
PEP	Petroleum Exploration Permit
PML	Petroleum Mining License
PMP	Petroleum Mining Permit
PoPA	Proportion of Population Affected
PPE	Personal Protective Equipment
Ppt	Parts per thousand
PSO	Protected Species Observer
PTS	Permanent Hearing Threshold Shift
RAM	Range-dependant Acoustic Model
RL	Received Level
RMS	Root Mean Square
SCP	Senior Contact Person
SEL	Sound Exposure Levels
SL	Source level
SoC	Species of Concern
SPL	Sound Pressure Level
SST	Sea Surface Temperature
STOS	Shell Todd Oil Services Limited
TL	Transmission propagation loss
TTS	Temporary Hearing Threshold Shift
USA	United States of America

WAUC	West Auckland Current
WC	Westland Current
ZoI	Zone of Influence

1. Introduction

1.1 Background Information

Gardline Environmental Limited (GEL) has been contracted by Shell Todd Oil Services Limited (STOS) to conduct a Marine Mammal Impact Assessment (MMIA) for a high resolution small seismic survey planned in the Māui natural gas field, offshore Taranaki, New Zealand. The purpose of this assessment is to identify, quantify and evaluate the potential impacts of the survey on marine mammals potentially present within any zone of influence of the seismic survey. As per the requirements of the New Zealand Department of Conservation's (DOC's) '*2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals From Seismic Survey Operations*' (hereafter "the 2013 Code"), this document also includes a description of the existing environment with detailed descriptions of other marine megafauna i.e. seabirds, sea turtles and sharks.

The purpose of the Māui 8 site survey is to identify any potential shallow hazards prior to the drilling of the proposed Māui 8 well. Additionally, a seabed survey will be conducted to detect any hazards that would pose threats to the safe anchoring of the rig. Section 2 provides further details of the survey techniques and equipment to be used.

The survey site is to be located in the Māui Field, 40 km off the Taranaki coastline, New Zealand (Figure 1.1) in an area of water approximately 110 m deep. Māui has been a significant part of New Zealand's energy supply for more than 30 years, since the first discovery of natural gas in 1969. The nearest major settlement is on the coast at New Plymouth, approximately 80 km north-east of the proposed Māui 8 well location. The survey will be conducted using the seismic research vessel *M.V. Duke*, which is owned and operated by Gardline CGG. It is anticipated that the survey will commence late April to early May 2014 and last approximately 7 days (excluding down time for weather). To ensure that this MMIA covers an appropriate timescale (allowing for downtime and/or project delays) the survey window is extended to cover the period from March to May.

1.2 Permits and Legislation

STOS plan to undertake work in the area which includes Petroleum Mining Licence (PML) 381012. The Project Area is owned by a joint venture comprising Energy Petroleum Taranaki Limited (38.75%), Energy Petroleum Investments Limited (20%), Energy Petroleum Holdings Limited (18.75%), OMV New Zealand Limited (10%), Taranaki Offshore Petroleum Company of New Zealand (6.25%) and Todd Petroleum Mining Company Limited (6.25%), with STOS as the operator. Under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2013, seismic surveys are classified as permitted activities as long as they comply with the conditions of the 2013 Code. This MMIA has therefore been prepared in accordance with this document, which classifies the Māui 8 seismic survey as a Level 2 survey (total airgun capacity falls within the range 151 – 426 cu in).

1.3 Previous Environmental Impact Assessment

An Environmental Impact Assessment (EIA) has previously been undertaken by Resource and Environmental Management Limited (REM, 2013), which covered proposed exploratory drilling at the Māui 8 and Ruru 2 sites in the Taranaki Basin. This EIA was prepared under the transitional arrangements of the EEZ Act and was accepted as completed by the Environmental Protection Authority (EPA) in October 2013.

Figure 1.1 Location of Māui 8 in the offshore Taranaki Basin

1.4 Objectives of this Assessment

As outlined in the 2013 Code, this document aims to identify potential effects of the proposed activity on marine species and habitats in the receiving environment - in particular marine mammals - and consequently propose implementation of measures that are necessary to minimise these impacts to acceptable levels. To fulfil this objective the following will be covered in this document:

The 2013 Code Requirements	Applicable Sections within this Document
Describe the activities related to the proposed marine seismic survey	Section 1, 2
Describe the state of the local environment in relation to marine species and habitats, with particular focus on marine mammals, prior to the activities being undertaken	Section 5
Identify the actual and potential effects of the activities on the environment and existing interests, including any conflicts	Section 3, 7
Identify the significance (in terms of risk and consequence) of any potential negative impacts and define the criteria used in making each determination	Section 3, 7
Identify persons, organisations or tangata whenua with specific interests or expertise relevant to the potential impacts on the environment	Section 3, Appendix A
Describe any consultation undertaken with persons described above and specify those who have provided written submissions on the proposed activity	Section 3, Appendix A
Include copies of any written submissions from the consultation process	Appendix A
Specify any possible alternative methods for undertaking the activity to avoid, remedy or mitigate any adverse effects	Section 2
Specify the measures that the operator intends to take in order to avoid, remedy, or mitigate the potential adverse effects identified	Section 6, 8
Specify a monitoring and reporting plan	Section 10
Specify means of coordinating research opportunities, plans, and activities relating to reducing and evaluating environmental effects	Section 10
Sound transmission noise modelling	Section 4, Appendix B

1.5 MMIA Team

This MMIA has been compiled by an experienced technical team from the Marine Wildlife Department (MWD) within GEL.

Since 2008, the MWD has been providing advice on various aspects of marine mammal mitigation for offshore activities (seismic surveys, piling and the use of explosives) to various government agencies, environmental consultants and oil and gas operators and clients. Our specialist team offers a range of services including consultation on protocols and procedures, monitoring and mitigation applications, and comprehensive pre, during and post project reporting including specialist Geographic Information System (GIS) mapping. We employ our in-house detailed knowledge of seismic surveys and combine it with expertise on marine mammals and environmental legislation which gives us a unique ground of understanding on all aspects of mitigation. Additionally, the MWD has had extensive experience with desk-based consultancy work, across a wide range of fields within marine mammal science, marine mammal mitigation and conservation. Additional expertise on EIA methods is also provided by our in-house experts.

GEL's experience includes participation in the consultation, revision and design of the following marine mammal mitigation guidelines:

- Joint Nature Conservation Committee (JNCC) Guidelines and mitigation protocols for seismic surveys, piling and use of explosives 2004, 2009 and 2010;
- DOC's Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations 2012, 2013;
- International Association of Geophysical Contractors (IAGC) Recommended Mitigation Measures for Cetaceans during Geophysical Operations 2011; and
- National Parks and Wildlife Service (NPWS) Code of Practice for the protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters, 2007.

The MWD also runs Marine Mammal Observer (MMO) training courses: Pro-MMO (JNCC approved), Pro-PSO (BOEM/BSEE approved) and the recently DOC-approved full length MMO training course for New Zealand, Pro-MMO NZ.

2. Project Description

2.1 Survey Area

The Māui 8 survey site is located 80 km south west of New Plymouth, New Zealand, in an area of water approximately 110 m deep, within the Taranaki Basin (Figure 2.1). The site is located within the Māui Field, between the existing Māui A and Māui B platforms. The survey has been designed to cover two proposed drilling locations and includes a tie line (a survey line that connects a point to other surveyed lines) to a nearby well.

The operational area is defined in the 2013 Code as the total area where acoustic source activation could occur including seismic acquisition lines, airgun tests and soft starts. This area will be larger than the survey area (that area enclosed by the survey lines alone) as the source vessel will require additional space in which to manoeuvre, perform tests, and conduct line run-ins. No acoustic sources will be activated outside the specified operational area at any time. The coordinates of the designated operational area are given below (Table 2.1) and a map of the operational area is displayed in Figure 2.1.

Table 2.1 Operational area coordinates for the Māui 8 site survey

Site	Latitude	Longitude	Coordinate System	Block
Māui 8	39 29.349829 S	173 22.376969 E	NZTM Projection NZGD2000 Datum	PMP 381012
	39 29.472034 S	173 32.583675 E		
	39 36.937269 S	173 32.900855 E		
	39 44.212880 S	173 23.546835 E		
	39 34.604836 S	173 17.247164 E		

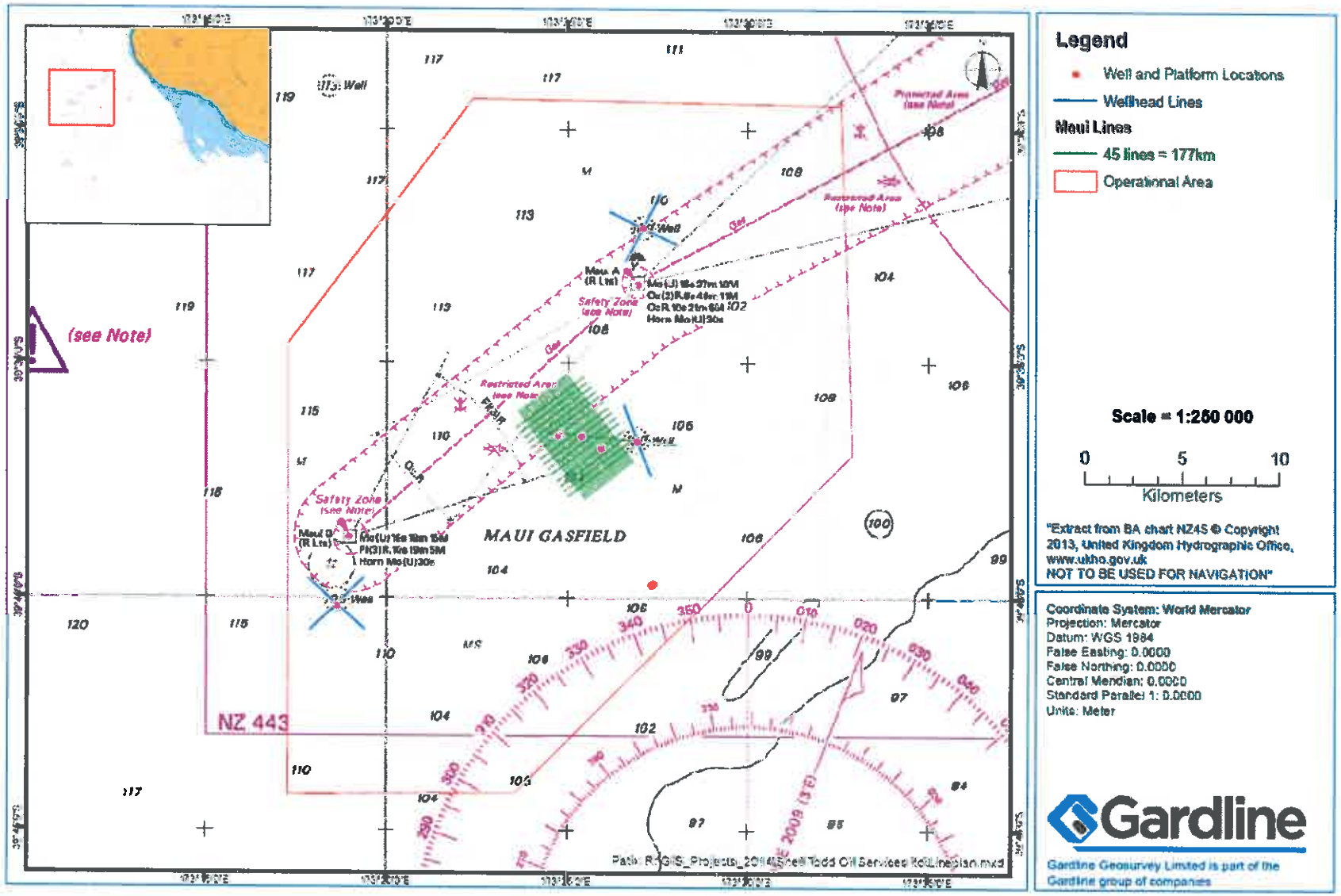

Figure 2.1 Map of the designated operational area for the Māui 8 site survey

2.2 Survey Vessel

The Māui 8 site survey is to be carried out onboard the *M.V. Duke*. The vessel details are as displayed in Table 2.2.

Table 2.2 Survey vessel specifications

M.V. DUKE

Owner and Operator	Gardline CGGV Pte Ltd
Flag / Port Of Registry	Bahamas / Nassau
Built / Rebuilt	1983 A/S Vaagen Verft, Norway / 1998 / 2011
Class	DNV - 1A1-EO-Sealer (for max. draught 5.30 m)
Class ID N°	DNV 13520
IMO Number	8200838
MMSI Number	311044800
Call Sign	C6YT7
Length (overall)	66.8 m
Beam	13.00 m
Max Draft	5.8 m
Gross Tonnage	2031 GRT
Cruising Speed	10 kts
Endurance	60 days
Range at Cruising Speed	12-13000 nm
Fresh Water Production	2- Alfa Laval, JWP C40. 8 m3/24 hrs total
Engines	2 MAK 6M 453aK 1640 kW / 2250 bhp each at 600 RPM
Total Propulsion	3280 KW

Propellers	1 Hjelset var.pitch. type HM 1530. Rpm 246. Dia 2800mm
Bow and Stern Thrusters	Brunvoll, 578 hp (both)
Generators	1 x E.C.C. 1640kVA shaft generator
Auxiliary Generator	2 x Stamford MC 534C - 305 kVA aux. generator
Seismic Compressors	2 x Hamworthy 800E + 2 x Hamworthy 425E (scfm)
Safe Manning Certificate	50 persons

2.3 Survey Parameters

The survey will comprise of high resolution seismic (HRS) work as well as analogue data acquisition and processing. These operations will be ongoing 24 hours covering both daylight and night time.

High resolution seismic (HRS) survey

The proposed seismic survey will be a 2D survey which is an exploration method used to create a map of the structures beneath the seabed. Acquisition of seismic data involves the transmission of controlled acoustic energy into the seabed and recording the energy that is reflected back from geologic boundaries in the subsurface (Figure 2.2). In the marine environment, the seismic energy source is predominantly an array of airguns towed below the sea surface behind a survey vessel. The airguns contain high pressure air in a firing chamber which is released through portholes by the action of a sliding shuttle with pistons at each end, which produces a primary energy pulse and an oscillating bubble. The airguns are fired at regular intervals as the vessel travels along pre-determined survey lines (as shown in Figure 2.3). Multiple airguns are towed in an array of different chamber volumes designed to generate an optimal tuned energy output of desirable frequencies. The energy reflected is detected by numerous hydrophones inside neutrally buoyant streamers also towed behind the vessel. During the proposed small seismic survey, airguns with a total volume of 220 cubic inch (cu. in.) will be used as the seismic source. The airgun volume of this capacity is defined as Level 2 survey in the 2013 Code.

Details of the HRS equipment which will be used to acquire data during the survey can be found in Table 2.3 and the proposed HRS line plan is shown in Figure 2.3. The HRS survey line coordinates can be found in Appendix C.

Analogue survey

In addition to HRS data acquisition, analogue survey equipment will be utilised in order to map the seabed surface. This analogue survey will serve to identify any potential hazards on the seabed for the safe anchoring of a rig. The equipment utilised will comprise swathe bathymetry, single beam echosounder, side scan sonar and sub-bottom profiler. Underwater sonar positioning will be calibrated by the temporary deployment of a sonar transponder on the seabed. Conductivity-Temperature-Depth (CTD) measurements and water velocity profiles will also be taken.

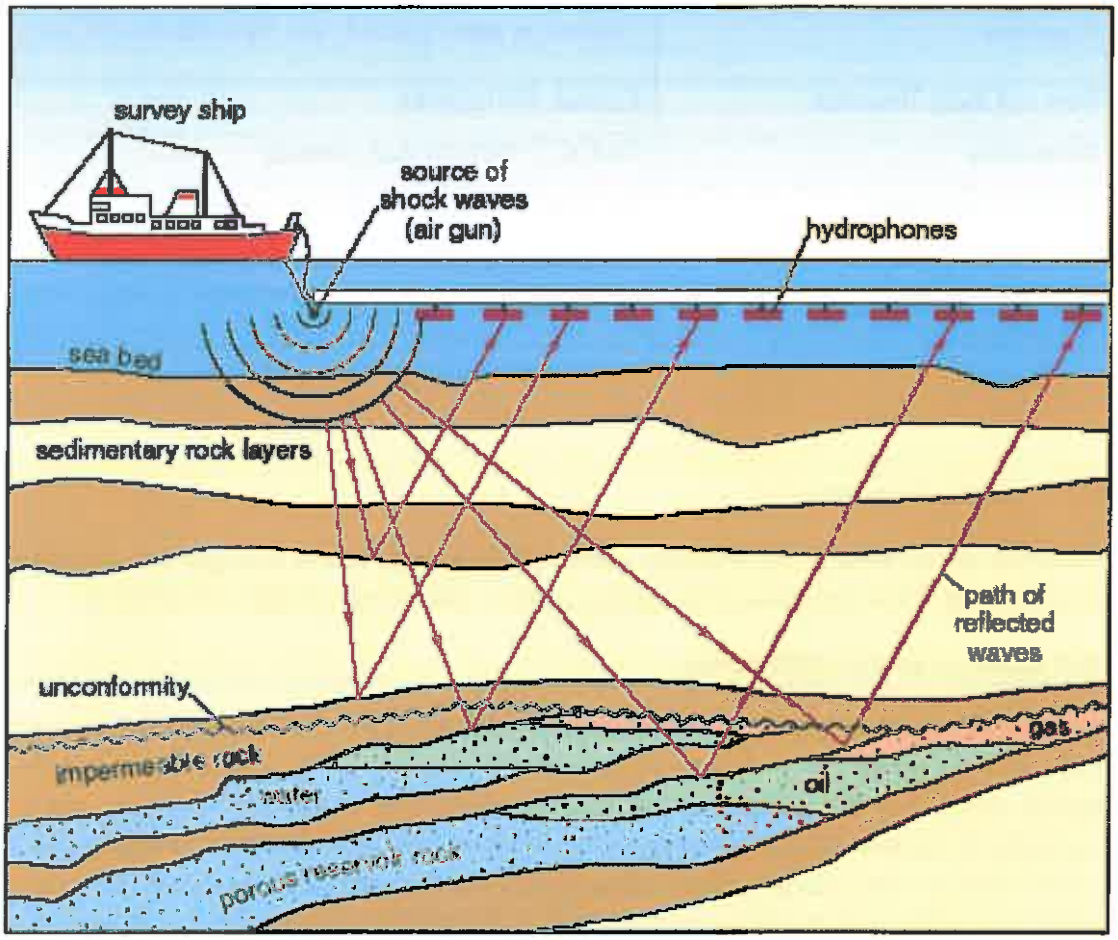

Figure 2.2 Schematic showing a marine high resolution seismic (HRS) survey (*source: The Open University, 2014*)

Table 2.3 HRS equipment for the Māui 8 site survey

Source	
Airguns	220 cu. in. Tuned Bolt Airgun Array
Number of airguns	4
Tow depth	2.5 m
Shot point interval	6.25 m
Operating pressure	2,000 p.s.i
Streamer	
Length	1,500 m
Channels	120
Group interval	12.5 m
Nominal streamer depth	2.5 m
Recording	
Sample rate	1 ms
Recording length	2 s

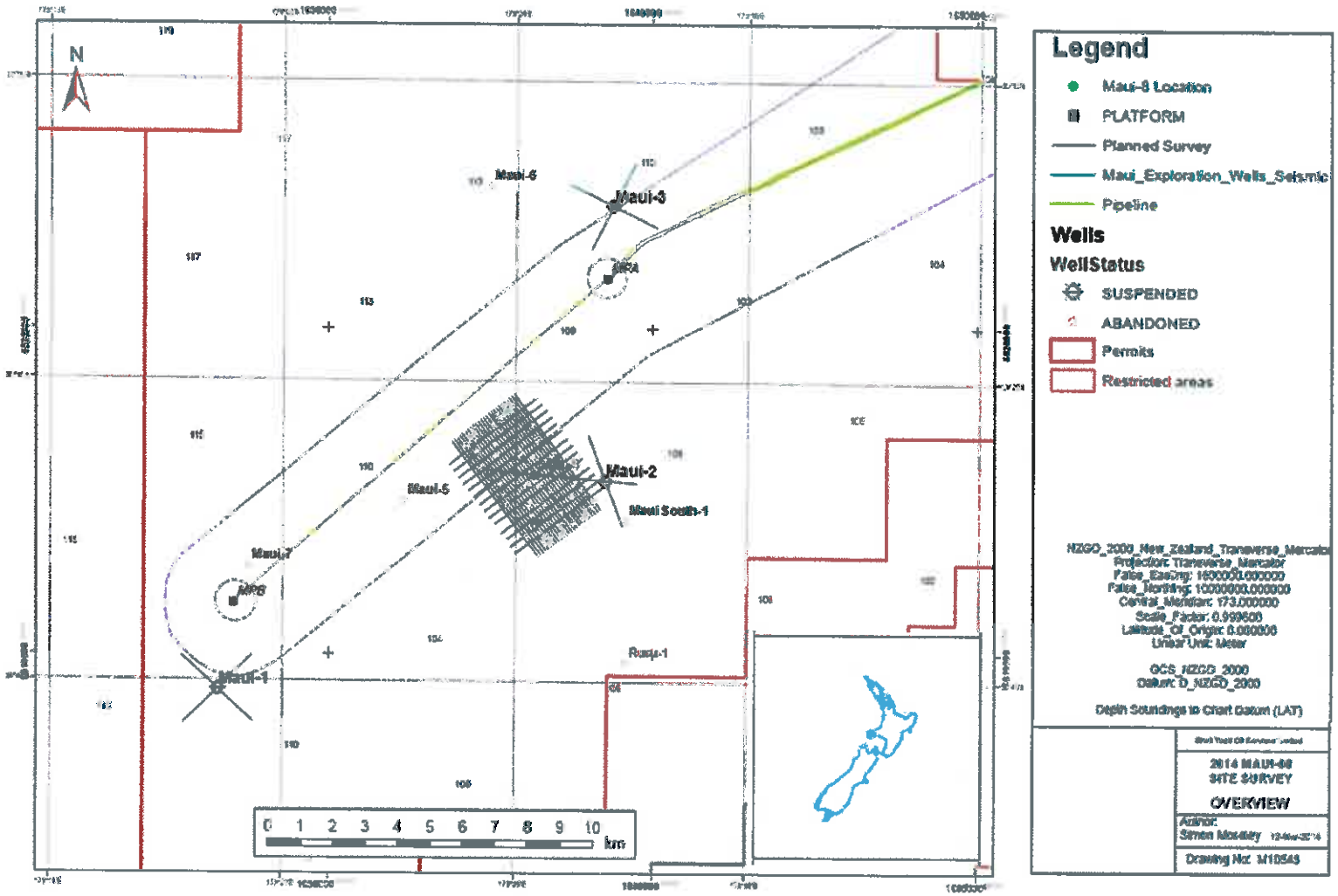

Figure 2.3 Map of the Māui 8 survey area with the proposed HRS line plan

2.4 Alternatives Considered

The design of this survey is in line with the International Association of Oil and Gas Producers (OGP, 2013) Guidelines for the conduct of offshore drilling hazard site surveys (Report No. 373-18-1). During the planning of the survey, a number of potential alternative approaches, techniques and operational ways of working have been considered.

Do Nothing

The alternative of not undertaking the work has been carefully considered. However, given that the survey is a pre-requirement for installing a future drilling rig in the area, not conducting this seismic survey would represent a risk to the environment. To ensure the drilling is done safely and at minimum risk to the environment, a map of any potential hazards lying on the seabed must be produced first. Therefore, this small seismic survey has to be completed to generate this map as accurately as possible.

Alternative Methods

The STOS procedures for the Geohazards Assessment for Offshore Operations follow the OGP's Guidelines which specify that when 3D seismic data is judged unsuitable for geohazards assessment, a dedicated site survey or high resolution seismic survey shall be performed. It has been determined that the pre-existing data is unsuitable due to the low frequency content which would not provide a high resolution image. Therefore, since a high resolution image is required for geohazards assessment, a new small high resolution survey, along with swathe bathymetry, is required by STOS.

The type of airgun or acoustic source could alternatively be changed to quieter equipment such as sparkers, pingers, boomers or any seismic acoustic source with a capacity less than 150 cu. in. However, these alternative sources would not produce images of sub-seabed hazards down to the desired casing depth, therefore the purpose of the survey would not be achieved.

Alternative Vessel

To reduce the impact on the marine environment, a small vessel should be ideally selected to conduct the survey. The *M.V. Duke* is the smallest vessel that will allow for both good quality data collection and lowest impacts on the marine environment. Indeed, completing the survey on a smaller vessel would extend the duration of the survey which would increase potential disturbance to the marine environment.

Alternative Parameters

To ensure good quality data collection, the following parameters have been determined by the project's geophysicists: tow depth of airguns, shot point interval, number of channels on the streamers, depth of the streamer, line position, line length and line spacing. Any changes in these parameters will mean that the site survey will not fulfill its purpose. Thus, there are no alternative parameters.

Alternative Locations

It is not possible to consider alternative locations as this survey is a pre-requirement of future drilling at the Māui 8 well. Therefore, the location of the seismic survey is pre-determined and there is no possibility to change it. The drilling zone is located above a producing natural gas field.

Alternative Timing and Duration

The location being unchangeable, there is the alternative to move the time of when the survey will be carried out. The survey is planned to occur between mid-March and mid-May 2014 which is probably the most suitable season to limit the impact to as few species as possible (see Section 5). The seismic survey will last approximately one week which is the shortest period over which the data can be collected assuming weather conditions are favourable. Thus, there is no possibility to adjust the duration.

3. Assessment Methodology

3.1 Method Overview

This MMIA is a form of Ecological Impact Assessment (EcIA), which is defined as, "the process of identifying, quantifying and evaluating the potential impacts of defined actions on ecosystems of their components" (Treweek, 1999). In this specific case the ecological component being assessed are mainly marine mammals.

The methodology used to evaluate the potential ecological effects arising from the survey has been derived in accordance with the principles laid down in the Guidelines for Ecological Impact Assessment in Britain and Ireland – Marine and Coastal (UK Institute of Ecology and Environmental Management (IEEM), 2010). Whilst this document was originally published to assist with EcIA in the UK, the concepts and overarching strategic methods are suitable for transfer to other nations as they provide a well thought out and rigorous mechanism for impact assessment specific for the marine environment. By considering marine mammal populations in New Zealand waters, as well as national and international conservation designations within the overall framework of the IEEM guidance it is considered that a comprehensive and robust assessment has been carried out. The assessment process includes the following components:

- identify the ecological features that could potentially be affected;
    - including the establishment of a Zone of Influence (ZoI) of the survey;
- determine the value of relevant ecological features;
- identify mitigation inbuilt within the survey;
- initially assess impacts affecting each receptor;
    - such an assessment is based on the 'magnitude' of any potential effect and, once combined with the value of a receptor the 'significance' of an effect is identified;
- from the initial assessment identify any mitigation, compensation or enhancement incorporated into the survey;
- assess potential residual effects following the incorporation of mitigation, compensation and enhancement; and
- identify any residual likely significant impacts on marine mammals.

3.2 Consultation

Running in parallel with the technical assessment phases described above has been a consultation process targeted at organisations or groups which may either have useful contributions to the technical assessment, or may have views on the project or its potential impacts on marine mammals. The advice and information provided by the consultees should shape both the assessment methodology and the scope of the assessment. STOS has an ongoing relationship with the local Māui community, where it has been operating for more than 55 years. The following groups have been engaged with and will continue to be engaged with:

- Iwi/hapū;
- Māui Community Advisory Group;
- Māui neighbours;
- Recreational and Commercial fishing groups;
- Local councils;
- Local marine businesses; and
- NGOs and Institutions.

The full list of consultees is provided in Appendix A.

Consideration of all consultation responses has been made within this MMIA and the key issues raised during the consultation are provided in Table 3.1.

Table 3.1 Consultations – key issues raised

Comment	Organisation (s)	Response
Concerns over potential feeding grounds of blue whales (*Balaenoptera musculus*) in the South Taranaki Bight and recommendation for additional mitigation or shifting the survey several months later to coincide with fewer blue whales	Project Jonah, New Zealand NIWA, Dr. Torres	The methodology followed identifies the blue whale as a high value receptor due to its potential to be found in the survey area and its conservation status. Due regard has therefore been taken by placing an appropriately high valuation on this species.
Concerns over disturbance of whales and dolphins and their habitat.	Sea Safaris, New Zealand	The MMIA fully takes in to account both physical and acoustic disturbance issues potentially related with seismic surveys and assesses them through an auditable and robust process.
Limited knowledge on distribution of Maui's/Hector's dolphins in the area	SeaFood, New Zealand Otago Univeristy, Dunedin, New Zealand	To improve the knowledge on their distribution, if Maui's/ Hector's dolphins are observed at any time during the seismic survey, DOC will be notified immediately. In such instances, a fixed wing plane and the DOC vessel will be mobilised to try and gather a biopsy sample and correctly identify the species.

3.3 Scoping

An early stage of the assessment process has been to scope the impact assessment identifying species or groups where significant effects are unlikely to occur. By undertaking this exercise the assessment concentrates on only those receptors where effects are potentially likely, thus eliminating the need to look at a very wide range of receptors which are not threatened by this seismic survey to any significant degree.

Table 3.2 identifies a range of receptors excluded from the further assessment. It should be noted that the baseline characterisation (Section 5) includes all receptors considered at the scoping stage so the reader has a full understanding of the baseline.

Table 3.2 Receptors scoped out of this assessment

Receptor	Rationale for Scoping Out
Seawater quality	The survey vessel will be operating under strict international regulations as set out in MARPOL Annex I (Prevention of Pollution by Oil), Annex IV (Prevention of Pollution by Sewage), and Annex V (Prevention of Pollution by Garbage). In addition, a Ship Oil Pollution Emergency Plan (SOPEP), along with a project-specific Environmental, Health and Safety Plan, will be followed to respond in the unlikely event of an oil spill from the vessel. As such, seawater quality should remain unchanged by the presence of the vessel. In order to prevent biofouling and the introduction of invasive species, the *M.V. Duke* will follow New Zealand's "Import Health Standard for Ships' Ballast Water from All Countries" (1993, and subsequent revisions). The survey vessel will already have been in New Zealand waters for several weeks prior to the commencement of the Māui 8 survey, and therefore biofouling is not considered likely to occur.
Sea turtles	The extent of potential impacts of anthropogenic noise to sea turtles is poorly understood. Their auditory system is considered less sensitive but the range of their best hearing seems to overlap with the low-frequency band of seismic airguns (DeRuiter & Doukara, 2012). The available evidence from literature suggests that sea turtles may show behavioural responses to an approaching operating airgun at a received level of around 166 dB re 1 µPa rms and avoidance responses at around 175 dB re 1 µPa rms (McCauley *et al.*, 2000). Both startle and avoidance responses to airguns have been documented by Weir (2007) and DeRuiter & Doukara (2012). Other potential effects include entrapment within seismic equipment and collision with the survey vessel. Sea turtles are only likely to be in the area during the summer months and although leatherback turtles (*Dermochelys coriacea*) have been recorded in the Taranaki region (WWF, 2010), it is very unlikely to expect that any sea turtles will be encountered during the proposed survey.
Fish	Previous research has shown that a seismic source can cause physical damage to fish only in the immediate vicinity of the airguns, at distances of less than a few metres. Adult fish will most likely flee from the intense sound source, while greater

	effects can be expected on fish eggs and larvae. However, mortality of fish eggs and larvae due the impact of airguns is insignificant compared to the natural mortality for most species at this life stage. Even though behavioural changes are likely to occur, the reported magnitude is variable. The impact on spawning, which is considered the most sensitive life stage for fish, will depend on the actual distance of behavioural impact. Overall, the potential for impact will depend on habitat, distribution and life histories of those species likely to be exposed to the sound source. Species least likely to be affected are deep dwelling soft bottom species and open water species that may occasionally occur within the survey area (Gausland, 2003). Given their abundance, wide distribution, and the temporal impacts of the proposed activity, any expected impacts on fish species will be insignificant.
Lobsters	Immature lobsters detect sounds in the range of 20-1000 Hz while sexually mature lobsters exhibit two distinct peaks: 20-300 Hz and 1-5 kHz (Pye & Watson, 2004). These frequencies - the lower end of the range in particular - overlap with seismic surveys' frequency range. However, there are no records of major startle or movement responses of crustaceans due to exposure to sound (Payne *et al.*, 2008). Also, a study investigating the effects of seismic surveys on catch rates of rock lobster (*Panulirus cygnus*) found that catch rates were unaffected in the weeks or years following seismic surveys (Parry & Gason, 2006). However, mortality of invertebrate larvae (planktonic phase) has been observed at close range (within 5 m) of a seismic acoustic source. Despite this, due to the size of the planktonic population and their high natural mortality rate, it is considered that significant effects from seismic surveys are unlikely (DMP, unknown). A reasonable number of lobster larvae ('*puerulus*') occur in the region, and possible settlement might be present along the New Plymouth coastline, specifically near Cape Egmont south of Patea (Daryl Sykes, pers. comm.). Lobster larvae at this stage can be affected by underwater noise, but considering the low intensity of the acoustic source such an effect can be expected only within the immediate vicinity of the source. It is therefore unlikely that there will be any significant effects to the settlement of lobster larvae near Cape Egmont.
Seabirds	There are a number of ways that birds can be affected by the survey: • Seabirds can interact with the survey vessel hence there is a potential for injury through collision or entanglement with the vessel equipment, particularly at night. This interaction can also be positive, with birds using the vessel as loafing and perching platforms. • Artificial lights on the vessel can cause disorientation and interfere with their ability to navigate (Black, 2005). • Acoustic injury can occur if any birds dive in very close proximity to the operating airgun array or they can get alarmed by the passing vessel. However a study on the effects of seismic surveys on seabirds (Stemp, 1985) failed to document any significant effects or fatalities. Variation of seabird abundance was

	less than the normal variation caused by weather and seasonal conditions. Stemp (1985) pointed out that seabirds are likely to fly or swim out of the way of the approaching vessel and, since airguns are being towed behind the vessel, they are less likely to be found in the imminent vicinity of the airguns. Given the short duration of the Māui 8 survey, the relatively simple towed equipment configuration, the low intensity of the sound source and the low likelihood of finding birds within the harmful range of airgun array, the potential effects on seabirds are considered to be insignificant. Also, it is likely that seabirds will avoid the area of the seismic activity especially given that the abundance of their prey in the immediate vicinity of operating airgun array is likely to be reduced due to avoidance reactions (Gausland, 2003).
Marine traffic	Due to the short nature of the Māui 8 site survey, any interference with local fishing activities and interaction with marine traffic is considered insignificant, especially given the fact that the survey will be take place in an area already developed, between two existing platforms where intensive fishing activities and frequent marine traffic are less likely to occur. In addition, there is an exclusion zone currently in place between the Māui A and Māui B platforms, which further reduces marine traffic in the proposed survey area.

3.4 Identification of Ecological Receptors and Establishing the Baseline

An early stage of the assessment establishes those marine mammals ('receptors') that may be affected by the proposed activities. Such receptors can include populations of particular species, communities of species, and designated conservation sites for any marine mammal species which could potentially be affected by the environmental changes created by the proposed survey. In order to determine what receptors may be affected, a Zone of Influence (ZoI) for the survey needs to be established. This is a method of quantifying the area within which impacts (positive and negative) are expected to occur. For a seismic survey, a ZoI is predominantly linked to the potential for underwater sound to propagate away from the sound source and influence potential marine mammal species at distance. Once the ZoI had been established for the Māui 8 site survey, potential marine mammal receptors were identified through a programme of desk study, and a baseline established for each species, taking into account the timing of the survey. It is the change from this baseline as a result of the survey activities which is assessed in order to quantify potential impacts. The baseline has been characterised using a desk-based approach using the following main data sources (Table 3.3).

Table 3.3 Baseline data sources

Data	Nature of Data	Source
Whale and dolphin international populations	Information on whale and dolphin species and their global threat classification	IUCN 2013. The IUCN Red List of Threatened Species. Version 2013.2
Whale and dolphin national populations	Data on the numbers of each marine mammal species present in New Zealand waters and their national threat classification	New Zealand Threat Classification System Lists – 2005. Department of Conservation, January 2007, 194
Whale and dolphin distribution	Distribution maps of whale and dolphin species present in New Zealand waters	NABIS 2014. New Zealand's National Aquatic Biodiversity Information System (NABIS)
Whale and dolphin distribution in the survey area	Information of whale and dolphin species and their distribution throughout the survey area	Torres, L.G. 2012. Marine mammal distribution patterns off Taranaki, New Zealand, with reference to OMV NZ

3.5 Valuing Receptors

In order to fully assess effects on an ecological receptor, the receptor must first be valued. Valuation of species is based on a relatively straightforward application of the two key aspects: conservation status, and abundance of the receptor within the ZoI.

Conservation Status

The conservation status of each species (using accepted IUCN and New Zealand national criteria) is determined using the definitions and associated scores set out in Table 3.4. This method takes full account of populations important at both the international and national levels. It should be noted that the overall Conservation Status score for each identified species is based on whichever of the two scores (IUCN or National) is highest according to Table 3.4.

Where data is deficient for a particular species, a conservative assessment has been assumed and a relatively high score of '7' assigned. If species are classed as 'Migrant' or 'Vagrant' according to New Zealand national criteria, then their IUCN status has been taken into an account.

Table 3.4 Conservation score[1]

Score	IUCN Red List Classification	National List	
10	Critically Endangered	Nationally Critical	Acutely Threatened
9			
8	Endangered	Nationally Endangered	
7	Data Deficient	Nationally Vulnerable or Data Deficient	
6	Vulnerable	Serious Decline	Chronically Threatened
5		Gradual Decline	
4	Near Threatened	Sparse	At Risk
3			
2	Least Concern	Range Restricted	
1			
0	Not Evaluated	Not Threatened	

Abundance within ZoI

The abundance and trajectory of a population within the ZoI has been incorporated into the valuation. This parameter governs the ability of a population to tolerate or recover from an impact. For example, a species that is possibly (but unlikely to be) present is scored lower than a species that is almost certainly present during a key life stage. Equally, whether a population is currently increasing or declining will affect how it reacts to particular changes in the environment. Taking into account the species abundance and trajectory therefore results in a more rounded assessment that considers the value of the ZoI for a species rather than just considering the conservation importance of the species alone. Table 3.5 sets out the abundance scoring definitions.

[1] The numbers 9,3 and 1 have no classifications against them as the number of IUCN and National List categories is less than 10, thus inevitably there are scores which are not used.

Table 3.5 Abundance valuation

Abundance	Population Trend	Score
Present in Internationally Important Numbers	Decreasing	10
	Unknown	9
	Stable	8
	Increasing	6
Present in Nationally Important Numbers	Decreasing	10
	Unknown	8
	Stable	7
	Increasing	5
Not present in Either Nationally or Internationally Important Numbers	Decreasing	4
	Unknown	3
	Stable	2
	Increasing	1

The overall value is determined numerically using the following formula:

$$Value = \frac{Conservation\ Score + Abundance\ Score}{20}$$

An overall valuation index of between 0 and 1 is therefore determined for each species (receptor) and Table 3.6 identifies the final value definitions used in this assessment.

For example, a species with a maximum conservation score of 10 (i.e. either IUCN critically endangered or nationally critical) and a maximum abundance score of 10 (i.e. present in the ZOI in internationally important, but declining, numbers) will score (10+10) / 20 = 1 (i.e. the maximum score) representing a species of high conservation value and with a low and declining abundance.

Table 3.6 Valuation of receptors

Valuation	Score
Very High	0.81 – 1.0
High	0.61 – 0.80
Medium	0.41 – 0.60
Low	0.21 - .0.40
Negligible	0 – 0.20

3.6 Identification of Mitigation Inbuilt Within the Survey Design

Two types of mitigation are considered within this MMIA:

- mitigation inbuilt within the survey design and operating protocols; and
- additional mitigation specifically designed to address issues not adequately covered by the inbuilt mitigation.

The first of these - inbuilt (or 'embedded') mitigation - is designed into the survey work from the outset as it is either a requirement of the 2013 Code (i.e. mandatory) which sets out the requirements for marine mammal mitigation for Level 2 surveys, or has been requested by the client as other mitigation they wish to follow. Such measures are identified and incorporated into the survey at the design stage and are therefore included in the initial assessment of effect magnitude as ignoring them would give a false view of the 'core' mitigation included within the survey.

3.7 Impact Magnitude

The magnitude of an effect is made up of two components: severity and the proportion of the population affected. When combined, these constitute the overall magnitude of effect on each receptor (species). Qualitatively, these two elements include consideration of the extent, duration, timing, reversibility and frequency of the effect and reflect a continuum of the potential consequences of a response by a receptor to a potential effect. These elements are key considerations in the determination of the magnitude of impacts as outlined in the IEEM (2010) guidance. The definitions for the different levels of severity range from 'no response' at the low end to 'death or injury leading to significant reduction in survival or fecundity of an individual' at the upper end (as set out in Table 3.7).

Severity of Effect

Severity is included as a key component as it describes the predicted nature of behavioural changes or injury to individuals as a result of each potential effect. Table 3.7 sets out definitions of severity used in this assessment.

Table 3.7 Impact severity

Definition	Score	Description
High	4	An effect which results in either long term (e.g. seasonal or yearly) behavioural responses by individuals that leads to avoidance of the survey area and/or permanent injury to individuals. Effects result in mortality or long term reductions in fecundity/populations.
Medium	3	Medium term (e.g. months) behavioural responses by individuals that leads to avoidance of the survey area resulting in medium term changes in foraging efficiency and possible reduction in fecundity. Permanent injury to individuals leading to medium term changes in foraging efficiency and possible reduction in fecundity.
Low	2	Short term (e.g. days) behavioural responses by individuals that may lead to avoidance of the survey area (or part of), leading to short term

		changes in foraging efficiency. Temporary injury to individuals leading to short term changes in foraging efficiency.
Negligible	1	Short term (e.g. hours) behavioural responses by individuals with no lasting avoidance of the survey area or impact on foraging efficiency. No injury to individuals.
None	0	No behavioural response or injury to any animal.

Proportion of Population Affected

A predicted effect may not affect all animals within the ZoI. For example, animals at the edge of the ZoI will not be subject to vessel collision risk or to the very highest impacts of noise (due to the dissipation of power level over distance). It is therefore considered appropriate to include a measure of the 'Proportion of Population[2] Affected' (PoPA) within the magnitude calculations.

The PoPA incorporates largely the extent of the impact but also incorporates elements of duration and frequency i.e. more individuals are likely to be affected by an impact with a larger footprint. In addition within a highly mobile and potentially responsive population, the frequency and duration of the effect will have a role in determining how many animals are affected. The flexibility in how the PoPA is calculated depending on the nature of the impact allows this framework to be applied across all potential impacts. For example, for noise impacts, the area over which noise impacts are expected to occur and the duration and frequency over which they occur are important elements in predicting how many animals may be at risk of auditory injury or behavioural disturbance.

For each potential effect, an assessment is made of the potential number of individuals that are likely to be affected. This assessment is quantitative, wherever possible, and a score is applied based on defined thresholds for the population concerned (see Table 3.8). In some instances, a quantitative assessment is not possible, either because there is uncertainty about the exact nature or mechanism of an impact on a receptor and therefore numbers affected cannot be calculated, or because data are lacking on the abundance of the appropriate reference population. In these cases assessment will be necessarily qualitative and is based on the available information on extent, duration, timing of impact, and expert opinion.

Table 3.8 Proportion of population affected

Definition	Score	Proportion of Population Affected
High	4	20.1%+
Medium	3	10.1 – 20%
Low	2	5.1 – 10%
Very Low	1	0.1 – 5%
Barely Perceptible or None	0	0 - 0.09%

[2] The population considered is that present within the ZoI, not the numbers in New Zealand waters or globally, as this is covered by the 'abundance' metric within the consideration of receptor sensitivity.

The overall impact magnitude is determined numerically using the following formula:

$$Impact\ Magnitude = Severity\ of\ Effect\ X\ Proportion\ of\ Population\ Affected$$

An overall valuation index of between 0 and 16 is therefore determined for each species (receptor) and Table 3.9 identifies the final impact magnitude definitions used in this assessment.

Table 3.9 Impact magnitude

Valuation	Score
High	10 – 16
Medium	5 – 9
Low	2 – 4
Negligible	0 – 1

3.8 Significance

The determination of impact significance involves the interaction of the receptor value, together with the assessment of the overall magnitude of the various impacts upon the receptor. The more valuable a receptor, and the greater the magnitude of a given impact on that receptor, the higher the significance of the impact.

This MMIA is undertaken in relation to the baseline conditions that would be expected to occur if the proposed seismic survey were not to take place, and therefore may include possible predictions of future changes to baseline conditions, such as environmental trends and other completed or planned developments. Both beneficial and adverse effects are possible. It should be noted that only potentially adverse effects are predicted in this MMIA and the methodology therefore concentrates on characterising and define such adverse (negative) effects (as defined in Table 3.11).

Table 3.10 identifies, in general terms, the way in which the significance of impacts is considered in this MMIA. It is important to appreciate that this does not represent a rigid framework for assessment - there are gradations between different categories of site and impact, and on occasion the significance of a particular impact may not be precisely in accordance with the categories shown below.

Table 3.11 provides descriptions of each of the significance descriptors used in Table 3.10. For the purpose of this assessment, only impacts identified as Major or Moderate are considered to be significant.

Table 3.10 Impact significance matrix

Value of Receptor	Magnitude			
	High	**Medium**	Low	**Negligible**
Very High	**Major**	**Major**	**Moderate**	Not Significant
High	**Major**	**Moderate**	Minor	Not Significant
Medium	**Moderate**	Minor	Minor	Not Significant
Low	Minor	Minor	Not Significant	Not Significant
Negligible	Not Significant	Not Significant	Not Significant	Not Significant

Table 3.11 Significance descriptions

Significance	Description
Major (Adverse)	An effect which, if adverse, gives rise to serious concern and is unacceptable in terms of the integrity of the receptor (site/species) or policy/legislative status. Additional mitigation is required to reduce the effect to an acceptable level.
Moderate (Adverse)	An effect which, if adverse, gives rise to some concern and is potentially unacceptable in terms of the integrity of the receptor (site/species) or policy/legislative status. Following the precautionary principle, additional mitigation is required to reduce the effect to an acceptable level.
Minor (Adverse)	An undesirable effect but of limited concern in terms of receptor integrity or policy/legislative status. No additional mitigation is required.
Not Significant	An impact of no concern in terms of receptor integrity or policy/legislative status. No additional mitigation is required.

3.9 Additional Mitigation, Re-Assessment and Identification of Residual Effects

If the initial impact assessment identifies any significant impacts (i.e. those marked Major or Moderate in Table 3.10), additional mitigation is normally required to either eliminate or reduce effects to a non-significant level.

Effects are re-assessed following the inclusion of any further mitigation and residual effects identified. If robust mitigation is available then it is likely that any residual effects will be reduced to a non-significant level. However, in some cases no further appropriate, effective mitigation can be identified and significant residual effects can remain. In this case, the survey will not be in compliance with the Code and an alternative method/survey will be required.

4. Noise Propagation Modelling

4.1 Introduction

During a seismic survey an array of airguns is used as the main acoustic source to provide imagery of the seabed and subsurface characteristics. The airgun can be seen as an anthropogenic sound source able to increase the ambient noise level in the area of activity. However, sound is also used by marine fauna, especially the marine mammals, to communicate, navigate, detect prey and predators, etc. Consequently a significant change of the acoustic environment could result in considerable impacts on marine mammals.

In accordance with the 2013 Code requirements, a dedicated noise propagation modelling study was completed in order to predict the expected received levels and impact ranges on marine mammals from a 220 cu. in. airgun array:

"Where activities are planned in Areas of Ecological Importance or Marine Mammal Sanctuaries, sound transmission loss modelling will be incorporated into the MMIA methodology and ground-truthed during the course of the survey by appropriate means. Such modelling will indicate predicted sound levels within the various mitigation zones and potential impacts on species present. If sound levels are predicted to exceed either 171 dB re 1 µPa2s (SEL) at distances corresponding to the relevant mitigation zones for Species of Concern or 186 dB re 1 µPa2s at 200 m (SEL), consideration will be given to either extending the radius of the mitigation zone or limiting acoustic source power accordingly."

Details of the modelling undertaken for this MMIA are provided below, including provision of results. The full noise propagation modelling report can be found in Appendix B.

In order to meet 2013 Code requirements and validate impact ranges predicted and the suitability of the mitigation area, underwater acoustic ground-truthing will be conducted during the course of the survey.

4.2 Noise Propagation

Sound results from the propagation of a mechanical disturbance in a compressible medium, which are associated fluctuations in pressure and density due to particle motion.

Water is denser and less compressible than air therefore the sound propagates faster in water than in air: sound speed on average in water is ~1521 m/s while in air ~344 m/s, and attenuation is generally less.

The source level (SL) can be given by the addition of the received level (RL) and propagation or transmission propagation loss (TL) by SL=RL+TL.

Propagation or Transmission Loss (TL) is the term used to describe the reduction of the sound level as a function of distance from an acoustics source, and will be dependent on the environmental characteristics of a specific area. The mechanisms by which the sound intensity reduces are primarily geometrical spreading, sound absorption in the water and losses into the seabed or other boundaries. The accurate estimation of the transmission loss requires a precise model for the transmission of the sound and its interaction with the seabed and sea surface.

4.3 Noise Propagation Modelling Method

The noise propagation study has employed the acoustic propagation model RAM (Collins, 1993) which uses the parabolic equation solution to the wave equation, based on AcTUP V2.2L. Parabolic equation models are an efficient class of models for solving low-frequency characteristic of the wave equation in range-dependent environments. The RAM variant which has been utilised in the study was RAMGeo. RAMGeo implements a stratified seabed model in which multiple bottom layers run parallel to the bathymetry.

The accuracy of the propagation model is limited by the quality and resolution of the available environmental data, such as: bathymetry data; sound speed profiles in the water column and geo-acoustic profiles of the ocean sub-bottom.

In order to assess the propagation loss radiating from the source point, eight transects were chosen (N, NE, E, SE, S, SW, W, NW) (Figure 4.1). Depth points along each modelling radial were taken from the bathymetry data supplied by STOS. It should be noted that the Māui 8 block is characterised by shallow water and almost flat bathymetry with water depths around 100 m.

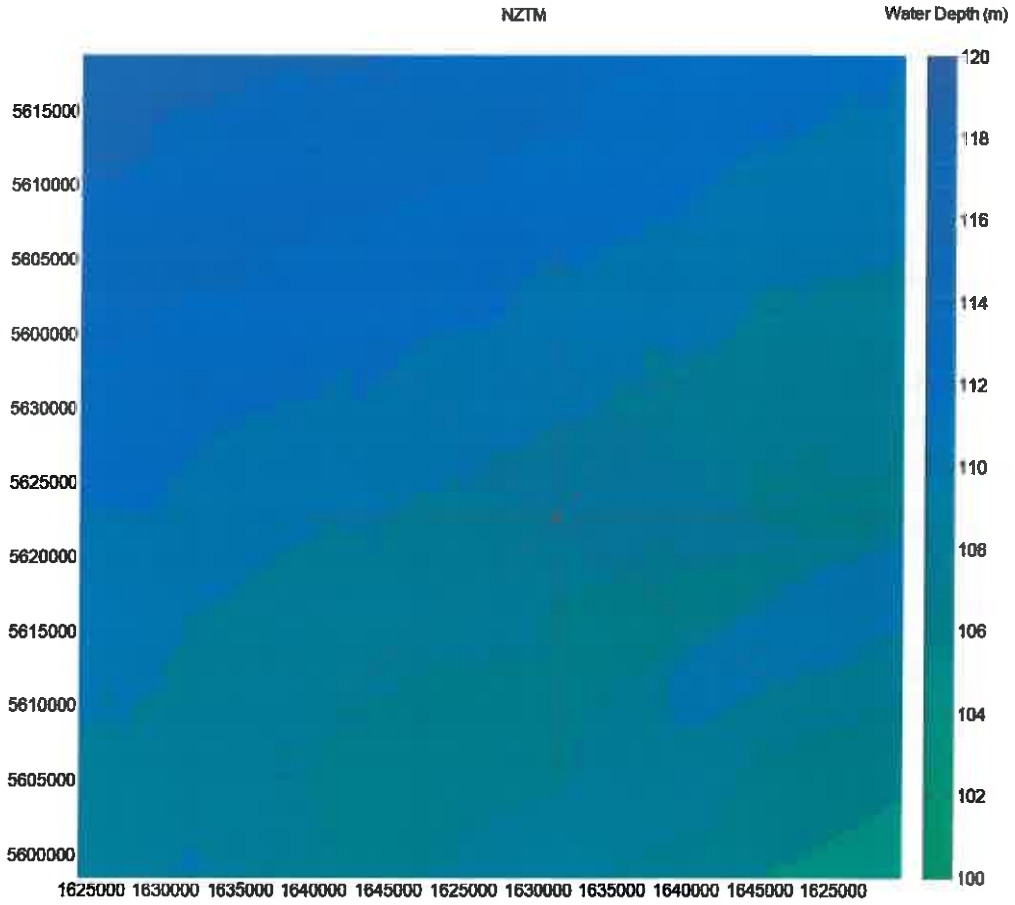

Figure 4.1 Bathymetry at the Māui 8 site and transects chosen for the propagation modelling

Transmission loss was computed in 1/3 octave bands from 10 Hz to 1 kHz — this frequency range contains the large majority of acoustic energy radiated by an airgun array, usually under 200 Hz.

The sound speed profile was calculated from ambient water column properties. The profile was provided by STOS from a previous site survey in the area in April 2004, with an overall mean sound speed of 1506.33 m/s. Regarding the geo-acoustic properties of the site, a clayey - silt seabed with a sound speed of 1535 m/s, density of 1380 kg/m^3 and an absorption between 1.25-1.5 dB/wavelength (Hamilton, 1970; Hamilton & Bachman, 1982) was assumed.

The sound source, with a zero-to-peak pressure 237 dB re 1 µPa^2.m^2 and a peak-to-peak pressure 243 dB re 1 µPa^2.m^2, was assumed as a point source located at 2.5 m depth.

4.4 Modelling Results and Impact Assessment

Due to the bathymetric characteristics of the area being similar across the different transects and in the Māui 8 area as a whole, the propagation loss and impact ranges obtained for the different transects were identical. While the proposed tie lines were not included in the acoustic modelling transects, again the consistent bathymetry across the whole site mean that the predicted noise propagation whilst the vessel is running the tie lines will follow the same pattern as described for the transects shown in Figure 4.1.

In order to predict the received levels at each distance, the propagation loss calculated for each centre 1/3 octave frequency band was subtracted from the source level. Un-weighted Sound Exposure Levels (SEL) for a pulse duration of 0.1 seconds, zero-to-peak Sound Pressure Level (SPL) and root mean square (RMS) SPL were estimated.

In order to provide supporting information for the mitigation plan for the area, in accordance with the 2013 Code requirements, an estimation of instantaneous impact and behavioural disturbance ranges was conducted.

The criteria in the 2013 Code are based on M-weighted values (Southall *et al.*, 2007) for pinnipeds in the water. In order to present a more comprehensive study in this report the impact range estimation also covered the cetacean groups (low, medium and high frequency) based on Southall *et al.* (2007).

The Southall *et al.* (2007) criteria are a dual – criteria approach based on zero-to-peak SPL and energy (SEL). In this method the signal was weighted relative to hearing abilities of the species group and the M-weighted SEL were calculated (Southall *et al.*, 2007).

Using the propagation loss model results and the impact criteria for marine mammals outlined in Southall *et al.* (2007), ranges over which marine mammals may be impacted during the Māui 8 seismic site survey have been estimated (Tables 4.1 and 4.2).

Table 4.1 Injury impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses)

Species Group / Injury Threshold Values (Single Pulse)	All Transects (N, NE, E, SE, S, SW, W, NW)
	Range (m)
High Freq. Cetaceans	
Peak SPL 230 dB re 1 µPa².m²	<10
SEL 198 dB re 1 µPa².m².s	<5
Mid Freq. Cetaceans	
Peak SPL 230 dB re 1 µPa².m²	<10
SEL 198 dB re 1 µPa².m².s	<5
Low Freq. Cetaceans	
Peak SPL 230 dB re 1 µPa².m²	<10
SEL 198 dB re 1 µPa².m².s	<5
Pinnipeds in water	
Peak SPL 218 dB re 1 µPa².m²	<20
SEL 186 dB re 1 µPa².m².s	<5

Table 4.2 Behavioural impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses)

Species Group / Behavioural Threshold Values (Single Pulse)	All Transects (N, NE, E, SE, S, SW, W, NW)
	Range (m)
High Freq. Cetaceans	
Peak SPL 224 dB re 1 µPa².m²	<10
SEL 183 dB re 1 µPa².m².s	<5
Mid Freq. Cetaceans	
Peak SPL 224 dB re 1 µPa².m²	<10
SEL 183 dB re 1 µPa².m².s	<5
Low Freq. Cetaceans	
Peak SPL 224 dB re 1 µPa².m²	<10
SEL 183 dB re 1 µPa².m².s	<5
Pinnipeds. in water	
Peak SPL 212 dB re 1 µPa².m²	<30
SEL 171 dB re 1 µPa².m².s	<5

As can be observed above, based on the peak noise criteria by Southall *et al.* (2007), injury in cetaceans is only likely to occur within 10 m of the airgun array source, and in pinnipeds within 20 m. Behavioural disturbance is only likely to occur within 10 m and 30 m, for cetaceans and pinnipeds respectively. Based on the M-weighted SEL noise criteria the injury and behavioural impact ranges are only likely to occur within 5 m of the airgun array source, for cetaceans and pinnipeds. The low impact ranges obtained through modelling are in line with those expected as the airgun array is small in capacity (220 cu. in.), and therefore the source levels are relatively small compared with larger volume airgun arrays.

It should be noted that these predictions were made for a single pulse of the airgun array (which is in line with the threshold criteria outlined in the 2013 Code for pinnipeds).

The sound levels during the survey are not expected to exceed 171 dB re 1 μPa^2s (SEL) at distances corresponding to the relevant mitigation zones for Species of Concern nor the 186 dB re 1 μPa^2s at 200 m (SEL). Consequently, there is no need to either suggest an extension to the radius of the mitigation zone, or to reduce the proposed acoustic source power.

5. Baseline and Evaluation of Receptors

This section sets out the environmental characteristics and the potential ZoI of the survey operations. Only those parts of the environment which are relevant to this MMIA are described, this is not a full, detailed characterisation of the marine environment, its physical-chemical properties, the attendant flora and fauna, or the socio-economic conditions pertaining to the Māui Field or wider drilling operations.

5.1 Zone of Influence

The ZoI is stated as the potential area subject to the seismic survey influence on marine mammals. In any impact assessment, the ZoI should be defined according to the source characteristic of the proposed activity. The seismic sound source is characterised by being a moving point source, as the vessel travels along predetermined survey lines. Consequently, the ZoI in this assessment will be relative to the movement of the source, not a fixed area for the duration of the entire seismic survey.

The noise prediction modelling (see Section 4), demonstrated that both injury and behavioural disturbance from the proposed acoustic source - an airgun array of 220 cu. in. - is only likely to occur within a maximum of 30 m of the airgun array source for cetaceans and pinnipeds, considering a single pulse.

However, for multiple pulses the cumulative sound exposure level during the survey period will increase the impact range of behavioural disturbance and the zero-to-peak SPL should be considered according to Southall, *et al.* (2007). The extension of the behavioural impact range due to multiple pulses is more difficult to estimate and it is related to the airgun source capacity. There are some opportunistic observations of behavioural changes of sperm whales and blue whales as a response to some airgun activities at great distances from the source (Bowles *et al.*, 1994; McDonald, *et al.*, 1995). Available data (McCauley, 1994) suggests that marine mammals avoid seismic vessels within a 1 – 3 km range (i.e. when received impulse levels reach 160 - 170 dB re 1 μPa^2). It should be highlighted that extension of the behavioural responses will be related to the sound source level, and therefore related with the acoustic source capacity. The acoustic sources in the aforementioned documented observations were far more powerful than the airgun array under the present assessment (220 cu. in.) therefore the extent of any potential behavioural changes during the Māui 8 survey is expected to be far smaller.

The acoustic source i.e. survey vessel will be constantly moving position therefore it is not possible to consider cumulative sounds exposure levels from a fixed point. In order to consider the greatest spatial extent of the potential impact of the source wherever it was positioned (which could be anywhere within the operational area), the appropriate ZoI will therefore extend beyond the defined operational area.

Taking all this into an account, the ZoI for the present MMIA has therefore been set at 1 km radius around the operational area, considering the mitigation area and a highly precautionary approach being used. Even though the noise prediction modelling identified the zone in which behavioural disturbance may occur, minor behavioural changes may be seen at far greater distances. In addition, cumulative sound exposure levels are difficult to predict, so a chosen distance will definitely encompasses them. The overall ZoI for the survey therefore covers 575 km^2 (Figure 5.1). By the noise prediction modelling at 1 km the zero-to-peak sound pressure level is expected to be less than 170 dB re 1 μPa^2 (See Appendix B).

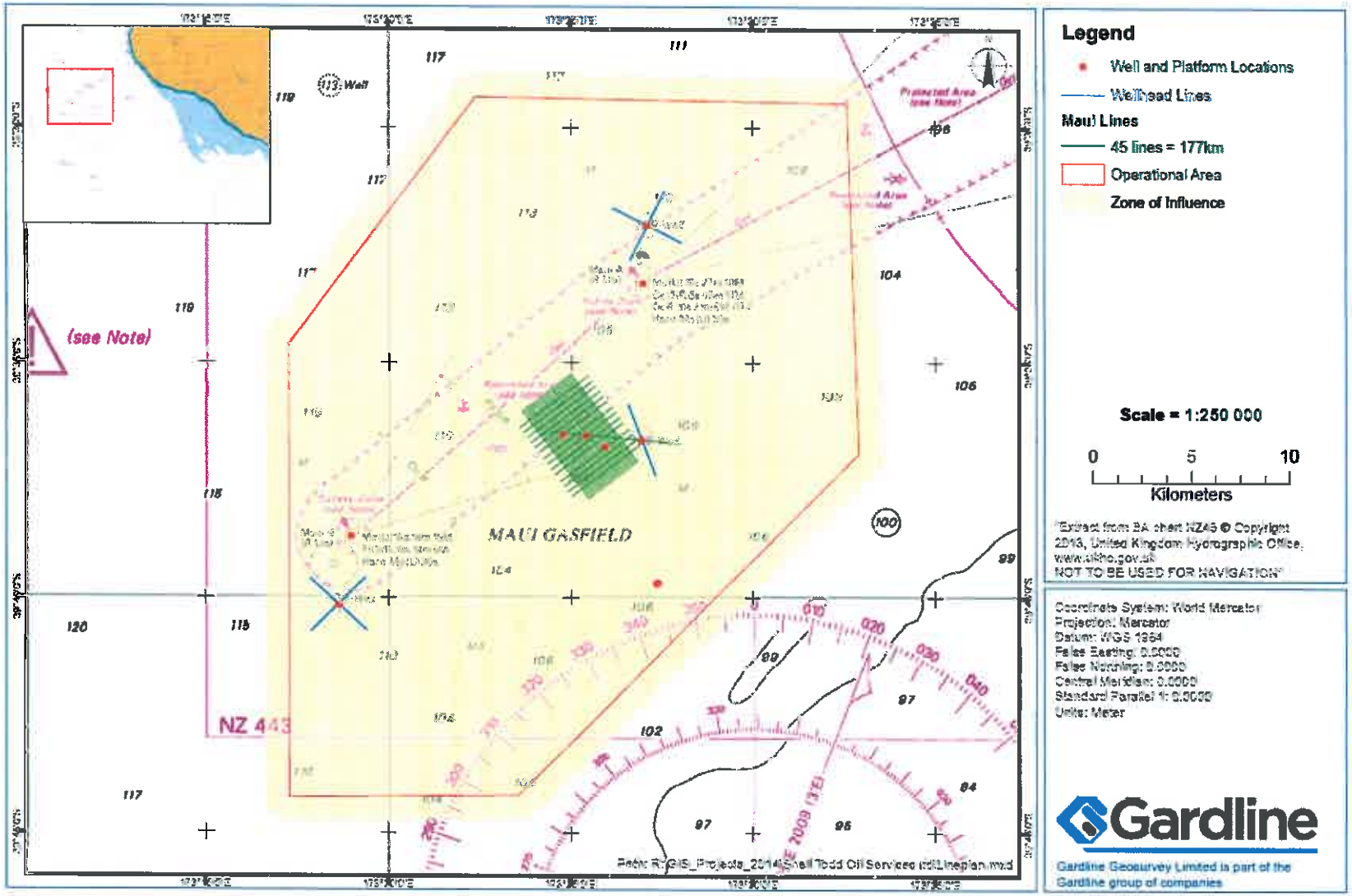

Figure 5.1 Map of the Māui 8 survey area indicating the Zone of Influence

5.2 The Social and Cultural Environment

Taranaki Iwi have existing interests through their exercise of mana whenua and mana moana within the area of interest. STOS understands that there are a range of cultural considerations relating to its activities within the area of interest and STOS continues ongoing discussions with the Taranaki Iwi Trust to identify any cultural impacts associated with these activities and how they may be addressed, as part of a broader relationship.

5.3 The Wider Anthropogenic Environment

Several human activities occur in the area surrounding the survey site. The dominant ones, aside from traditional Iwi activities mentioned above, are commercial and recreational fishing, shipping, and petroleum exploration and production. Details of the existing anthropogenic activities in and around the Māui 8 survey area are provided below.

Fisheries

Alongside customary fisheries, there are two other important types of fisheries in New Zealand: commercial and recreational. Commercial fishing is regulated through quotas established by the Quota Management System (QMS) for each Fisheries Management Area (FMA). It is well monitored by the Ministry for Primary Industries (MPI). In 2009, the total asset value of New Zealand's commercial fisheries was NZ$ 4,017 million (Statistics NZ, 2010). Although there are no exact numbers of employment in commercial fisheries, it is known that in the Taranaki region, the forest, agricultural and fishing industries are among those with the highest number of employees in 2012 (Statistics NZ, 2014). Trawling is the main fishing method used in New Zealand to catch fish, and these are the vessels most likely to be expected in the survey area (MPI, 2014c). However, trawling effort is less present in the survey area compared to other regions in New Zealand (Figure 5.3). In addition to trawling, set net fishing is another fishing method employed in the area (MPI, 2014d). Figure 5.3 and 5.4 shows the general spatial pattern of trawl fishing activity and set net activity around the North Island.

Recreational fishing targeting several species also occurs in the Taranaki region. These fisheries are regulated through different means compared to commercial fisheries and are not part of the QMS. Nevertheless, there are regulations in place such as minimum size and catch limits. There are also specific rules for several species of finfish, two species of rock lobster (*Jasus edwardsii* and *Sagmariasus verreauxi*) and several other rules for shellfish (MPI, 2014e). During summer, big game fishing also occurs (Hauldsworth & Haul, 2012) which is likely to increase the number of vessels in the area. In general, the amount of recreational fishing vessels in the survey area itself is not expected to be high owing to the absence of significant fish aggregations and nearby local boat launching ramps (Johnston *et al.*, 2012; Johnston & Forrest, 2012).

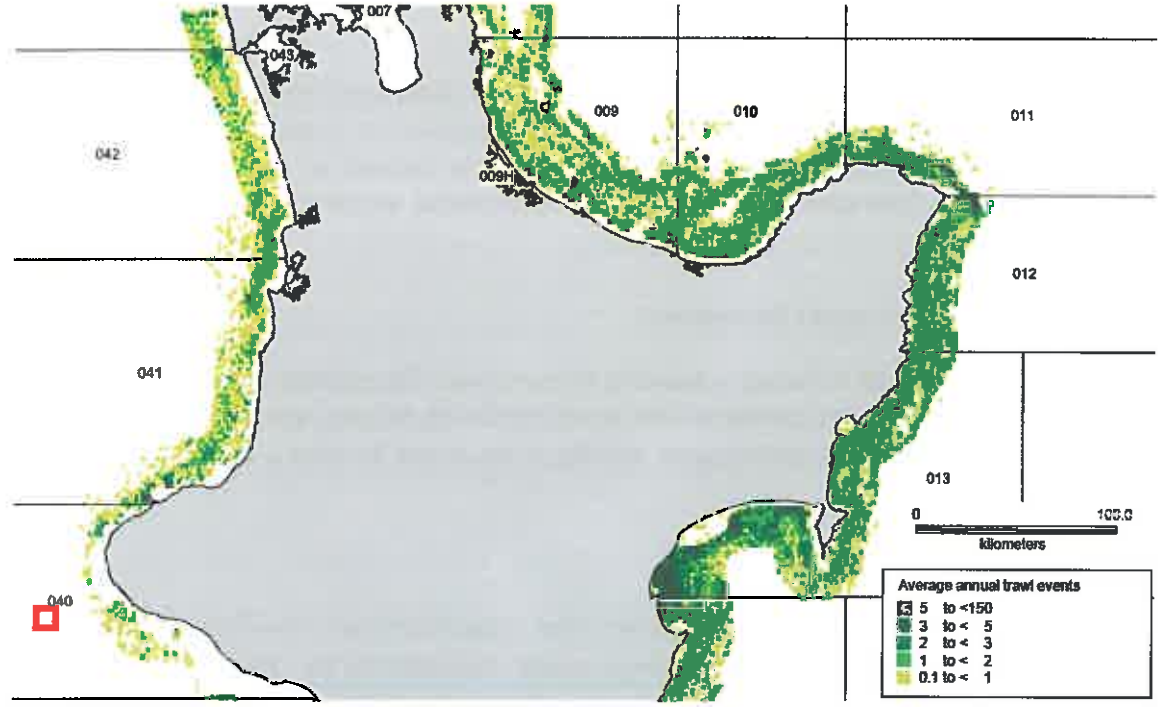

Figure 5.2 General spatial pattern of trawl fishing activity based on data set 2007-2010 (approximate location of the Māui 8 site is marked with red square)

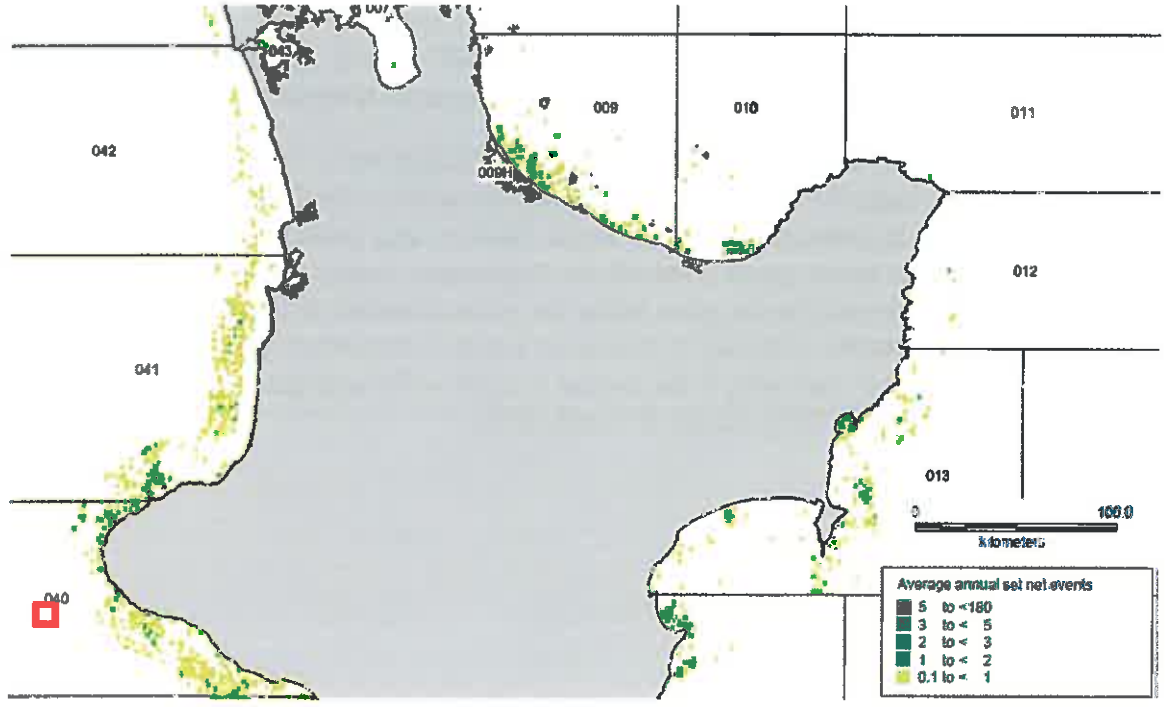

Figure 5.3 General spatial pattern of set net fishing activity based on dataset 2007-2010 (approximate location of the Māui 8 site is marked with red square)

Shipping

Marine traffic is important in the survey area due to the proximity of Port Taranaki in New Plymouth, which is one of thirteen major ports in New Zealand. Traffic is mainly due to commercial shipping and oil and gas activities. The main shipping lanes are between the major fishing bases of Nelson and Port Wellington. Due to the high level of petroleum activity in the region, and in order to prevent collisions, in 2006 the International Maritime Organisation created a Precautionary Area, the Taranaki Offshore Area, which entered into force in 2007. This informs all vessels of the occurrence of petroleum activities (Maritime NZ, 2014).

Petroleum Exploration and Production

Petroleum exploration and production activities are well established in the Taranaki Basin, and currently the region is the only one where oil and gas is found in economically viable quantities. Seismic surveys conducted since the 1950s have resulted in the drilling of 400 onshore and offshore exploration and production wells. To date no wells have been drilled beyond the continental shelf (NZPAM, 2014).

Other Considerations

Other uses of the marine environment in the Taranaki region tend to be much more coastal, such as tourism activities including sailing tours. Despite the presence of cetaceans in the area there are currently no whale- or dolphin-watching tours organised. Occasionally, research expeditions take place in the area, with the most recent one conducted in January 2014, the main goal of which was to collect data on the presence of blue whales in the South Taranaki Bight (NIWA, 2014).

5.4 The Physical Environment

Due to the potential for seismic sound to be affected by the physical properties of the water of the Taranaki Basin, a description of the physical characteristics of the seabed and overlying waters are provided in the following sub-sections.

5.4.1 Bathymetry

The south eastern boundary of the Taranaki Basin is the shallowest region (Figure 5.4). The seafloor drops in the northwest to 1250 m at which point the slope gradient decreases and eventually reaches a depth of 2000 m. There is a steep rise in the central north segment of the basin however all other parts are comparatively shallower and flatter than the northern region. The shelf area is approximately 30,000 km^2 and slopes towards the west with an overall gradient of less than 0.1˚. The Māui 8 survey will be carried out in depths of approximately 110 m.

5.4.2 Circulation and Currents

Circulation in the Taranaki Basin is influenced predominantly by wind, regional circulations and tides which are semi-diurnal. New Zealand is situated on the eastward-forward southern branch of the South Pacific sub-tropical gyre. This is driven by the southeast Trade Winds to the north and the Roaring Forties westerly winds to the south which creates the anti-clockwise circulation within the gyre (Figure 5.5). Currents on the west coast are usually weaker and more variable than those along the east coast. The West Auckland Current (WAUC) flows

southwards along the west coast of the North Island and is met by north-flowing currents from the Westland Current (WC) in the Taranaki Bight. These currents are both sub-tropical in origin, and therefore, sea temperatures generally range from 13°C to 22°C. Based on the Global Hybrid Coordinate Ocean Model (Global HYCOM), sea surface currents average between 0.35 to 0.5 m/s in the operational area of the survey and are stronger on the continental shelf of Taranaki where velocity can be as high as 2 m/s (Chassignet *et al.*, 2007). In the South Taranaki Bight, the D'Urville Current (DC) is forced south-east through Cook Strait by the prevailing westerly and north-westerly winds. This current is relatively warm, saline and well stratified compared to water in the Tasman Sea.

5.4.3 Water Density (Temperature and Salinity)

Seasonal and monthly average temperatures of the sea surface near the proposed location are shown in Table 5.1. In the operational area at the time of the survey, SST is expected to be between 16°C and 19°C and salinity is expected to be between 35 and 36 parts per thousand (ppt).

5.4.4 Thermocline

Thermal stratification occurs in the Taranaki Basin during the spring and summer months due to solar heating of the upper water column, with comparatively low levels of dissolved inorganic nutrients being present. Stratification is broken down in late autumn as a result of turbulent mixing of the water column and less solar radiation creating an isothermal water column. A seasonal thermocline occurs at the mid-water level which breaks down in winter and spring. The level of stratification is influenced by weather conditions, and thermal stratification could breakdown in summer as a result of vertical mixing caused by storms. In contrast it is possible for a well defined thermocline to develop in summer during settled periods.

5.4.5 Seabed Sediments

The Taranaki Basin is a Cretaceous and Tertiary sedimentary basin along the western side of the North Island. The Taranaki shelf consists of sandy silts to silt and muds further offshore. Surficial sediments at the Māui A platform predominantly consist of mud-sized particles, whereas at Māui B sediments were grading towards the finer grain sizes, with silt and clay accounting for the bulk sediment type (Johnston & Forrest, 2012).

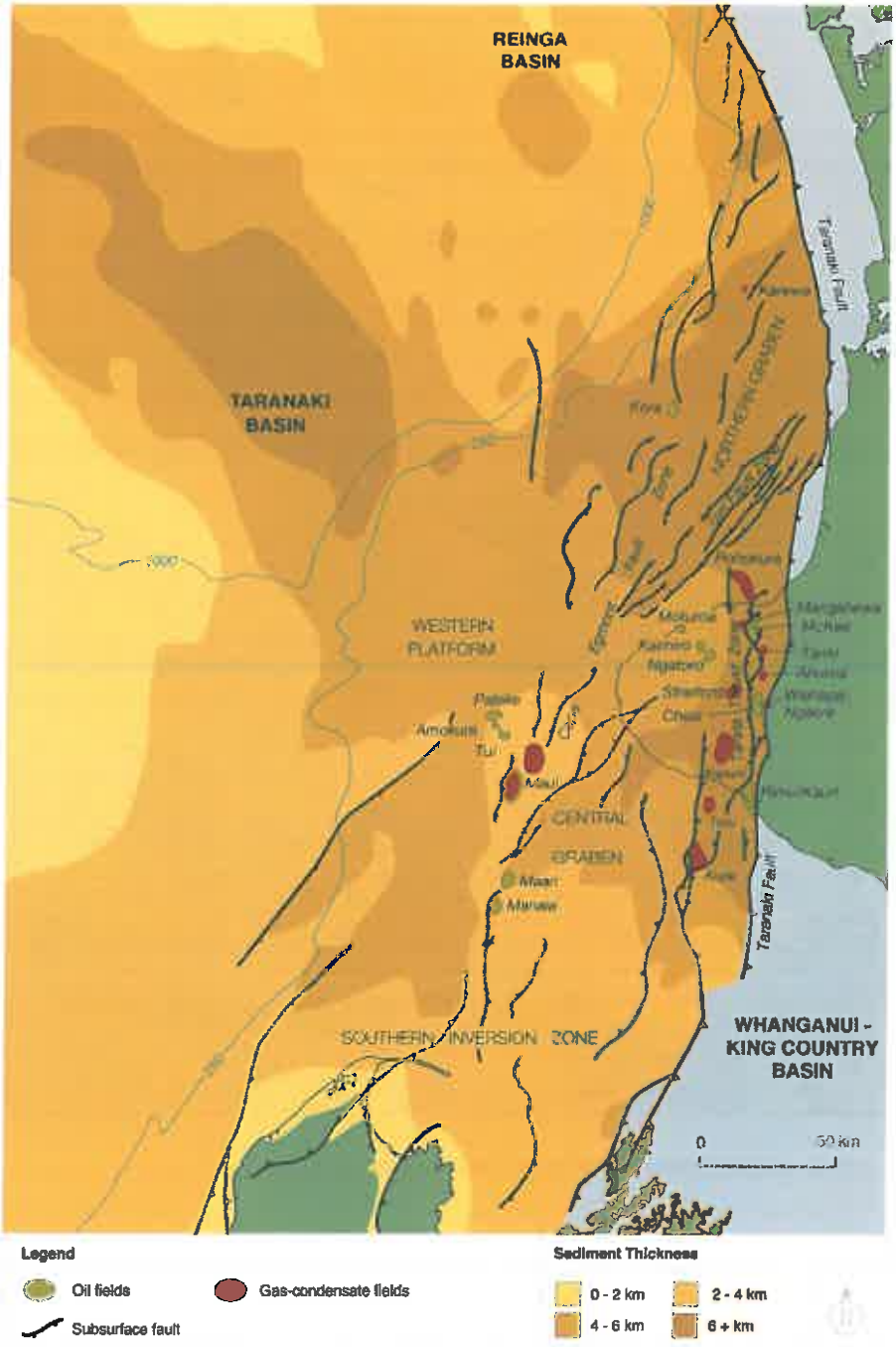

Figure 5.4 Taranaki Basin map and bathymetry *(source: NZ Petroleum and Minerals, 2013)*

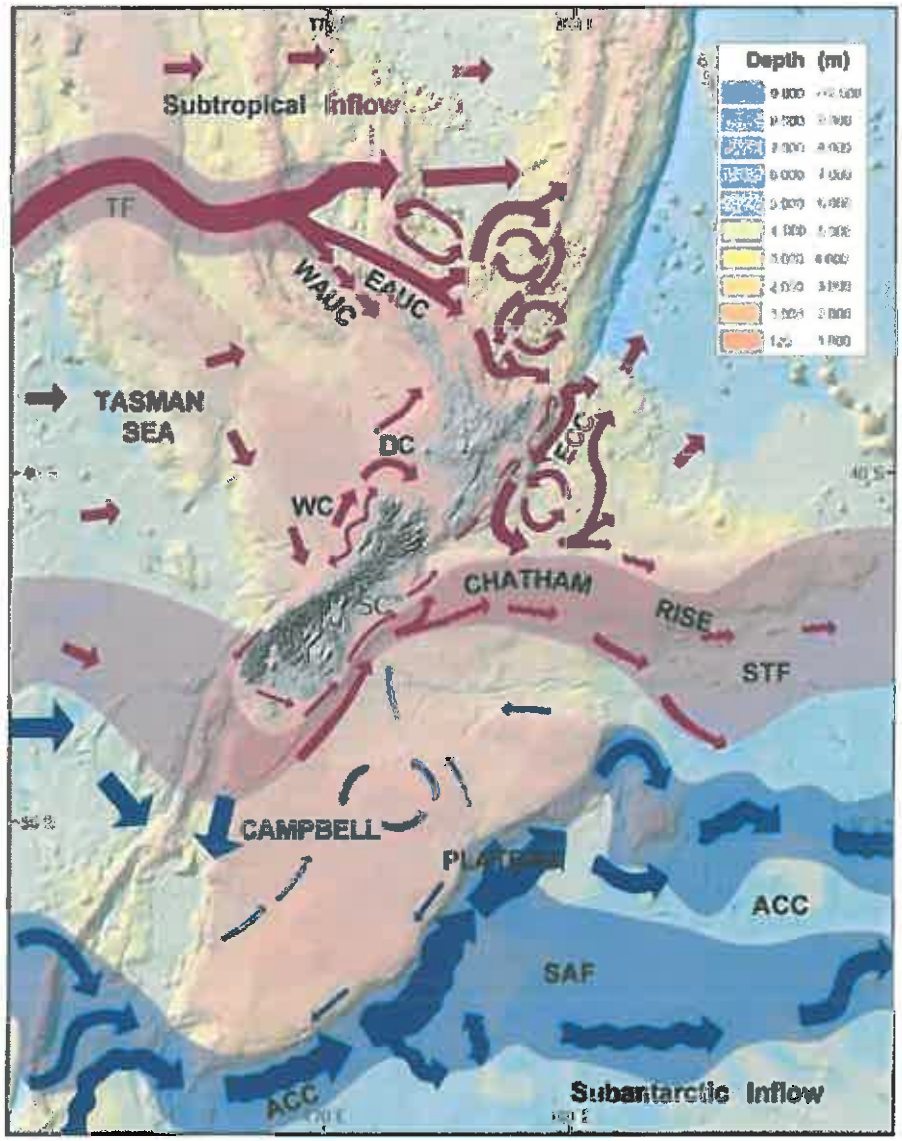

Figure 5.5 New Zealand currents and water masses *(source: Te Ara, 2014)*

Table 5.1 Mean monthly sea surface temperatures (SST) at 39.353870°S / 173.338710°E from satellite data (2000-2009) for period March-May.

Month	Sea Surface Temperature (°C)	
	Monthly Average	Seasonal Average
March	18.27	17.59
April	17.75	
May	16.73	

5.5 Designated Marine Conservation Sites

There are over 30 legally protected marine reserves in New Zealand providing the highest level of marine protection and covering 7.06% of the territorial sea, and these are managed by DOC. The marine reserves have been established to protect representative marine habitats and communities for science and education, and to provide a safe haven for marine life to live and breed. In addition, all the animals, plants and the seabed within reserves are legally protected under the Marine Reserves Act 1971 which states:

- No fishing, netting, spearing, taking or killing marine life including seaweeds. All methods of fishing from the shore or at sea are prohibited within the reserve area.
- No activities that pollute, disturb or damage marine life or the seabed.
- No removal of any natural material from the marine reserve.

There are a number of marine reserves in the vicinity of the survey area with the Tapuae Marine Reserve (west North Island) being the closest (Figure 5.6 and 5.7). This reserve covers 1,401 ha and it is characterised by a diverse range of habitats from canyons to boulder fields which serve as a shelter and nursery for many marine species (DOC, 2014c). Many species of fish, invertebrates and algae can be found here together with several marine mammal species such as short-beaked common dolphins (*Delphinus delphis*), pilot whales (*Globicephala sp.*), killer whales (*Orcinus orca*), humpback whales (*Megaptera novaeangliae*) and southern right whales (*Eubalaena australis*). Also, the New Zealand fur seal (*Arctocephalus forsteri*) has an important breeding and haul out site within the reserve.

Paraninihl Marine Reserve is positioned north of Tapuae while two more reserves are present around the Wellington coastline, Kapiti and Teputeranga. There are a further four marine reserves (Westhaves, Tonga Island, Horoirangi and Long Island) along the northern coastline of the South Island which could be considered proximate to the wider Taranaki region.

New Zealand has a total of six marine mammal sanctuaries (MMS). MMSs are established throughout New Zealand waters to create a permanent refuge for marine mammals. The sanctuaries prohibit activities known to harm particular marine mammal species. The key component to each sanctuary is to protect the remaining populations of endemic species from fisheries. However, other activities i.e. tourism, mining and energy exploration, are also strictly controlled within these areas. Through the Marine Mammals Protection Act 1978, DOC is responsible for administering and managing marine mammal sanctuaries.

The West Coast North Island Marine Mammal Sanctuary, which was established in 2008 as part of the Hector's (*Cephalorhynchus hectori*) and Maui's dolphin (*Cephalorhynchus hectori maui*) Threat Management Plan, is situated north from the Māui 8 survey area along a large part of the Taranaki coastline. The West Coast North Island MMS includes the area from Maunganui Bluff in Northland to Oakura Beach, Taranaki in the south. The total area of the sanctuary is approximately 1,200,086 ha covering 2,164 km of coastline and it contains a huge variety of coastal and marine habitats although its main priority is the protection of Maui's dolphins (Figure 5.6). Further away, the nearest MMS off the South Island is Clifford and Cloudy Bay, situated on the south side of the Cook Strait.

Moreover, there are seventeen Benthic Protection Areas (BPA) within New Zealand's EEZ covering 1.2 million km^2 of seabed (approximately 32% of the EEZ), established to protect the seabed habitats. Bottom trawling and shellfish dredging are forbidden within these areas. The closest BPA, the Challenger North Plateau, is located west from the Māui 8 site.

The boundaries of the proposed survey area, and the established ZoI, do not overlap with any MMSs, BPAs, or marine reserves and it is therefore predicted that these protected sites (and any marine mammal populations present within these during the survey period) are not going to be directly affected by the proposed seismic activity.

Additionally, DOC has identified a number of Areas of Ecological Importance (AEI) (Figure 5.8) for marine mammals based on information from the sightings and stranding database. Within these sensitive, ecologically important areas, seismic surveys should not be planned especially during key times for Species of Concern (SoC) such as breeding, calving, resting, feeding and migrating, or in confined areas. When demonstrated that conducting surveys within these areas is unavoidable and necessary, further mitigation measures might be required to minimise potential impact. These are assessed during the appropriate MMIA process. Furthermore, in these instances sound transmission loss modelling is a component of the MMIA, as shown in Section 4 of this document. The results of this modelling give an indication of the relative distances from the acoustic source over which behaviour modifications and injury could be expected (see Section 4). Ground-truthing of the sound transmission loss modelling must also take place during the survey, to verify the accuracy of the model.

It should be noted that the proposed survey area is situated within an AEI thus all potential impacts on marine mammals will be robustly assessed and the results of the sound transmission loss modelling will be taken into account together with all requirements of the 2013 Code.

To further minimise any potential impacts within an AEI , additional mitigation measures will be put in place for the duration of the Māui 8 survey, including:

- as recommended in the 2013 Code and supported by STOS as best practice, two Passive Acoustic Monitoring System (PAMS) Operators will be present onboard the seismic vessel throughout the survey to conduct acoustic monitoring for marine mammals and provide 24 hours monitoring;
- Two qualified MMOs will be on watch during all pre-start observations during daylight hours and any other key times (heath and safety permitting);
- immediate notification of the Director-General of DOC if Species of Concern are encountered in unusually high numbers;
- if any Hector's dolphins or Maui's dolphins are sighted at any time during the survey (including transits), the Director-General of DOC will be informed at the first possible instance;
- calibration of received sound levels at the prescribed mitigation distances will be checked during the survey and the results presented in the final trip report. If the results of these measurements significantly differ from the noise modelling conducted as a part of this MMIA, the Director-General will be immediately notified;
- at least one MMO is to be on the watch during transits or at any times of increased vessel speed (i.e. above usual survey speed). If any baleen whales are sighted in the vicinity ahead of the vessel and if it is judged by the MMO that the animal/s is/are not responsive (i.e. during times of resting, feeding, socialising), the vessel's course will be altered to avoid collision with the animal/s.

Figure 5.6 North Island marine reserves and marine mammal sanctuaries (approximate location of the Māui 8 site is marked with red square) *(source: Department of Conservation, NZ)*

Figure 5.7 South Island marine reserves and marine mammal sanctuaries (approximate location of the Māui 8 site is marked with red square) *(source: Department of Conservation, NZ)*

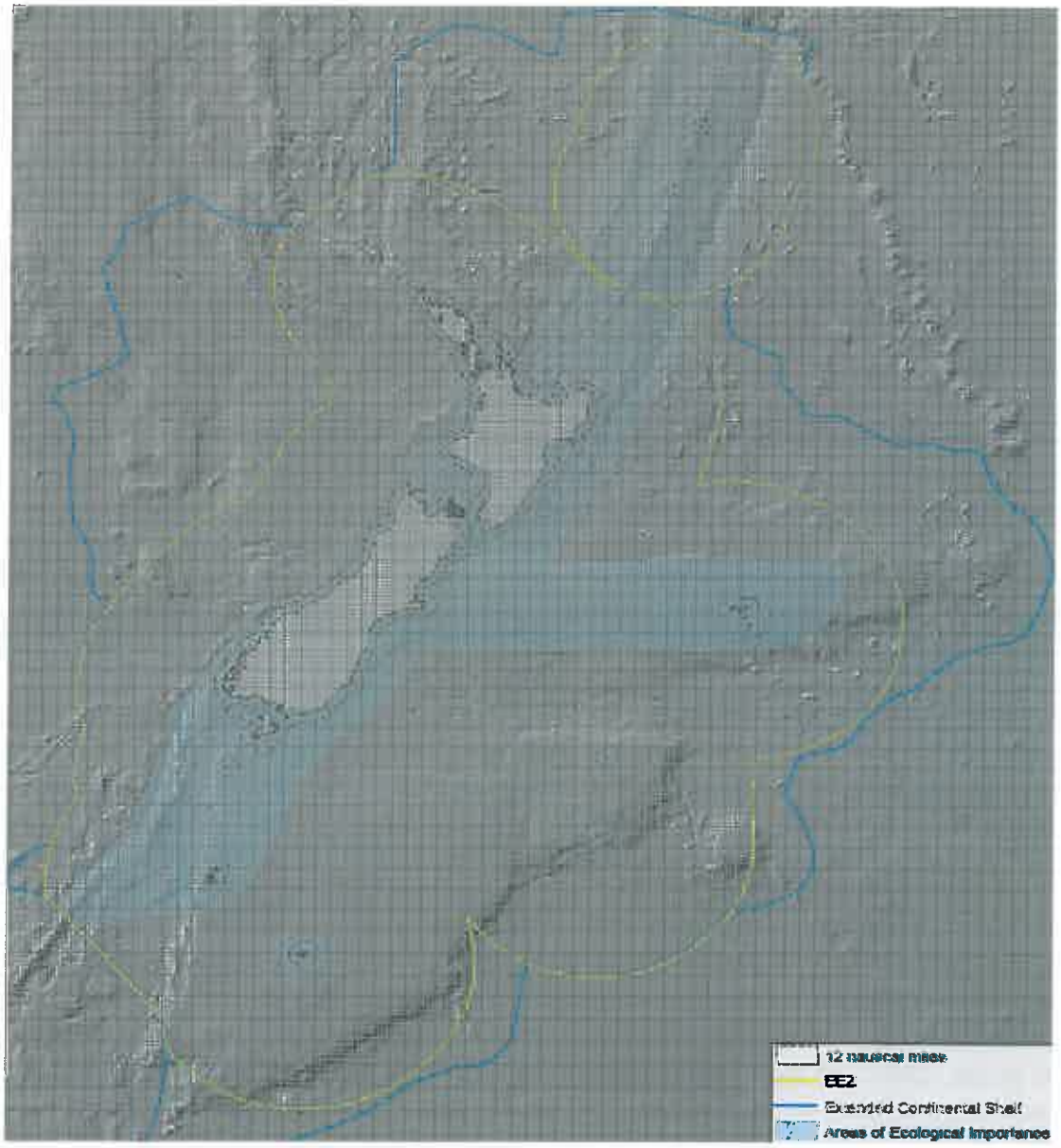

Figure 5.8 Areas of Ecological Importance for marine mammals *(source: Department of Conservation, NZ)*

5.6 The Biological Environment

The Taranaki region has a coastline of 295 km which is exposed to the Tasman Sea. The coast is characterised by a variety of habitats: rocky shores, cliffs, sandy beaches, subtidal reefs, river mouths and estuaries (Taranaki Regional Council, 2009). Under the New Zealand Marine Environment Classification (NZMEC), the survey area is listed as a Class 60 habitat; described as "moderately shallow waters (mean = 112 m) on the continental shelf (Snelder *et al.*, 2005). It experiences moderate annual solar radiation and winter time sea surface temperature (SST) and has moderately high average chlorophyll *a* concentrations" (Snelder *et al.*, 2005). The area is also described by a diverse marine fauna and flora including plankton, benthos and fish.

The plankton community is represented by the bacterio-, phyto- and zooplankton. High phytoplankton biomass occurs south of the Taranaki Bight due to intermittent upwellings, driven by strong westerly winds, which brings nutrient rich waters to the surface layers. This bloom of phytoplankton induces an increase in zooplankton

biomass. This biomass is recognised as one of the highest of all coastal regions in New Zealand (Shirtcliffe *et al.*, 1990; MPI, 2014b) and is dominated by the euphausiid, *Nyctiphanes australis* (Bradford & Chapman, 1988). Regarding both phyto- and zooplankton, their abundance is likely to vary in the area depending on weather conditions. Indeed, wind, rainfall and temperature can influence the stratification of the water column which regulates the flux of nutrients from the deep layer to the surface layer where light is available (Miller & Wheeler, 2005).

A number of benthic fauna and fish feed on zooplankton (Levinton, 2001). In the Taranaki region, specific information on deep sea benthos is lacking. However, Class 60 habitats are characterised by *Dentaliidae, Cardiidae, Carditidae, Nuculanidae, Amphiuridae, Pectinidae* and *Veneridae* (Snelder *et al.*, 2005). Furthermore, in other locations around New Zealand, the presence of the following taxonomic classes has been reported: *Holothuroides, Echinoidea, Ophiuroidea, Asteroidea* and *Gastropoda* (Probert & McKnight, 1993; McKnight & Probert, 1997). Thus, it can be expected to find a similar assemblage in the Taranaki Basin. Another important group of the benthos is deep sea soft corals, which are known to inhabit New Zealand waters. Among the various coral species, the black corals (*Anthipatharia*) and gorgorians (*Gorgoniidae*) are the two families most likely to be encountered. Indeed, they have been recorded on the Aoten Knoll near the survey area (Consalvey *et al.*, 2006; WoRMS, 2014). Other groups of corals that might be found include: metallic coral (*Actinodiscus*), dendrophillid coral (*Dendrophyllidae*), gold coral (*Parazoanthidae*), oculini coral (*Occulinidae*), red coral (*Corallidae*) and bubblegum coral (*Paragorgiidae*) (Consalvey *et al.*, 2006; MPI, 2014a).

There are two common species of rock lobster in New Zealand including the red or spiny rock lobster (*Jasus edwardsii*) and the green or packhorse rock lobster (*Jasus verreauxi*) both of which are listed as least concern in the International Union for the Conservation of Nature Red List (IUCN, 2014). The red rock lobster is the more common species in the South Taranaki Bight although occasional specimens of the packhorse rock lobster are caught along the Taranaki coast (Booth, 2011).

In New Zealand waters, over 1,000 species of fish have been recorded (Fishbase, 2014). In the vicinity of the survey site, the following species are frequently caught and therefore very likely to be encountered: three species of jack mackerel (*Trachurus* declivis, *T. novaezelandiae* and *T. murphyi*), skipjack tuna (*Katsuwonus pelamis*), blue mackerel (*Scomber australasicus*), barracouta (*Thyrsites atun*), and frostfish (*Trichiuridae* sp.) (MPI, 2014a). Based on the NZMEC, six other species are commonly encountered in the Class 60 habitat: red gurnard (*Chelidonichthys cuculus*), John Dory (*Zeus faber*), spiny dogfish (*Squalus acanthias*), snapper (*Pomatamus saltatrix*), sea perch (*Helicolenus percoides*) and arrow squid (*Doryteuthis plei*) (Snelder *et al.*, 2005; WoRMS, 2014). More specifically, a number of pelagic species (including marlin and tuna species) visit Taranaki region during the summer months when warmer currents move down from the north and bring the abundance of food. Sharks are also observed in New Zealand waters, with 15 recorded species including one endemic, the dark ghost shark, *(Hydrolagus novaezealandiae*) (Hitchmough *et al.*, 2005).

5.7 Marine Mammals

New Zealand has an abundance of marine mammals with 41 species of cetaceans and nine species of pinnipeds known to inhabit New Zealand waters (Suisted & Neale, 2004). Of these species, eight are classified as either as Threatened or At Risk, while the majority of marine mammals are classified as Migrants or Vagrants under the New Zealand Threat Classification List (DOC, 2007). In the Taranaki Basin, 29 of these species are thought to occur with some regularity (NABIS Database, 2014). These include eight species of baleen whales, 20 species of toothed whales and dolphins and one pinniped species (Table 5.2). Many of these species are also listed as Species of Concern in Schedule 2 of the 2013 Code, as those particularly vulnerable to the potential effects seismic survey activities.

Table 5.2 Marine mammals recorded in the Taranaki Basin

Species Group	Common Name	Scientific Name	NZ Threat Classification	Species of Concern
Baleen whales	Humpback whale	*Megaptera novaeangliae*	Migrant	Yes
	Blue whale	*Balaenoptera musculus*	Migrant	Yes
	Bryde's whale	*Balaenoptera edeni*	Nationally Critical	Yes
	Fin whale	*Balaenoptera physalus*	Migrant	Yes
	Dwarf minke whale	*Balaenoptera acutorostrata*	Not Threatened	Yes
	Antarctic minke whale	*Balaenoptera bonaerensis*	Migrant	Yes
	Sei whale	*Balaenoptera borealis*	Migrant	Yes
	Southern right whale	*Eubalaena australis*	Nationally Endangered	Yes
Toothed whales and dolphins	Short-beaked common dolphin	*Delphinus delphis*	Not Threatened	No
	Killer whale	*Orcinus orca*	Nationally Critical	Yes
	Bottlenose dolphin	*Tursiops truncatus*	Nationally Endangered	Yes
	Hector's dolphin	*Cephalorhynchus hectori*	Nationally Endangered	Yes
	Maui's dolphin	*Cephalorhynchus hectori Māui*	Nationally Critical	Yes
	Short- finned pilot whale	*Globicephala macrorhynchus*	Migrant	Yes
	Long-finned pilot whale	*Globicephala melas*	Not Threatened	Yes
	Dusky dolphin	*Lagenorhynchus obscurus*	Not Threatened	No
	Sperm whale	*Physeter macrocephalus*	Migrant	Yes
	Beaked whales	12 sp. of family *Ziphiidae*	Data Deficient	Yes
Pinnipeds	New Zealand fur seal	*Artocephalus forsteri*	Not Threatened	No

The available literature has been consulted to assess the likeliness of each species' presence in the project area during the proposed survey period (March - May). The findings are presented in Table 5.3.

Table 5.3 Marine mammals and their likelihood of occurring in the project area at the time of survey

Common Name	Local Distribution	Likeliness to Occur in Project Area
Humpback whale	Possibly encountered at the end of the proposed survey period as this species migrates along the coast between May and December from their summer feeding grounds in the Antarctic to their winter breeding grounds in the tropics (Shirihai & Cox, 2002).	Likely
Blue whale	Likely to be encountered throughout as the South Taranaki Bight is considered part of their foraging grounds (Torres, 2013). The latest research shows that blue whale presence in the region coincides with the periods of increased productivity with peak numbers in March and low presence between July and September (Torres *et al.*, unpublished data).	Likely
Bryde's whale	Bryde's whales prefer temperate waters and can be found year round between 40°S and 40°N (Reilly *et al.*, 2008b). Their presence in the survey area is generally unlikely but few individuals have been recorded previously during summer months (Torres, 2012).	Unlikely
Fin whale	It is considered that fin whales use the area only during the summer - this seasonal pattern is evident in previous literature where only a few individuals have been sighted in December and January (Torres, 2012).	Unlikely
Dwarf minke whale	Dwarf minke whales inhabit the waters of Antarctica between December and March and migrate north between March and October (Kasamatsu *et al.*, 1995). Possibly encountered throughout the survey due to migration times and as they are known to approach vessels (Mangott *et al.*, 2011).	Less likely
Antarctic minke whale	Antarctic minke whales are thought to migrate north during winter and are known to be primarily oceanic, sighted beyond the continental shelf break (Perrin *et al.*, 2009). Possibly encountered towards the end of the proposed survey period.	Less likely
Sei whale	Sei whales are known to migrate south during February and March to Antarctic feeding grounds (Hutching, 2012) although sei whales have been sighted in the project region during summer months (Torres, 2012).	Unlikely
Southern right whale	Southern right whales have been sighted in the region during winter months between July and October, when they are known to migrate from summer feeding areas in order to breed. They may be encountered towards the end of the proposed survey period if they survey is delayed (Torres, 2012).	Less likely
Short-beaked common dolphin	Short-beaked common dolphins in New Zealand have a seasonal offshore-shift where the dolphins are known to move further offshore during autumn/winter (Neumann, 2001).	Likely

Killer whale	Killer whales around the project area have a seasonal distribution pattern, with high numbers observed between October and March and a relatively low number of sightings are recorded between April and September (Visser, 2007). Therefore, it should be anticipated that killer whales could be sighted during the survey and more frequently at the beginning, during March.	Likely
Bottlenose dolphin	Sightings of bottlenose dolphins with the survey area are likely to be the offshore sub-species of bottlenose dolphins. These cover a wide range can be sighted throughout the year (Torres, 2012).	Likely
Hector's dolphin	Hector's dolphins are less likely to occur in the survey area as they are primarily an inshore species with patchy distribution around the South Island. However they were recorded to venture offshore up to 15 nm especially during winter (Slooten *et al.*, 2006) and have been recorded previously in the Taranaki Basin (Torres, 2012).	Less likely
Maui's dolphin	This is predominantly a coastal species, particularly during summer months (Slooten *et al.*, 2005; Ferrerira & Roberts, 2003). While winter distribution tends to be more dispersed and further offshore. Furthest offshore distance recorded is 7 nm (Du Fresne, 2010). The survey area is south of their known distribution limit (Hutching, 2012; NABIS database, 2014), however there have been reports of sightings from existing platforms in the Māui Field (DOC, per. comm.).	Less likely
Short-finned pilot whale	Short-finned pilot whales are usually observed in the north of the North Island and do not range south of 40°S (Jefferson *et al.*, 1993).	Unlikely
Long-finned pilot whale	Long-finned pilot whale sightings are mostly likely to occur during summer months and less likely to occur between April and September (Torres, 2012).	Likely
Dusky dolphin	Dusky dolphins have been observed in the South Taranaki Bight year around (Torres, 2012). Dusky dolphins show both seasonal and daily movements offshore, being closest to shore during summer and during the day (Würsig *et al.*, 2007). Therefore it is likely dusky dolphins will be encountered due to their seasonal movements.	Likely
Sperm whale	Sperm whale sightings in the area peak offshore in the summer months between December and April (Torres 2012; Gaskin, 1968). Even though they prefer deeper habitats (Shirihai & Cox, 2002), there were number of reported strandings of sperm whales along Taranki coastline therefore it can be assumed that this species may be observed within the survey area.	Likely
Beaked whales	Most data for beaked whales comes from strandings and there are only very few records of sightings in New Zealand. Main habitats of these species are deep waters and underwater canyons (Cox *et al.*, 2006) therefore it is unlikely for these species to occur within the shallow project area.	Unlikely

New Zealand fur seal	Due to their abundance, the suitable foraging habitat of the Taranaki Basin situated close to the shelf edge, the proximity to breeding and haul out sites and the continual presence at nearby Māui platforms it is very likely that New Zealand fur seals will be encountered throughout this survey (Torres, 2012; Mattlin *et al.*, 1998).	Likely

In summary, sightings of killer whales and long–finned pilot whales (*Globicephala melas*) in the survey area are likely during March, though the probability of sightings will decline further into the autumn as lower numbers are encountered between April and September. At this time, around May, sightings of humpback whales are expected as they migrate along the coast, and further into winter short-beaked common dolphins and dusky dolphins (*Lagenorhynchus obscurus*) begin to move offshore around the North Island. Sperm whales could be potentially sighted in April based on the previous records of their sightings in offshore waters. Blue whales are very likely to be encountered throughout as well as New Zealand fur seals and offshore bottlenose dolphins (*Tursiops truncatus*).

5.7.1 Baleen Whales (*Mysticetes*)

There are ten species of baleen whale which have been recorded in the waters of New Zealand. Of these, four are classified as Endangered by the IUCN (IUCN, 2013); these are the sei, blue, fin and humpback whale (Oceania subpopulations). However, two further species are listed on the New Zealand Threat Classification list: the Bryde's whale which is Nationally Critical, and the southern right whale which is Nationally Endangered (Table 5.2).

Every year most of these species undertake extensive migrations (Figure 5.9). Their spring migration takes them from the Pacific Islands to the Antarctic Ocean to feed, returning to the Pacific Islands to breed during the autumn-winter (May - July) migration (DOC, 2007). The majority of baleen whales are observed in offshore waters (Torres, 2012).

The Taranaki Basin is an important area for baleen whales and has been identified as an area of migration and foraging (Torres, 2012). This is a result of a cold water coastal upwelling system off Farewell Spit that generates highly productive plumes of water which extend northwards into the South Taranaki Bight. The enhanced primary productivity as a result of the upwelling event creates large blooms of zooplankton. Of all the coastal regions of New Zealand, the Taranaki Bight and the Cook Strait contained the highest abundance of zooplankton (Shirtcliffe *et al.*, 1990). Based on the available literature the most likely species to be recorded in the Taranaki Basin region during the proposed survey period are the humpback whale and blue whale (Shirihai & Cox, 2002; Torres, 2013).

Figure 5.9 Whale distribution and migration routes in New Zealand waters *(source: Te Ara, 2014)*

Humpback whale *(Megaptera novaeangliae)*

Humpback whales are a migrant species in New Zealand and are sighted along the coast between May and December when they migrate from their summer feeding grounds in the Antarctic to their winter breeding grounds in the tropics (Shirihai & Cox, 2002). These whales feed on krill and small schooling fish using diverse feeding techniques including lunging, stunning prey with flippers and forming "bubble-nets" (Fleming & Jackson, 2011). Recent research indicates humpback whales migrating through New Zealand waters form part of the eastern Australia breeding stock (Franklin *et al.*, in press) and the New Caledonia/Tonga breeding population (Constantine *et al.*, 2007). Franklin *et al.* (in press) indicates that humpback whales migrating through the Cook Strait show site-fidelity to eastern Australia, while whales re-sighted in Caledonia and Tonga migrate north along

the eastern coast of the North Island (Constantine *et al.*, 2007). The South Pacific Whale Research Consortium (SPWRC) (2008) provided a preliminary estimate of the Oceania breeding population of 3,827 for 1999-2004. While Noad *et al.* (2006) estimated the eastern Australia population as 7,090 for 2004. As the survey is expected to continue through to May it is possible to encounter humpback whales as they migrate through the Cook Strait (Figure 5.9).

Blue whale *(Balaenoptera musculus)*

During their migration between the summer feeding grounds in the Antarctic and equatorial waters where they spend the winter, blue whales sometimes migrate through the Cook Strait. However, it has been suggested that not all whales conduct this migration and some have a foraging ground in the South Taranaki Bight feeding on large aggregations of euphausiids. This is supported by evidence that *Nyctiphanes australis* is found in dense concentrations in the region (Torres, 2013). Although previous records indicate that sightings of blue whales peak in June (Torres, 2012), the latest research indicates a high density of blue whales in the Taranaki feeding ground throughout the year (Torres, 2013), with peak numbers in March and low presence between July and September (Torres *et al.*, unpublished data). Currently, the blue whale is classified as a Migrant under the New Zealand Threat Classification System, which means they are not awarded the same level of conservation protection as other large baleen whales that use coastal waters around New Zealand such as the southern right whale.

Southern right whale (*Eubalaena australis)*

Southern right whales are listed as Least Concern by the IUCN (2013) but are classified as Nationally Endangered in New Zealand due to population size of approximately 900 individuals (Suisted & Neale, 2004). Southern right whales calve in coastal waters during winter, with summering grounds predominantly between 40-50°S (Reilly *et al.*, 2013a). In New Zealand, their main wintering and calving grounds are around the sub-Antarctic islands (Patenaude, 2003). Recent evidence indicates re-establishment of wintering grounds around mainland New Zealand, although numbers remain low with only 28 cow-calf pairs reported between 2003 and 2010 (Carroll *et al.*, 2014). Sightings are predominantly recorded around the South Island (Figure 5.10) with concentrations reported from the Foveaux Strait, Otago Penisula as well as the east coast of Northland. Southern right whales are mainly encountered in shallow, coastal waters but have been recorded offshore particularly between July and October (Torres, 2012).

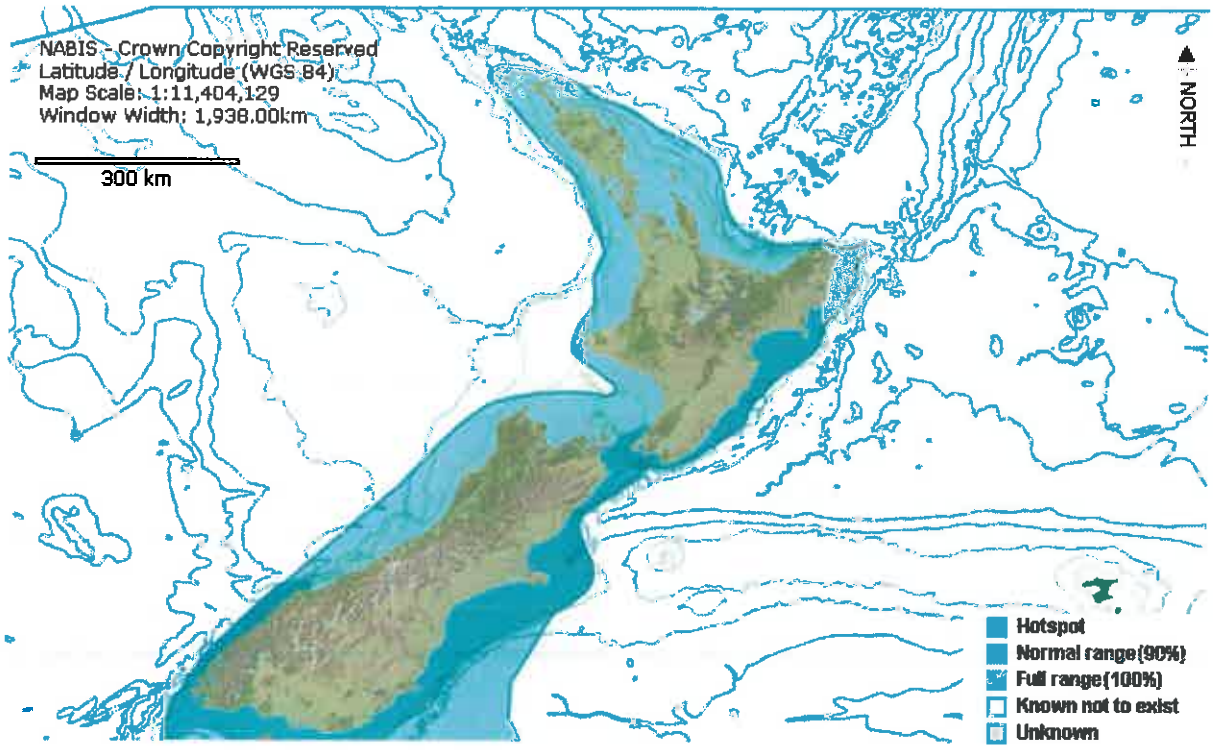

Figure 5.10 Southern right whale distribution in New Zealand waters *(source: NABIS, 2014)*

Dwarf minke whale (*Balaenoptera acutorostrata*)

Dwarf minke whales (*Balaenoptera acutorostrata*) are considered to be widely distributed throughout the Southern Hemisphere, although much of the data on the species is ambiguous with respect to identification between dwarf and Antarctic minke whales (*Balaenoptera bonaerensis*) (Reilly *et al.*, 2008a). The most northerly confirmed record is from 2°S off Brazil (Magalhães *et al.*, 2007) with records of individuals taken as far south as 65° (Kasamatsu *et al.*, 1993). From December to March, most sightings occur in sub-Antarctic waters, with evidence suggesting the species migrates north between March and October to breed, concentrating in waters around 10 to 20°S (Kasamatsu *et al.*, 1995). Where sympatric with Antarctic minke whales, dwarf minke whales appear to occur in shallower, more coastal waters over the continental shelf (Perrin & Brownell Jr., 2002). Dwarf minke whales have been recorded in New Zealand coastal waters (Dawson & Slooten, 1990). It is possible that dwarf minke whales could be recorded in the survey area during their migration northwards during the time of the survey. In Australia, dwarf minke whales are known to be highly inquisitive, often approaching vessels (Valentine *et al.*, 2004). Dwarf minke whales are listed as Least Concern by the IUCN (2013).

Antarctic minke whale (*Balaenoptera bonaerensis*)

Antarctic minke whales are distributed throughout the Southern Hemisphere, where they generally occur at lower latitudes and are more abundant than the sympatric dwarf minke whale. In summer they are abundant south of 60°S (Reilly *et al.*, 2008b) where they predominantly feed on euphausiids (Perrin *et al.*, 2009). The winter distribution is less well known due to co-occurrence with dwarf minke whales, although the Antarctic minke is thought to migrate north to mid-latitudes where it is primarily oceanic and sighted beyond the continental shelf break (Perrin & Brownell Jr., 2002). An unknown proportion of the population remains in Antarctic waters during

the winter (Mead & Brownell Jr., 2005). Antarctic minke whales have previously been recorded in the Taranaki area, with only one sighting occurring during the summer months (Torres, 2012). Sightings of Antarctic minke whale could therefore be possible during their migration to and from breeding and feeding grounds. Antarctic minke whales are listed as Data Deficient by the IUCN (2013).

Other baleen whales

The Bryde's whales have a circumglobal distribution and are largely restricted to tropical and sub-tropical waters, preferring waters 16°C or warmer and generally not moving more than 40° in either hemisphere (Reilly *et al.*, 2008c). While they may not show extensive migrations as with other large species of baleen whale, seasonal migrations within the tropics have been reported for some populations (Best, 2001). A small resident population of Bryde's whale inhabits the Hauraki Gulf (Figure 5.11) (Baker & Madon, 2007; Wiseman *et al.*, 2011) and the species is listed as a Nationally Critical Threatened species. Sightings have been recorded during in offshore areas of the Taranaki region during summer months (Torres, 2012). Although Bryde's whale are present year round occurrence in the Hauraki Gulf peaks during winter months, which is attributed to the more frequent upwellings during this time (Wiseman *et al.*, 2011). The cold water coastal upwelling system within the Taranaki region and enhanced primary productivity during such events may provide similar suitable foraging habitat for Bryde's whale (Torres, 2012).

Fin whales are typically found in deep offshore, oceanic waters (Shirihai & Cox, 2002), and undertake extensive migrations between summer feeding and winter breeding grounds (Aguilar, 2002). In the Southern Hemisphere while some individuals penetrate the high Antarctic most summer in the mid-latitudes between 40 and 65°S. Winter distribution is less known, although is likely to reach southern Africa and South America (Reilly *et al.*, 2013b). Fin whales have a seasonal presence in New Zealand waters travelling through during their migration, and tending to remain at or beyond the continental shelf edge (McDonald, 2006). Small numbers have been recorded in the Taranaki Basin where they were recorded offshore and during summer months (Torres, 2012). Fin whale diet does overlap with that of blue whales (Aguilar, 2002), and it is possible that fin whales use the area as a foraging ground similar to blue whales.

As with fin whales, sei whales typically favour deeper, offshore waters (Shirihai & Cox, 2002). Sei whales also migrate between tropical/sub-tropical latitudes in winter and sub-polar latitudes in summer, although they do not penetrate into as high latitudes as other species remaining between 8 and 18°C (Reilly *et al.*, 2008c). In the Southern Hemisphere the summer distribution is predominantly between 40 and 60°S (Miyashita *et al.*, 1996). Known wintering grounds include areas off South America and southern Africa (Horwood, 2002). Sei whales have been recorded in New Zealand waters predominantly during their migration (Shirihai & Cox, 2002). Small numbers have been recorded in the Taranaki Basin, where they were recorded in offshore, deeper waters and during summer (Torres, 2012). As with fin whales, there is overlap in the diet of sei and blue whales (Horwood, 2002), and it is possible this species could use the area as a foraging ground. Sei whales are listed as Endangered by the IUCN (2013).

5.7.2 Toothed Whales and Dolphins (*Odontocetes*)

There are 19 species of dolphin which have been recorded in the waters of New Zealand, five of which are resident species: the short-beaked common dolphin, bottlenose dolphin, dusky dolphin, killer whale and Hector's dolphin, including a sub-species of the Hector's dolphin known as Maui's dolphins. Hector's dolphins are classified as Endangered and the sub-species Maui's dolphins are listed as Critically Endangered by the IUCN

(2013). Based on the available literature, the most likely odontocete species to be recorded in the Taranaki Basin region at the time of the survey include the dusky dolphin, short-beaked common dolphin and the bottlenose dolphin. In addition, killer whales and long-finned pilot whales could be recorded at the beginning of the proposed survey period (Torres, 2012; Neumann, 2001; Visser, 2007), while sightings of sperm whale and Hector's dolphins are considered less likely since the proposed survey area is not situated in their suitable habitat.

Sperm whale *(Physeter macrocephalus)*

Sperm whales are classified as Vulnerable by the IUCN, although they are not regarded as a threatened species in New Zealand (Suisted & Neale, 2004). Sperm whales are a cosmopolitan species usually encountered in deep waters near the continental shelf break or near deep canyons as these habitats are productive for foraging on squid. They can dive for over an hour and during those deep dives they heavily rely on acoustic senses to navigate, communicate and target prey (Whitehead, 2002). Sperm whales have distinct distributions depending on the sexes. Females prefer waters over 1000 m, over 15°C at latitudes between 40°N and S (except in North Pacific where their range has been recorded to 50°N). Young male sperm whales remain with the females in tropical and sub-tropical waters until they are 4-21 years when they then migrate to higher latitudes. Males gradually become more solitary, with the largest males inhabiting highest latitudes (Whitehead, 2002). There is a well known population of sperm whales inhabiting the productive waters of the deep canyons off Kaikoura in New Zealand. This population is made up predominantly of males (Richter *et al.*, 2003) that show long term site fidelity, returning to the same locations between years (Whitehead, 2003). Sperm whales have been previously recorded in the deep offshore areas of the Taranaki Basin, with sightings tending to peak in the summer months between December and April (Torres, 2012; Gaskin & Cawthorn, 1967). Additionally, a number of sperm whale strandings have been recorded along the south Taranaki, Wanganui and Kapati coastlines as well as in Golden Bay and Farewell Spit. Given this, sperm whales may be observed in the survey area.

Short-beaked common dolphin (*Delphinus delphis*)

Short-beaked common dolphins are widely distributed in warm temperate and tropical waters of the Atlantic and Pacific Oceans (Culik, 2011). Short-beaked common dolphins occur around most of the North Island with an apparently more limited distribution around the South Island, although groups are regularly observed off Wellington and large aggregations are reported in Cook Strait during winter months (Figure 5.11) (Stockin & Orams, 2009). Neumann (2001) reported a seasonal off-shore shift in short-beaked common dolphins in New Zealand waters which appears to be correlated with sea surface temperature. During autumn/winter short-beaked common dolphins move further offshore (Neumann, 2001) and tend to be found in larger groups, thought to be the result of nutrient upwelling leasing to increased prey availability (Stockin *et al.*, 2008). Based on previous studies (Torres, 2012), the short-beaked common dolphin is expected to be one of the most commonly recorded species during the survey period.

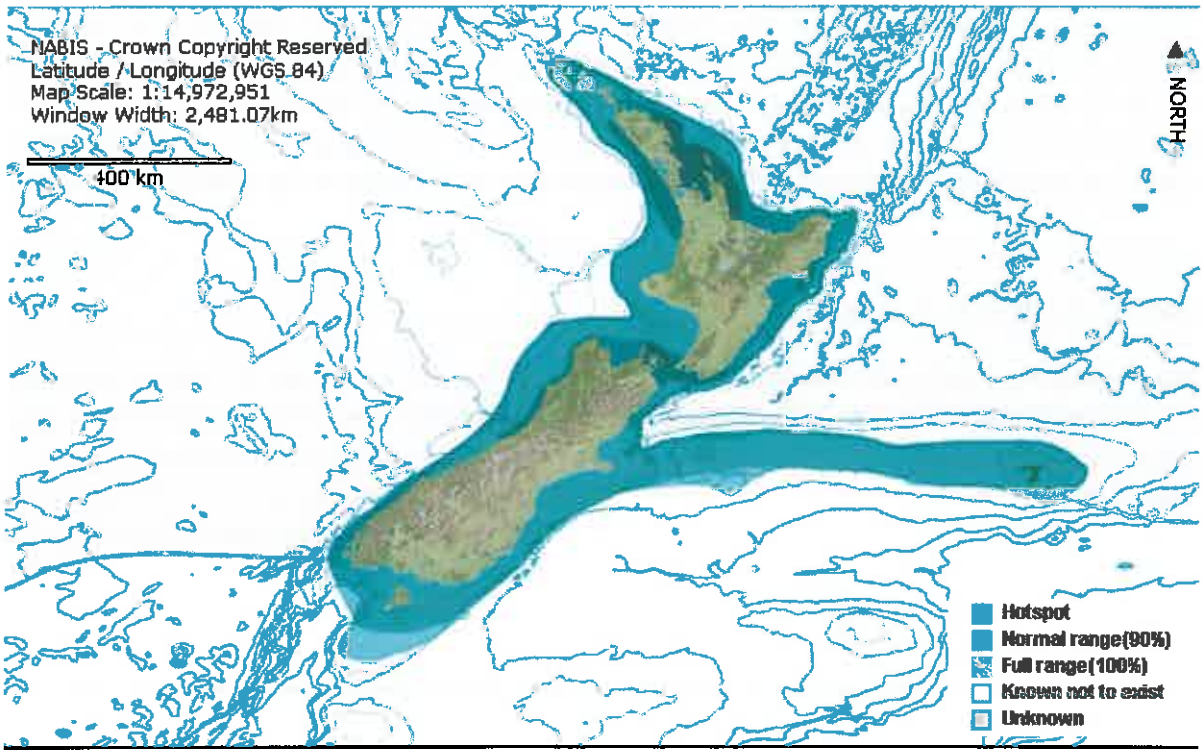

Figure 5.11 Short-beaked common dolphin distribution in New Zealand waters *(source: NABIS, 2014)*

Killer whale (*Orcinus orca*)

The killer whale occurs in almost every marine region in both hemispheres, and appears to be most common in near shore, cold temperate to sub-polar regions (Culik, 2011). Studies indicate there are several types of killer whale, with up to five forms reported in the Southern Hemisphere and five in the Northern Hemisphere (NOAA Fisheries Service, 2013). Recent genetic studies indicate there may be more than one species of killer whale (Morin *et al.*, 2010). Killer whales are therefore classified as Data Deficient by the IUCN (2013) and a Nationally Critically Threatened species in New Zealand as the population is relatively small consisting of approximately 120 individuals (Suisted & Neale, 2004; Visser, 2000). Research by Visser (2000) indicates there may be three sub-populations of killer whale inhabiting New Zealand waters. In addition there is evidence that Antarctic Type killer whales also visit New Zealand waters (Visser, 1999). Prey type consists of four main types; rays, sharks, fish and cetaceans although other prey types including birds and cephalopods are occasionally taken (Visser, 2007). Around the Taranaki Basin killer whale sightings have mainly been near New Plymouth, with other sightings from northern Malborough Sounds and in deep offshore waters around Kapiti Island (Figure 5.12) (Torres, 2012). Within the Taranaki region killer whales show a seasonal distribution pattern, with high numbers recorded between October and March and lower numbers between April and September (Visser, 2007). Therefore it is anticipated that killer whales could be sighted during the Māui 8 survey period, and potentially more frequently during March.

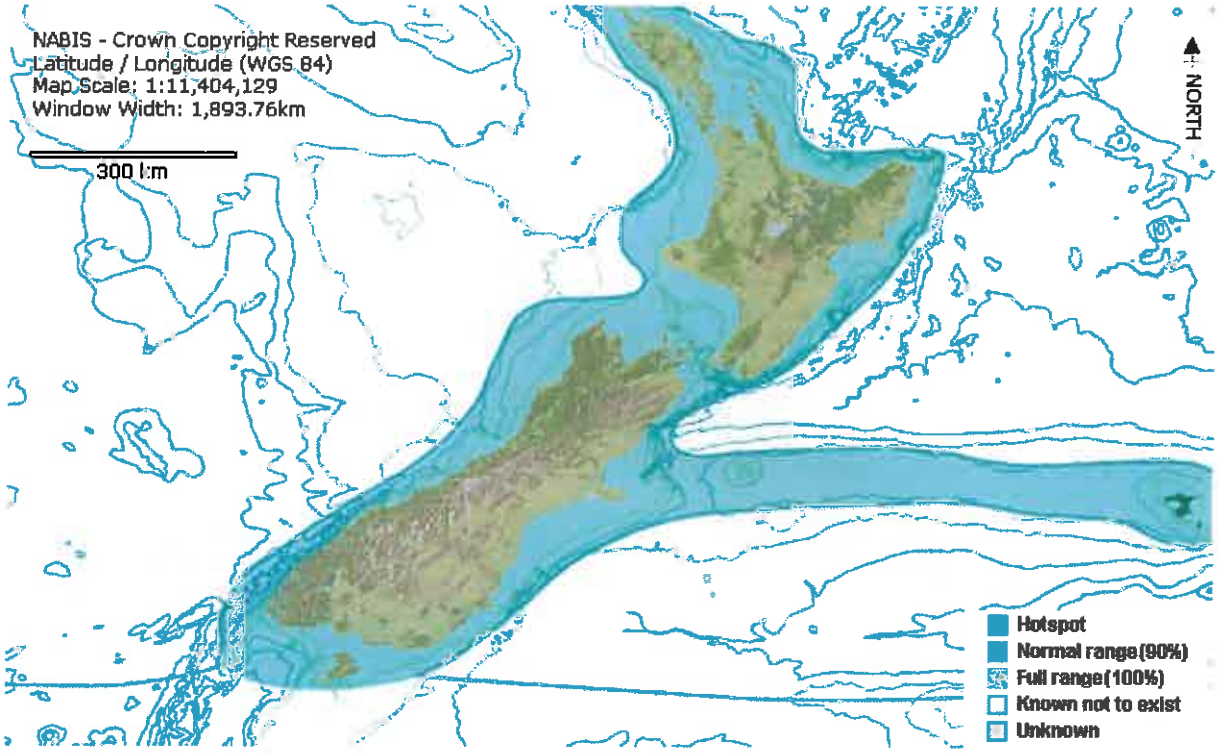

Figure 5.12 Killer whale distribution in New Zealand waters *(source: NABIS, 2014)*

Bottlenose dolphin (*Tursiops truncatus*)

Bottlenose dolphins are found primarily in coastal and inshore temperate and tropical waters worldwide, although there are also offshore, pelagic populations (Culik, 2011). Bottlenose dolphins are listed as Least Concern by the IUCN (2013) although they are listed as a Nationally Endangered species in New Zealand due to low abundance and concerns over potential declines of coastal populations (Suisted & Neale, 2004; Baker *et al.*, 2010). There are three main coastal populations of bottlenose dolphin around New Zealand (Baker *et al.*, 2010) with recent analysis indicating little gene flow between them (Tezanos-Pinto *et al.*, 2009). In addition, an offshore population is observed more widely although less frequently around New Zealand (Figure 5.13). This population is considered a separate sub-species although it is not taxonomically distinct from inshore populations (Tezanos-Pinto *et al.*, 2008). Sightings within the Taranaki Basin are likely to be of offshore bottlenose dolphins (Torres, 2012). Sightings of offshore bottlenose dolphins are likely during the survey period as these populations are encountered year-round (Torres, 2012).

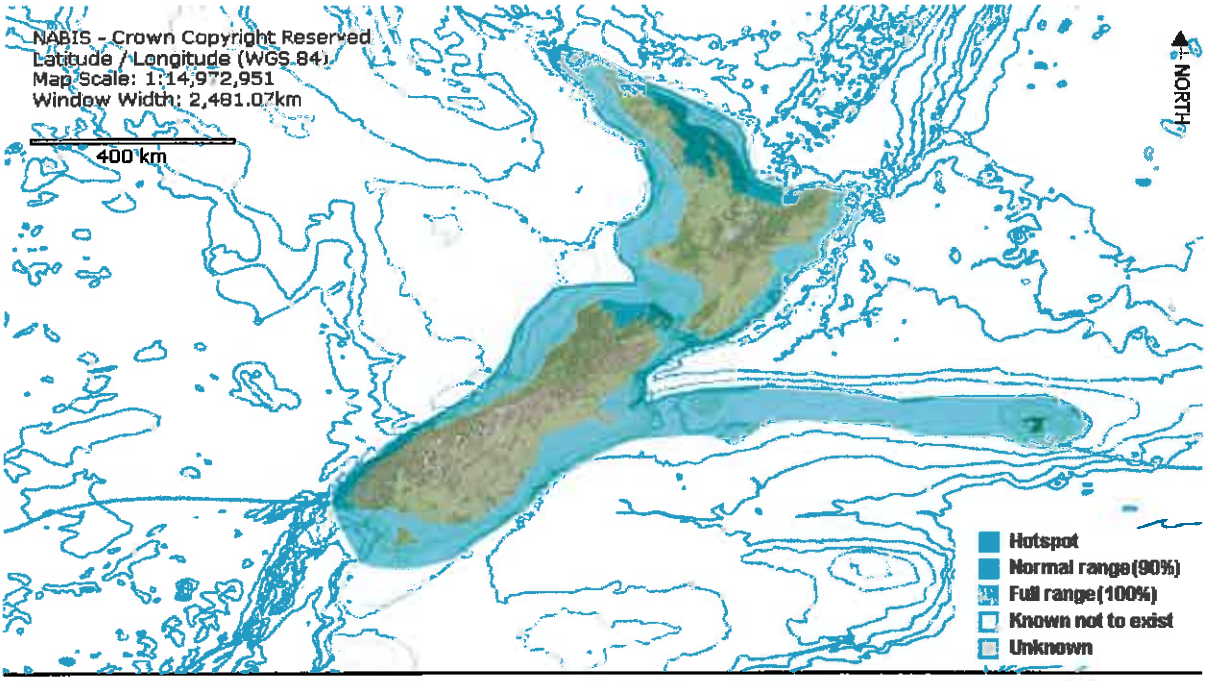

Figure 5.13 Bottlenose dolphin distribution in New Zealand waters *(source: NABIS, 2014)*

Hector's dolphin *(Cephalorhynchus hectori)*

Hector's dolphins are endemic to New Zealand waters, are classified as Endangered by the IUCN (2013) and a Nationally Endangered species in New Zealand where the population size is estimated to be approximately 7,400 (Suisted & Neale, 2004). They have a patchy distribution around the coast of the South Island (Figure 5.14) preferring shallow waters less than 100 m deep, although they are recorded to venture offshore up to 15 nm especially during winter (Slooten *et al.*, 2006). Within the survey region, Hector's dolphins are believed to move between the Malborough Sounds and Taranaki regions, and have been recorded within the South Taranaki Basin (Torres, 2012). Of these sightings only two occurred offshore, both of which occurred during June reflecting the seasonal movements of Hector's dolphins elsewhere (Slooten *et al.*, 2006). Given this it is less likely that Hector's dolphins will be encountered during the survey period, although there is the potential for sightings as the survey progresses.

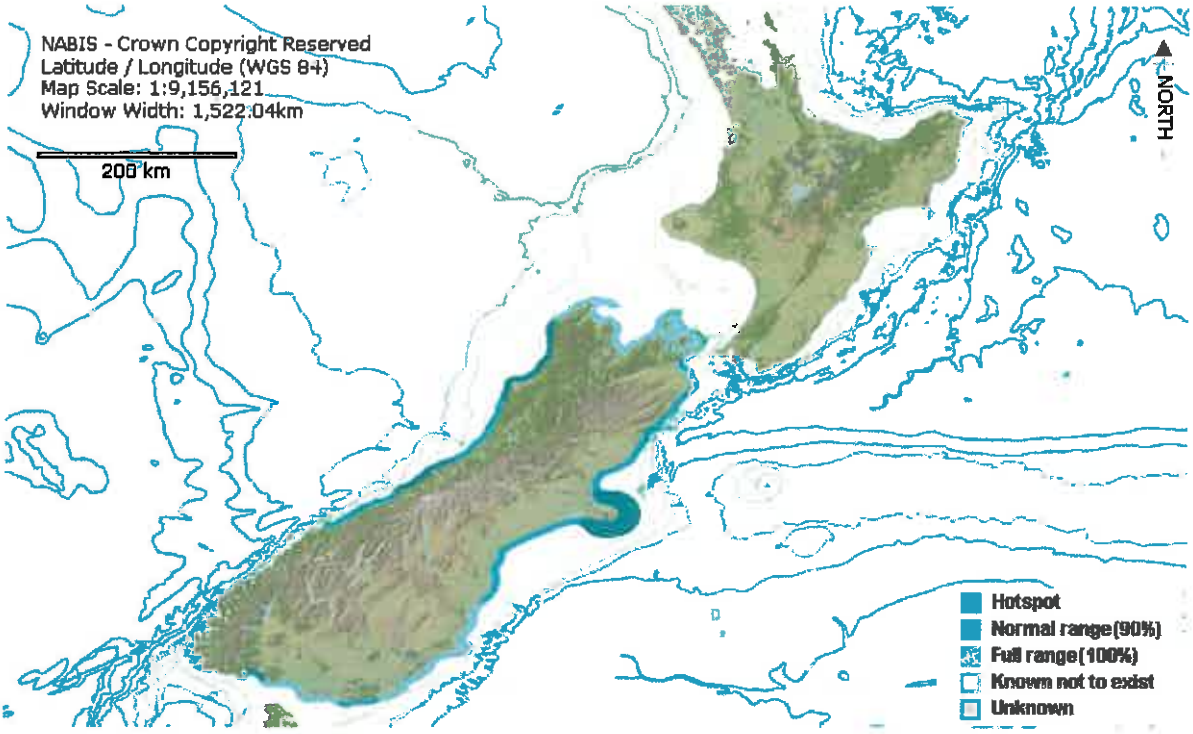

Figure 5.14 Hector's dolphin distribution in New Zealand waters *(source: NABIS, 2014)*

Maui's dolphin *(Cephalorhynchus hectori maui)*

Maui's dolphins are a sub-species of Hector's dolphin found only off the west coast of the North Island, regularly occurring between Kaipara Harbour in the north and Kawhia Harbour in the south (Figure 5.15). Maui's dolphins are also seen further south in the Taranaki/New Plymouth area (Du Fresne, 2010) and their southern range probably extends to at least Whanganui (Currey *et al.*, 2012). They are predominantly a coastal species encountered within 4 nm of the shore, especially during summer (Slooten *et al.*, 2005; Ferrerira & Roberts, 2003). Winter distribution tends to be more dispersed and further offshore, with the furthest distance recorded at 7 nm (Du Fresne, 2010). Maui's dolphin are classified as Critically Endangered by the IUCN (2013) and a Nationally Critical Threatened species in New Zealand (Suisted & Neale, 2004), with the population estimated to be of only 55 individuals (Hamner *et al.*, 2012). Recent sightings in the Taranaki/New Plymouth area have recently been verified by DOC (Du Fresne, 2010; DOC pers. comm.). The cluster of sightings in the area may be an excursion of Maui's dolphins beyond their normal home range or there may be a small resident group not seen often.

If a Maui's/Hector's dolphin is observed during the seismic survey, DOC will be notified immediately. Both National Office (Ian Angus and the Taranaki Area office (Callum Lilley, or Brian Williams, should be informed in order to mobilise a fixed wing plane and the DOC boat to try and gather a biopsy sample. The biopsy sample would then be used to verify whether the sighting was a Maui's or Hector's dolphin using genetic (DNA) analysis. This would add to the knowledge of the southern extent and offshore range of Maui's dolphin.

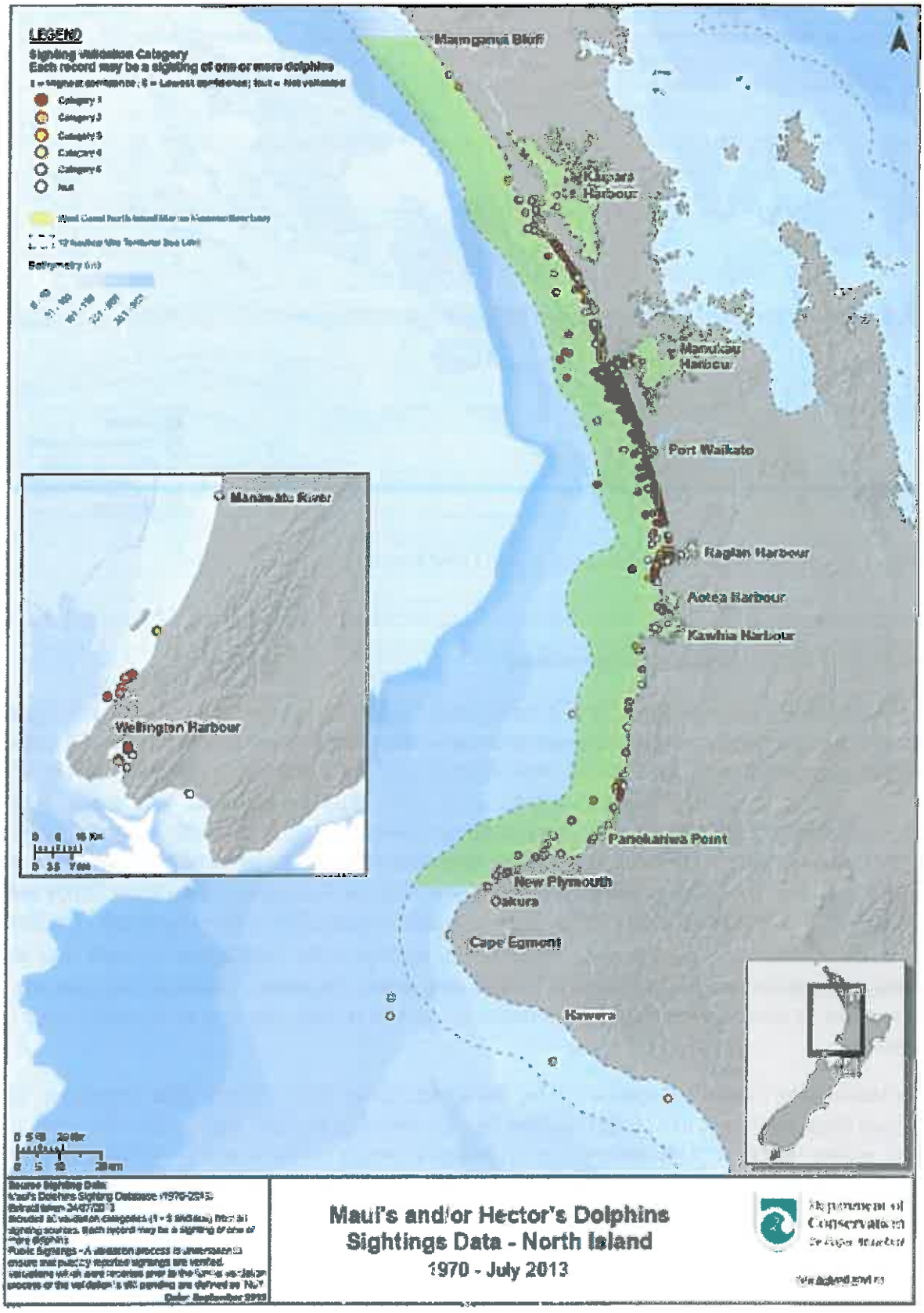

Figure 5.15 Sightings of Maui's and/or Hector's dolphins recorded between 1970 and 2013 *(source: DOC, 2014)*

Long-finned pilot whale *(Globicephala melas)*

Long-finned pilot whales occur in temperate and sub-polar regions, in oceanic and coastal waters and reach as far south in the Southern Hemisphere as 68°S (Taylor *et al.*, 2008). They are listed as Data Deficient by the IUCN (2013) and not threatened in New Zealand (Baker *et al.*, 2010). Around New Zealand long-finned pilot whales range from Great Barrier Island in the North to the Antarctic Convergence in the south (Rice, 1998). In the Taranaki region sightings occur predominantly in the summer months with no sightings between April and September. Initial analysis indicates a strong preference for waters >17 °C (Torres, 2012). Long-finned pilot whales primarily forage on cephalopods (Beatson *et al.*, 2007), but occasionally feed on small fish (Desportes & Mouritsen, 1993; Jefferson *et al.*, 1993). Foraging takes place mostly at night, when dives may last for 18 minutes or more and reach depths of over 800 m (Carwardine, 1995; Heide-Jørgensen *et al.*, 2002). In the Taranaki region sightings occur predominantly offshore in depths of over 100 m (Torres, 2012). Sightings could therefore occur during the early part of the Māui 8 survey period.

Dusky dolphin *(Lagenorhynchus obscurus)*

Dusky dolphins are widespread but discontinuous throughout the Southern Hemisphere, with three distinct populations, that are considered separate sub-species (Van Waerebeek, 1993; Cassen *et al.*, 2003). The species is classified as Data Deficient by the IUCN (2013) and not regarded as threatened in New Zealand (Suisted & Neale, 2004). The New Zealand population consists of between 12,000 and 20,000 individuals (Markowitz *et al.*, 2004) concentrated in two regions: off the northeast of the South Island between Kaikoura and Haumuri Bluffs 20.5 km to the southwest, and in the Marlborough Sounds (Figure 5.15) (Würsig *et al.*, 2007). New Zealand populations exhibit inshore-offshore movements on a diurnal and seasonal basis. Dusky dolphins tend to move into deeper, offshore waters during winter, returning to shallow coastal areas during the summer months. Off Kaikoura dusky dolphins also tend to spend mornings inshore, moving offshore during late afternoon particularly during autumn and summer (Würsig *et al.*, 2007). Dusky dolphins forage mainly on krill, copepods and small meso-pelagic fish at night over deeper waters (Würsig *et al.*, 2007). Dusky dolphins have been recorded in the Taranaki Basin throughout the year, with a slight trend towards deeper waters in winter (Torres, 2012). Sightings of dusky dolphins during the survey period are therefore very likely.

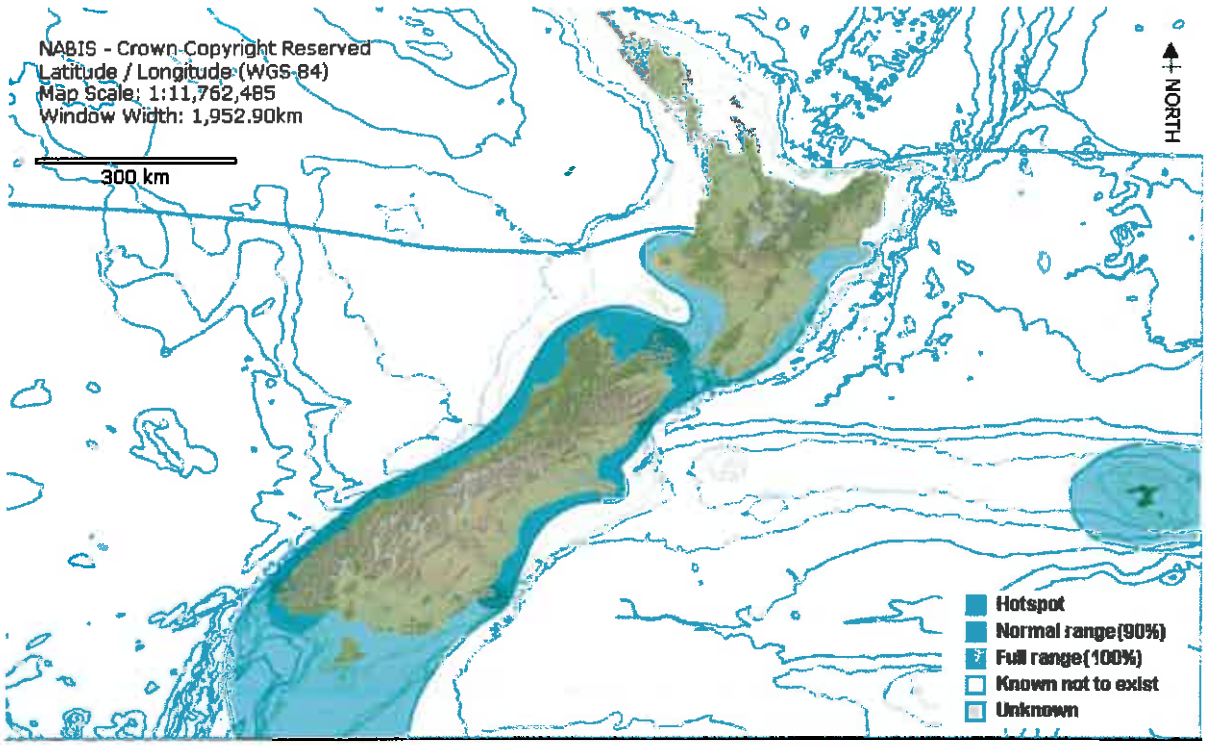

Figure 5.16 Dusky dolphin distribution in New Zealand waters *(source: NABIS, 2014)*

Other toothed whales

Short-finned pilot whales are unlikely to occur in the survey area as they are usually observed in the north of the North Island and do not range south of 40°S (Jefferson *et al.*, 1993). Beaked whales are amongst the least known species of cetacean, occurring in deep, offshore areas (Cox *et al.*, 2006). Most data comes from strandings and there are only a few records of sightings in New Zealand. There are 12 species of beaked whale listed under the New Zealand Threat Classification System, nine of which are considered Data Deficient, and a further three are considered Vagrants. The Gray's beaked whale (*Mesoplodon grayi*) is the most common beaked whale to strand in New Zealand, and other species that are more commonly recorded are the Arnoux's beaked whale (*Berardius arnouxi*), Cuvier's beaked whale (*Ziphius cavirostris*) and strap-toothed beaked whale (*Mesoplodon layardi*) (Brabyn, 1991). However it is unlikely that beaked whales will be encountered during the survey due to the relatively shallow water depths in the survey area.

5.7.3 Pinnipeds

There are nine species of pinniped which have been recorded in the waters of New Zealand (Baker *et al.*, 2010). Only one, the New Zealand sea lion (*Phocarctos hookeri*), is classified as Vulnerable by the IUCN (2013) and Nationally Critical on the New Zealand Threat Classification List (Baker *et al.*, 2010). The most likely pinniped species to be recorded in the survey area is the New Zealand fur seal.

New Zealand fur seal (*Arctocephalus forsteri*)

New Zealand fur seals are the most common seal in New Zealand waters, classified as Data Deficient by the IUCN and not regarded as a threatened species in New Zealand (Baker *et al.*, 2010) as the population is large, consisting of approximately 55,000 individuals (Suisted & Neale, 2004). New Zealand fur seals forage on fish,

cephalopods such as squid and octopus and crustaceans including krill (Willis *et al.*, 2008; Boren, 2010). New Zealand fur seals will forage up to 200 km beyond the continental slope, often diving as deep as 200 m where most dives last 1 or 2 minutes (Davis, 2012). Research indicates foraging habitat separation and behaviour between adult male, female and juvenile seals (Page *et al.*, 2005; 2006). Males tend to diver deeper and longer than females and also utilise waters over the continental shelf (Page *et al.*, 2005). In addition, while little seasonal differences in behaviour have been recorded in males, females and juvenile forage closer to colonies in summer months over the continental shelf, moving further offshore during winter and demonstrating seasonal differences in dive characteristics (Mattlin *et al.*, 1998; Page *et al.*, 2006; Harcourt *et al.*, 2002). New Zealand fur seals are widely distributed around both islands, with a large number of breeding and haul out sites (Figure 5.16). They are also often sighted in the vicinity of Māui platforms which act as artificial reefs for large schools of fish whose abundance in turn attracts fur seals. Due to the deep water of the Taranaki Basin, its location close to the shelf edge, the proximity to breeding and haul out sites and the continual presence at nearby Māui platforms, it is expected that New Zealand fur seals could be sighted through the survey period.

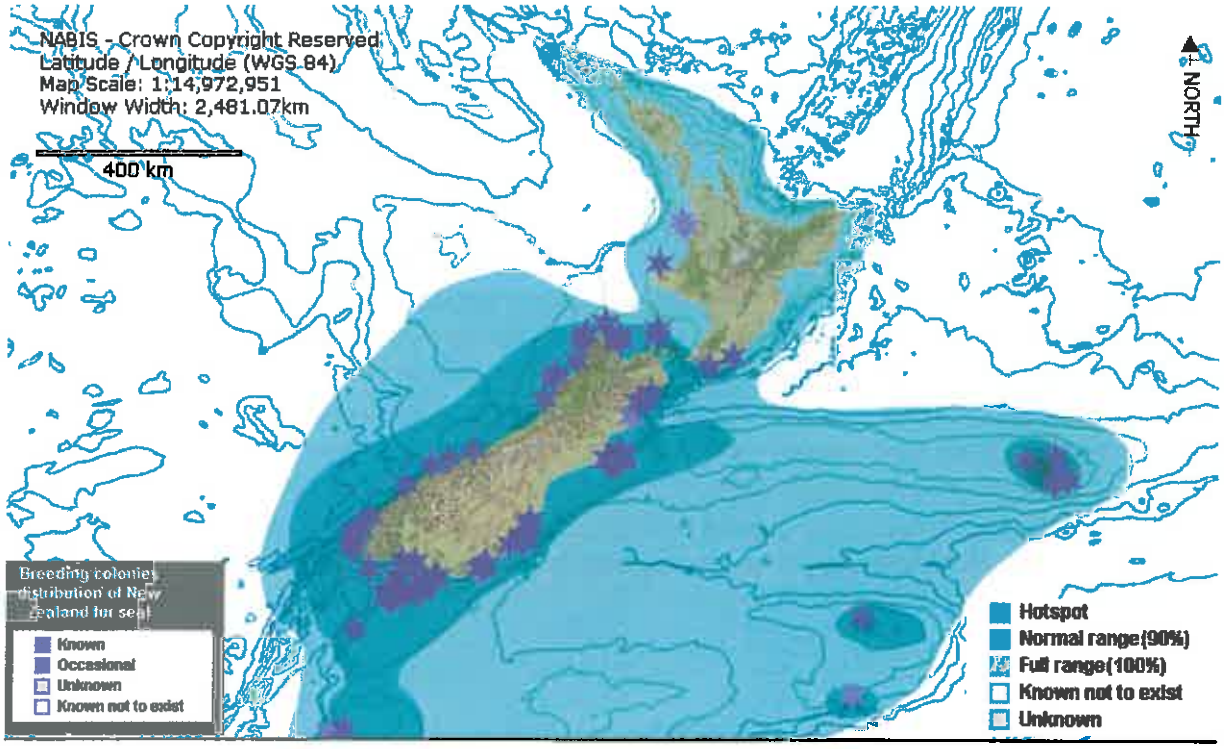

Figure 5.17 New Zealand fur seal distribution in New Zealand waters *(source: NABIS, 2014)*

Other pinnipeds

Of the remaining eight species of pinniped recorded in New Zealand waters, seven are considered either Migrants or Vagrants (Baker *et al.*, 2010). The New Zealand sea lion is classed as Nationally Critical (Baker *et al.*, 2010). New Zealand sea lions are unlikely to occur in the survey area, as they inhabit the Campbell and Auckland Islands, Stewart Island and the southern tip of mainland New Zealand (Childerhouse & Gales, 1998). Only the leopard seal has been reported on a few occasions around the Taranaki region (DOC, 2010).

5.8 Other Marine Mega Fauna

5.8.1 Sea Turtles

Five sea turtle species are known to occur off the coast of New Zealand; the loggerhead turtle (*Caretta caretta*), the green turtle (*Chelonia mydas*), the hawksbill turtle (*Eretmochelys imbricate*), the olive ridley turtle (*Lepidochelys olivacea*) and the leatherback turtle. Though poorly understood, their distribution and abundance tends to be greater in waters to the north of the North Island. The leatherback turtle, however, has been reported as far south as Otago and is the only turtle species to be observed within Taranaki waters, possibly due to resident feeding ground nearby down the west coast of the South Island (DOC, 2014a; WWF, 2010). Rare sea turtles are likely to visit the Taranaki coastline predominantly during the summer months when warm water currents travel down the western side of New Zealand. Species that are classified as Migrant include the green turtle and the leatherback turtle; all remaining species are regarded as Vagrant. The leatherback and olive ridley turtles are classified as Vulnerable, the green and loggerhead turtles are regarded as Endangered and the hawksbill turtle is listed as Critically Endangered by the IUCN (2013).

5.8.2 Sharks and Rays

Great white sharks (*Carcharodon carcharias*) are fully protected within New Zealand waters under the Wildlife Act 1953 as well as whale sharks (*Rhincodon typus*), basking sharks (*Cetorhinus maximus*), smalltooth sand tiger sharks (*Odontaspis ferox*), oceanic whitetip sharks (*Carcharhinus longimanus*), giant manta rays (*Manta birostris*), and spinetail devil rays (*Mobula japonica*). The New Zealand Threat Classification System lists great white sharks as in Gradual Decline (Baker *et al.*, 2010) and they are listed as Vulnerable by the IUCN (2013). Most great white sharks tagged in New Zealand waters have undertaken long distance migrations to subtropical and tropical parts of the southwest Pacific, departing New Zealand over an extended period between February and September (DOC, 2014b). Given this, it is unlikely for great white sharks to be in the survey area at the time of Māui 8 survey. Other shark species such as shortfin mako (*Isurus oxyrinchus*) and blue shark (*Prionace glauca*) are found in the Taranaki Basin during the summer when warmer currents move south wards, therefore these species may be sighted at the beginning of the survey period (REM, 2013). Shortfin mako sharks are classified as Vulnerable with the global population decreasing and blue sharks are Near Threatened according to IUCN (2013).

5.8.3 Seabirds

In New Zealand 86 species of seabirds have been recorded including albatrosses (*Diomedeidae*), cormorants and shags (*Phalacrocoracidae*), fulmars, petrels, prions, shearwaters (*Procellariidae*), terns (*Sternidae*), gulls (*Laridae*), penguins (*Spheniscidae*) and skuas (*Stercorariidae*), including 36 (42%) endemic species which breed nowhere else in the world (Biswell, 2007; Robertson *et al.*, 2007). Although the majority of these species feed in coastal habitats some seabirds travel long distances offshore to feed and therefore are likely to be recorded in the survey area. As albatrosses and petrel species are more pelagic and wide ranging they are more likely to be recorded in the survey area. It is likely that black-browed albatross (*Thalassarche melanophrys*), the Campbell albatross (*T. Impavida*), the white-capped albatross (*T. Steadi*) and giant petrels (*Macronectes* spp.) could occur in the area (Robertson *et al.*, 2007; Jenkins, 1981).

The nearest colonies to the survey area are situated on the Sugar Loaf Islands off the coast of New Plymouth which host thousands of breeding pairs and nesting seabirds, including black-backed (*Larus dominicanus*) and

red-billed gulls *(Chroicocephalus scopulinus)*, white-fronted terns (*Sterna striata*) and at least three types of petrel, including grey-faced petrel (*Pterodroma macroptera gouldi*) and common diving-petrel (*Pelecanoides urinatrix*). Other breeding birds in the region occur on coastal breeding sites on the mainland in the Cook Strait (Biswell, 2007).

Species which may occur in the area when travelling to or from breeding sites include flesh-footed shearwater (*Puffinus carneipes*), sooty shearwater (*P. griseus*), fluttering shearwater (*P. gavial*), Buller's shearwater (*P. bulleri*), Westland petrel (*Procellaria westlandica*), common diving petrel, cape petrel (*Daption capense*), grey-faced petrel and fairy prion (*Pachyptila turtur*) (Jenkins, 1981; 1988; Taylor, 2000a; 2000b; Robertson *et al.*, 2007; Shaffer *et al.*, 2009), and there is some evidence that Cook's petrel (*Pterodroma cookii*) may be sighted in the area (Rayner *et al.*, 2008). However, some species may be present at their breeding colonies nearby for the duration of the survey such as grey-faced petrel, which are mainly at their burrows during March and April (Robertson *et al.*, 2003). During the winter months it is possible that all six species of prion may be found in the Taranaki region (Robertson *et al.*, 2007).

The Australasian gannet (*Morus serrator*) has been recorded along south Taranaki and given its at-sea distribution it is possible to be sighted in the Māui 8 area due to the proximity of a colony nearby at Farewell Spit where there are approximately 5,000 birds present between September and April (Robertson *et al.*, 2007; REM, 2013). Two species of tern, the Caspian tern (*Sterna caspia*) and the white-fronted tern (*S. striata)* are widespread and common throughout the Taranaki region (Robertson *et al.*, 2007). A total of five species of shag occur in the area including black shag (*Phalacrocorax carbo)*, pied shag (*P. varius)*, little black shag (*P. sulcirostris)*, little shag (*P. melanoleucos)* and spotted shag (*P. punctatus)*. Of these, black shag and little shag are the most likely to occur as previous data showed they were the most numerous and had the most widespread distribution in the area (Robertson *et al.*, 2007).

Several of these species occurring in the area have coastal distributions, including shag, gull and tern species. Whereas albatross, shearwater, prion and petrel species are inclined to be more pelagic and wide ranging in their distributions and therefore will likely occur throughout the survey area (Robertson *et al.*, 2007). The list of seabird species most likely to occur in the project area is given in Table 5.4.

Table 5.4 Seabird species most likely to occur in the project area and their conservation status

Common Name	Scientific Name	IUCN Classification	New Zealand Threat Classification	Presence of a Breeding Colony Nearby Project Area
Caspian tern	*Sterna caspia*	Least Concern	Nationally Vulnerable	Yes
White-fronted tern	*Sterna striata*	Least Concern	Declining	No
Grey-faced petrel	*Pterodroma macroptera gouldii*	Least Concern	Not Threatened	Yes
Common diving-petrel	*Pelecanoides urinatrix*	Least Concern	Not Threatened	No
Black-browed albatross	*Thalassarche melanophrys*	Near Threatened	Coloniser	No

White-capped albatross	*Thalassarche steadi*	Near Threatened	Declining	No
Sooty shearwater	*Puffinus griseus*	Near Threatened	Declining	Yes
Flesh-footed shearwater	*Puffinus carneipes*	Least Concern	Declining	Yes
Red-billed gull	*Chroicocephalus scopulinus*	Least Concern	Nationally Vulnerable	No
Black-backed gull	*Larus dominicanus*	Least concern	Not Threatened	No

5.9 Valuation of Receptors

Using the methodology set out in Section 3.5, each identified marine mammal species potentially present within the ZoI has been valued according to its conservation status and potential abundance within the ZoI. The results of this exercise are presented in Table 5.5.

Table 5.5 Receptor valuation

Species	Conservation Status (Cs)		Abundance Score (As)		Receptor Value	
	Conservation Status	**Score**	**Abundance within ZoI**	**Score**	**Value** $(\frac{Cs+As}{20})$	**Valuation**
Baleen whales						
Humpback whale *(Oceania subpopulation)*	IUCN Endangered	8	Not present in Nat. or Int. important numbers-Unknown	3	0.55	Medium
Blue whale	IUCN Endangered	8	Nationally Important - Unknown	8	0.8	High
Antarctic minke whale	IUCN Data Deficient	7	Not present in Nat. or Int. important numbers-Unknown	3	0.5	Medium
Dwarf minke whale	IUCN Least Concern	2	Not present in Nat. or Int. important	2	0.2	Negligible

			numbers- Stable			
Southern right whale	Nationally Endangered	8	Not present in Nat. or Int. important numbers- Stable	2	0.5	Medium
Toothed whales and dolphins						
Sperm whale	IUCN Vulnerable	6	Not present in Nat. or Int. important numbers- Unknown	3	0.45	Medium
Short-beaked common dolphin	IUCN Least Concern	2	Not present in Nat. or Int. important numbers- Unknown	3	0.25	Low
Killer whale	Nationally Critical	10	Not present in Nat. or Int. important numbers- Stable	2	0.6	Medium
Bottlenose dolphin[3]	Nationally Endangered	8	Not present in Nat. or Int. important numbers- Decreasing	4	0.6	Medium
Hector's dolphin	Nationally Endangered	8	Not present in Nat. or Int. important numbers- Decreasing	4	0.6	Medium
Maui's dolphin	Nationally Critical	10	Not present in Nat. or Int. important numbers- Decreasing	4	0.7	High

[3] Nationally Endangered status of bottlenose dolphins in NZ is due to restricted habitat, total abundance and evident decline in two coastal populations (Baker *et al.*, 2010). The size and trend of offshore bottlenose dolphins (which are likely to be present in the survey area) is unknown, however they are not regarded as taxonomically distinct from inshore populations therefore they are assigned the same status.

Long-finned pilot whale	IUCN Data Deficient	7	Not present in Nat. or Int. important numbers- Unknown	3	0.5	Medium
Dusky dolphin	IUCN Data Deficient	7	Not present in Nat. or Int. important numbers- Unknown	3	0.5	Medium
Seals						
New Zealand fur seal	IUCN Least Concern	2	Not present in Nat. or Int. important numbers- Stable	2	0.2	Negligible

6. Inbuilt Mitigation

The inbuilt mitigation designed into this survey work is mainly derived from the 2013 Code which sets out the requirements for marine mammal mitigation for Level 2 surveys, as set out below.

Observers

Two qualified MMOs are required on-board the survey vessel at all times and, as a minimum, one must be on watch during all daylight hours whilst the sound source is in the water. As requested by STOS, a further two qualified Passive Acoustic Monitoring System (PAMS) Operators will be utilised and at least one of these will remain on watch at all times while the source is in the water. Observers will be responsible for recording and reporting (in detail) all marine mammal sightings or detections, sighting conditions, seismic source operations and non-compliances. In the case of non-compliances the observer will report such instances immediately to the Director-General of DOC.

PAM

If operating in an area where calves are anticipated to be present or have been visually observed during the survey, then vocalisations detected by PAM are assumed to be produced from a cow/calf pair and as such the most stringent mitigation zones will be applied unless a sighting by the MMO can confirm otherwise. Furthermore, any ultra-high frequency cetacean vocalizations (30 – 180 kHz) will require an immediate shut down or delay (as per procedures described below) unless the MMO can confirm that the species detected falls under the 'other marine mammal' category. If the PAMS malfunctions or becomes damaged, operations may continue in the absence of PAM while repairs are conducted.

The operator will ensure that information relating to the activation of an acoustic source and the power output levels employed throughout survey operation is readily available to support the activities of the qualified observers in real time by providing a display screen for acoustic source operations

Soft Starts

Soft starts are required whenever the acoustic source is to be activated, with the exception of certain tests (see below) and breaks in firing that are less than 10 minutes in duration immediately following normal operations at full power. In the case of the latter, the acoustic source may start at full power provided the qualified observers have not detected marine mammals in the relevant mitigation zones (as per Section 4.2.4 of the 2013 Code). Soft starts should gradually increase the acoustic source power output, starting with the lowest capacity gun, over a minimum of 20 minutes and should not exceed 40 minutes in duration. On completion of the soft start, operations should be planned so that the survey line starts shortly after. Soft starts give any mobile marine mammals in the area time to move away from the source before full power is reached.

Pre-start Procedures

The acoustic source can only be activated once the vessel is within the specified operational area (see Section 2, above). Operations can then commence with a soft start provided the following:

DAY TIME

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

- A qualified PAMS Operator has conducted acoustic monitoring for at least 30 minutes before activation of the acoustic source and no vocalising cetaceans have been detected in the respective mitigation zones.

NIGHT TIME / POOR SIGHTING CONDITIONS

- A qualified PAMS Operator has conducted acoustic monitoring for at least 30 minutes before activation of the acoustic source and no vocalising cetaceans haven been detected in the respective mitigation zones.

Delays and Shutdowns

Qualified observers have the authority to shut down (for Species of Concern) or delay seismic operations if a marine mammal is detected in the following mitigation zones:

a) *1000 m for Species of Concern[4] with calves*

b) *600 m for Species of Concern*

c) *200 m for any other marine mammal.*

Operations can only start or re-commence once the marine mammal has been observed leaving the respective mitigation zone or, despite continuous observations, a period of 30 minutes has passed since the last detection within the mitigation zone. In the case of New Zealand fur seals, operations may commence if 10 minutes has passed since the last detection within 200 m of the source or the individual or group has been observed leaving the 200 m mitigation zone.

Seismic Source Tests

All tests require soft starts, with the exception of tests below a total volume of 150 cu in. In this instance, tests can commence without a soft start provided the relevant pre-start observations have been made. For all other tests, the soft start must not exceed the rate of a normal soft start but can be less than the 20 minute duration. Tests can commence provided the qualified observer has confirmed no marine mammals are present in the relevant mitigation zones. Acoustic source tests cannot be used for mitigation purposed, or to avoid implementation of soft start procedures.

Line Turns

At the end of each survey line the acoustic source will be shut down and reactivated with a soft start according to the pre-start observation procedures prior to commencement of the next survey line.

Vessel Speed Restrictions

Although not part of the 2013 Code requirements the survey vessel will be restricted to a normal surveying speed of between 3.5 knots (6.5 km/h) and 5.5 knots (10 km/h)), with cruising to/from the survey location restricted to 10 knots (18.5 km/h), which falls below the most dangerous levels of speeds that cause vessel strikes (Laist *et al.*, 2001; Jensen & Silber, 2003; Vanderlaan & Taggart, 2007). This mitigation will act as a significant mitigation in relation to vessel strikes, especially for larger whale species.

[4] There are 36 marine mammal species listed as Species of Concern (SoC) in Schedule 2 of the 2013 Code, as those species particularly sensitive to seismic activities.

7. Assessment of Potential Effects

There are a number of potential effects on marine mammals from the survey operation and these are outlined in Table 7.1. The following sub-sections assess each potential effect against the species identified in Table 5.3.

Table 7.1 Scope of the assessment

Source	Pathway	How the Receptor Could Potentially be Affected	Receptors
Increased vessel activity	Collision	Injury / Mortality	Mainly baleen whales
	Physical presence of vessel and associated noise	Disturbance to ecologically important behaviours (foraging, resting, nursing, breeding) Displacement from habitat	All marine mammal species
Seismic survey	Noise	Physiological (non-auditory and auditory injury and mortality) Perceptual (masking of vocalisations) Behavioural changes Indirect (effects on prey)	All marine mammal species

As explained in sections 3.7 and 3.8, each impact will be assessed by assigning appropriate *impact severity* (0-4) (Table 3.7) and *proportion of population affected* (0-4) (Table 3.8) scores. This will in turn help determine the impact magnitude (0-1 *negligible*; 2-4 *low*; 5-9 *medium*; and 10-16 *high*). Finally, the determination of impact significance involves the interaction of the receptor value together with the assessment of the overall magnitude (Table 3.10).

7.1. Vessel Collision Risk

Given the presence of a seismic survey vessel in the area, the potential for collisions with marine mammals, notably larger whale species, must be evaluated.

Large vessels might collide with large whales and cause fatalities or injuries – a report by Jensen and Silber (2003) found that 68% of reported ship strikes on large whales resulted in fatality, whereas 16.4% resulted in non-fatal injury. Of 11 cetacean species known to be hit by vessels, fin whales are struck most frequently, while right whales (*Eubalaena glacialis* and *Eubalaena australis*), humpback whales, sperm whales, and grey whales (*Eschrichtius robustus*) are hit commonly. The most lethal or severe injuries are caused by ships 80 m or longer and those travelling 14 knots or faster (Laist *et al.*, 2001).

There are other factors that can influence the chances of collision such as the age and gender of animals, distraction by feeding or mating activities, habituation to vessels (or otherwise failing to sense and react to vessel approach) and congregation in feeding or breeding areas (risk may be density dependent) (Dolman *et al.*, 2006). Additionally, certain areas and regions are considered hotspots for vessel collisions. Namely, 90% of incidents occur in either the continental shelf or slope region (Laist *et al.*, 2001), while most global ship strike records come from the North Atlantic coast of USA and Canada (Jensen & Silber, 2003).

Out of the 11 collision risk species listed above, four baleen whales (southern right whale, humpback whale, blue, and minke whale sp.) and two odontocetes (sperm whale and killer whale) are likely to occur in the Māui 8 survey area. Most of the baleen whale species occur in relatively low numbers and mostly during periods of migration that are outside of the seismic survey window. Blue whales, however, appear to use the South Taranaki Bight as a foraging ground and therefore are present in higher numbers which in turn increases their risk of vessel collisions (Torres, 2013). Moreover, the southern right whale might be particularly vulnerable to ship strikes as they do not respond quickly to vessel noise or presence (Kemper *et al.*, 2008).

As per the 2013 Code requirement, at least one MMO will be on watch during transits to/from site and during operational activity whilst on site and therefore will be able to report on any marine mammals present in the imminent vicinity of the vessel that could pose a collision risk.

As vessel speed appears to be the most significant factor for vessel strikes, the speed restrictions set out in Section 6 (normal surveying speed of between 3.5 knots and 5.5 knots and cruising to/from the survey location restricted to 10 knots) will act as effective inbuilt mitigation.

Table 7.2 sets out the results of the impact assessment taking in to account the inbuilt mitigation identified.

Table 7.2 Collision risk assessment

Species	Receptor Value	Impact Magnitude		Impact Magnitude	Impact Significance
		Severity	PoPA		
Baleen Whales					
Humpback whale	Medium	4	0	Negligible	Not significant
Blue whale	High	4	1	Low	Minor
Antarctic minke whale	Medium	4	0	Negligible	Not significant
Dwarf minke whale	Negligible	4	0	Negligible	Not significant
Southern right whale	Medium	4	1	Low	Minor
Toothed whales and dolphins					
Sperm whale	Medium	3	0	Negligible	Not significant

Short-beaked common dolphin	Low	3	0	Negligible	Not significant
Killer whale	Medium	3	0	Negligible	Not significant
Bottlenose dolphin	Medium	3	0	Negligible	Not significant
Hector's dolphin	Medium	3	0	Negligible	Not significant
Maui's dolphin	High	3	0	Negligible	Not significant
Long-finned pilot whale	Medium	3	0	Negligible	Not significant
Dusky dolphin	Medium	3	0	Negligible	Not significant
Seals					
New Zealand fur seal	Negligible	2	0	Negligible	Not significant

Due to the nature of the impact and their vulnerability, the associated impact severity score for baleen whales as a group is considered *high (4)*. The survey will not coincide with major seasonal whale migration therefore greatly reducing the likelihood of interactions with these species. Given the short anticipated duration of the survey and the area of open water in which the vessel will be operating, it is expected this impact will be limited to very low numbers of individuals travelling through the area at the time of the survey (proportion of population affected score *barely perceptible (0)* apart from southern right and blue whales which have been assessed as *very low (1)*).

The associated severity score for toothed whales and dolphins and seals is considered *medium (3)* and *low (2)* respectively. This is due to the fact that these animals are less likely to suffer injury or fatality due to ship strikes in comparison to baleen whales. Therefore, the expected impact significance is considered *not significant*.

As such, the overall magnitude of this impact is considered to be predominantly *negligible (low* for southern right whale and blue whale) and impact significance varies from *not significant* to *minor* per species. No significant effects are predicted and no additional mitigation is either identified or required in relation to collision risk.

Mitigation measures set in place to prevent boat-boat collisions are included within the Shipboard Safety Procedures Manual for the survey vessel and marine crew onboard will be familiar with the specified measures.

7.2 Physical Disturbance Due to Presence of Vessels

The presence of a vessel and its associated activity together with the noise produced could potentially disturb marine mammals whilst engaged in ecologically important behaviours (foraging, resting, nursing or breeding) or cause a displacement from their habitat if such disturbance is persistent and long term. Short-term behavioural

changes of bottlenose dolphins in Doubtful Sound, New Zealand have been recorded due to vessel presence (Lusseau, 2006). During these interactions, dolphins tended to move horizontally and vertically to avoid vessels whilst their movement become more erratic. A study by Williams *et al.* (2006) investigated the activities of northern resident killer whales in the presence and absence of vessels. They found that when vessels were nearby, killer whales reduced their time spent feeding and socialising. Moreover, a multi-year study on humpback whales showed that whales change their behaviour in the presence of cruise ships. The typical reactions of whales to the presence of vessels (up to 4 km away) included avoidance by diving underwater or swimming away, reducing surface time, and changing their breathing rates (Baker & Herman, 1989). The reaction of animals depends on many factors including behaviour state of animals, type of vessel and vessel activity (Lusseau, 2006). In addition, the bathymetry of the location in which the animals encounter vessels must be considered, as this will affect the propagation of noise from the vessel, and therefore alter the sound levels encountered by the animals.

Table 7.3 sets out the result of the impact assessment for physical disturbance.

Table 7.3 Physical disturbance assessment

Species	Receptor Value	Impact Magnitude		Impact Magnitude	Impact Significance
		Severity	PoPA		
Baleen Whales					
Humpback whale	Medium	1	2	Low	Minor
Blue whale	High	2	2	Low	Minor
Antarctic minke whale	Medium	1	1	Negligible	Not significant
Dwarf minke whale	Negligible	1	1	Negligible	Not significant
Southern right whale	Medium	1	1	Negligible	Not significant
Toothed whales and dolphins					
Sperm whale	Medium	1	2	Low	Minor
Short-beaked common dolphin	Low	1	2	Low	Not significant
Killer whale	Medium	1	2	Low	Minor
Bottlenose dolphin	Medium	1	2	Low	Minor
Hector's dolphin	Medium	1	1	Negligible	Not

					significant
Maui's dolphin	High	1	1	Negligible	Not significant
Long-finned pilot whale	Medium	1	1	Negligible	Not significant
Dusky dolphin	Medium	1	2	Low	Minor
Seals					
New Zealand fur seal	Negligible	1	2	Low	Not significant

Due to the short length of the Māui 8 survey with the presence of only one survey vessel in a relatively small survey area, the associated impact severity score for all species, except blue whales, is considered *negligible (1)*. Also, it has been recorded that the survey area is not located in the immediate vicinity of any important resting, breeding or nursing grounds for the majority of species, and there are no major migrations happening during the proposed survey period, therefore if any temporal displacement did occur, it would not result in changes to a key life stage.

However, there is evidence that blue whales do use the Taranaki Basin as a feeding ground (Torres, 2013) hence their associated severity score is higher. However given the temporal and short nature of the survey, occurring in open waters, it is expected this impact will be limited to very low numbers of individuals moving through the area at the time of the survey (proportion of population affected score *very low (1)* for species that are less likely to be present in the survey area while those assessed as likely (see Table 5.3) to be present scored *low (2)*).

As such, the overall magnitude of this impact is considered to be either *low* or *negligible* while impact significance predominantly *not significant*.

7.3 Seismic Sound Effects

There is the potential for negative impacts from underwater noise as the frequencies at which marine mammals detect and produce sounds overlaps with those of the seismic source (Figure 7.1). Such impacts can be direct and indirect depending on acoustic characteristics of the source (noise level, duration, duty cycle, rise time and spectrum), the medium (bathymetry and hydro- and geo-acoustics parameters of the environment) and the receiver (age, size, behavioural state, auditory capabilities) (Erbe, 2012).

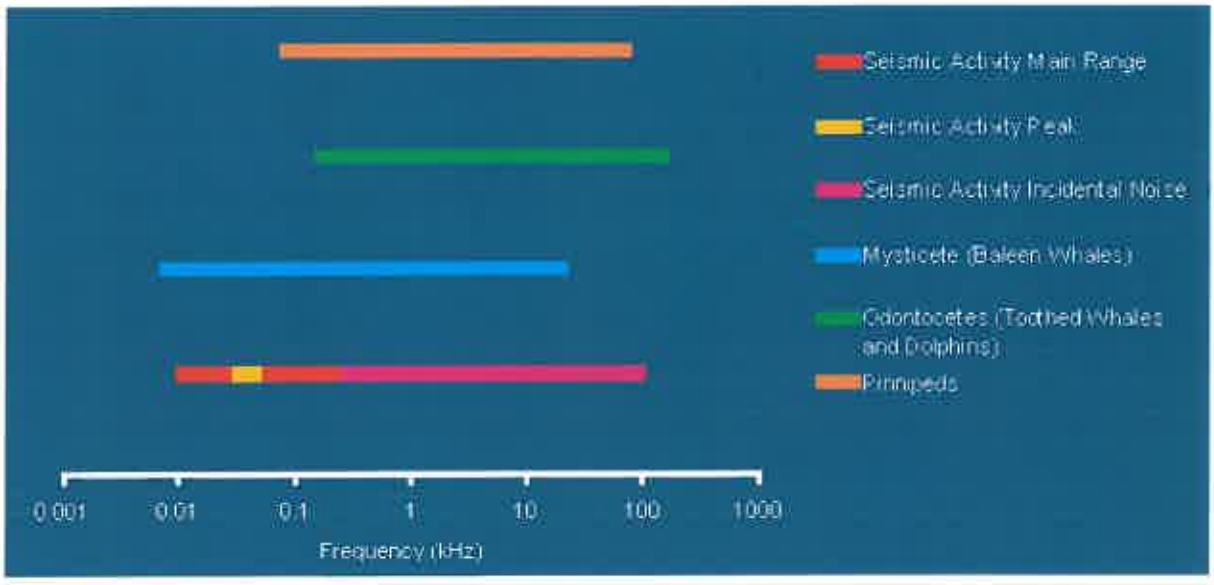

Figure 7.1 Auditory frequencies used by marine mammals and main frequency range of seismic activity based on Götz *et al.* (2009) and Southall *et al.* (2007)

The impacts of underwater noise produced by a seismic sound source to marine life in general can be:

- Physiological:
    - non-auditory – damage to body tissues and induction of gas and fat embolism and auditory (sound induced hearing loss)
    - damage to the auditory system, permanent hearing threshold shift (PTS) and temporary hearing threshold shift (TTS)
- Perceptual: masking of communication with con-specifics[5], masking of other biologically important sounds used for navigation, finding prey, etc...
- Behavioural: interruption of normal behaviours such as feeding, breeding and nursing, behaviour modification, adaptive shifting of vocalisation intensity/frequency, and displacement from area (short or long term)
- Disturbance or reduction in prey species

Baleen whales are considered particularly vulnerable to seismic sound as their hearing frequency range (7 Hz to 22 kHz) overlaps greatly with those frequencies used for seismic surveys (10 to 120 Hz) (Figure 7.1). However, other marine mammals can be affected as well given the fact that seismic surveys can produce incidental noise of up to 22 kHz (Goold & Fish, 1998).

It should be noted that the primary objectives of the 2013 Code aims to minimise disturbance to marine mammals and to minimise noise in the marine environment arising from seismic survey activities. All the mitigation measures outlined in the Code serve these primary objectives and these are included in the inbuilt mitigation (see Section 6).

[5] Con-specific: two or more individual organisms, populations or taxa that belong to the same species.

Based on the results of the sound transmission modelling for this particular survey (Section 4), the given mitigation zones for Level 2 surveys greatly exceed the zones in which behavioural disturbance or injury are predicted. The results of this modelling plus the mitigation included in the survey design reduce any potential negative impacts to a low level.

7.3.1 Physiological Impacts

High levels of underwater sound can impact marine life as it could cause physical damage to tissues and organs (in particular gas-filled organs) and cavitations (bubble formation) (Erbe, 2012). Any mortality or direct physical injury from the noise and vibrations generated by a particular sound source is associated with very high peak pressure or impulse levels. Typically, these effects are associated with blasting activities or in the immediate vicinity of an acoustic source. It has been observed that at high exposure levels, such as those typical of underwater explosive activities or offshore impact pile-driving activities, fatality may occur in species of fish and marine mammals where the incident peak to peak sound level exceeds 240 dB re 1 µPa10. The likelihood of fatality increases with levels above 240 dB re 1 µPa, and as the time period of the exposure increases. Similarly, physical injury has been seen to occur where peak to peak levels exceed 220 dB re. 1µPa (Hill, 1978; Goertner, 1982; Richardson *et al.*, 1995; Hastings & Popper, 2005).

Permanent and temporary injury as a result of acoustic exposure can occur in the form of hearing loss when the source level is of sufficient energy. This occurs when loud noises affect the hearing sensitivity of an individual either permanently (known as permanent threshold shift, PTS) or temporarily (temporary threshold shift, TTS; Richardson *et al.*, 1995).

A direct injury as a result of seismic surveys is only likely at very close range to an acoustic source of very high sound intensity, hence the potential for any serious physiological impact during the Māui 8 survey can be considered highly unlikely, especially when the low intensity of the sound source (220 cu. in.) and the inbuilt mitigation measures are taken into an account (see modelling results in Section 4).

However, due to marine mammal sensitivity to underwater noise and their protected status, a precautionary severity score of *2 (low)* is assigned for this assessment. Marine mammals are highly mobile and will most likely avoid acoustic sources causing them discomfort before they get within the range at which physiological damage might occur (Gordon *et al.*, 2003). Taking that fact into account together with the inbuilt mitigation measures, the associated score for the proportion of population affected is assigned as *barely perceptible (0)*. Overall, impact magnitude is then *negligible* and impact significance *not significant*.

Table 7.4 sets out the result of the impact assessment.

Table 7.4 Non-auditory and auditory injury and mortality assessment

Species	Receptor Value	Impact Magnitude		Impact Magnitude	Impact Significance
		Severity	PoPA		
Baleen Whales					
Humpback whale	Medium	2	0	Negligible	Not significant

Blue whale	High	2	0	Negligible	Not significant
Antarctic minke whale	Medium	2	0	Negligible	Not significant
Dwarf minke whale	Negligible	2	0	Negligible	Not significant
Southern right whale	Medium	2	0	Negligible	Not significant
Toothed whales and dolphins					
Sperm whale	Medium	2	0	Negligible	Not significant
Short-beaked common dolphin	Low	2	0	Negligible	Not significant
Killer whale	Medium	2	0	Negligible	Not significant
Bottlenose dolphin	Medium	2	0	Negligible	Not significant
Hector's dolphin	Medium	2	0	Negligible	Not significant
Maui's dolphin	High	2	0	Negligible	Not significant
Long-finned pilot whale	Medium	2	0	Negligible	Not significant
Dusky dolphin	Medium	2	0	Negligible	Not significant
Seals					
New Zealand fur seal	Negligible	2	0	Negligible	Not significant

7.3.2 Perceptual (Masking of Vocalisations)

Marine mammals produce vocalisations and rely on sound as their primary sense for a variety of biologically significant functions. Increased levels of background noise can interfere with an individual's ability to detect relevant sounds by masking communication and echolocation signals as well as environmental sounds produced by prey species (David, 2006). Some species will respond to masking by ceasing vocalisation (Bowles *et al.*, 1994), whilst others may alter the intensity, length or frequency of their vocalisation (Di Iorio & Clark, 2010). Consequently, this can have implications for marine mammals' communication, navigation and foraging activities.

The greatest potential for masking of acoustic signals occurs in species that produce and perceive low frequency sounds, such as the baleen whales, seals and sea lions (Wright, 2008). Baleen whales in particular are thought

to be sensitive to frequencies as low as 0.01 kHz with their vocalizations typically occurring in the 0.01 to 0.3 kHz frequency range (Richardson *et al.*, 1995). In this case acoustic masking may occur over large areas particularly in those species that communicate in the lowest frequency ranges (i.e. blue and fin whales). The potential for masking at higher frequencies (1 to 25 kHz) exists when the vessel is in close proximity to the animal (Wright, 2008). In these circumstances other marine mammals, including dolphins and porpoises may also experience masking to some degree. Table 7.5 shows the frequency range of vocalisations produced by marine mammals likely to be in the survey area. Since frequencies used for communication in odontocetes are in the lower frequency range in comparison to those used for echolocation, these are more likely to be masked by seismic noise. Therefore animals' communication and social behaviour would be more affected than the foraging activities associated with echolocation signals.

Table 7.5 Frequencies of acoustic signals produced by marine mammals that are likely to be encountered in the survey area

Species	Communication Frequencies (kHz)	Echolocation Frequencies (kHz)	References
Humpback whale	0.02 - 10	N/A	Howorth, 2003
Blue whale	0.012- 31	N/A	Howorth, 2003
Dwarf minke whale	0.05 - 9.4	N/A	Gedamke *et al.*, 2001
Antarctic minke whale	130 - 160	N/A	Gedamke *et al.*, 2001
Southern right whale	0.03- 2	N/A	Richardson *et al.*, 1995
Short-beaked common dolphin	2-18	0.5 - 67	Richardson *et al.*, 1995; Howorth, 2003
Killer whale	1.5 - 18	0.5 - 120	Richardson *et al.*, 1995; Howorth, 2003
Bottlenose dolphin	0.2 - 24	40 - 150	Lôpez & Shirai, 2009
Hector's dolphin	Data deficient	115–135	Kyhn *et al.*, 2009
Long-finned pilot whale	1 - 8	1 - 18	Richardson *et al.*, 1995
Dusky dolphin	1-27	40-110	Richardson *et al.*, 1995
Sperm whale	0.1 - 30		Howorth, 2003
New Zealand fur seal	0.5-2.6	N/A	Page *et al.*, 2002

Seismic airguns are characterised by emitting high intensity and low frequency noise. Most of the energy produced by a 220 cu. in. seismic array is under 200 Hz in frequency with a broad peak around 20 to 120 Hz (Breitzke *et al.*, 2008). Based on this, the main seismic frequency range heavily overlaps with frequencies used by baleen whales that are likely to occur in the Māui 8 survey area, while there is also a certain degree of overlap between the whole seismic frequency range (including incidental frequencies) and odontocetes, sperm whale and bottlenose dolphins in particular (Figure 7.2). Sperm whales are the largest odontocetes and are thought to have better low frequency hearing than smaller odontocetes (Ketten, 1992). Thus it is likely that sperm whales are more vulnerable to disturbance from seismic surveys. Madsen *et al.* (2006) quantified the air-gun pulses recorded on sperm whales and concluded that despite the presence of high frequency energy in some air-gun

pulses, the low duty cycle of air-gun noise suggests that the pulses are not likely to pose a significant masking problem for sperm whale acoustic communication or echolocation (Madsen *et al.*, 2006; Mate *et al.*, 1994).

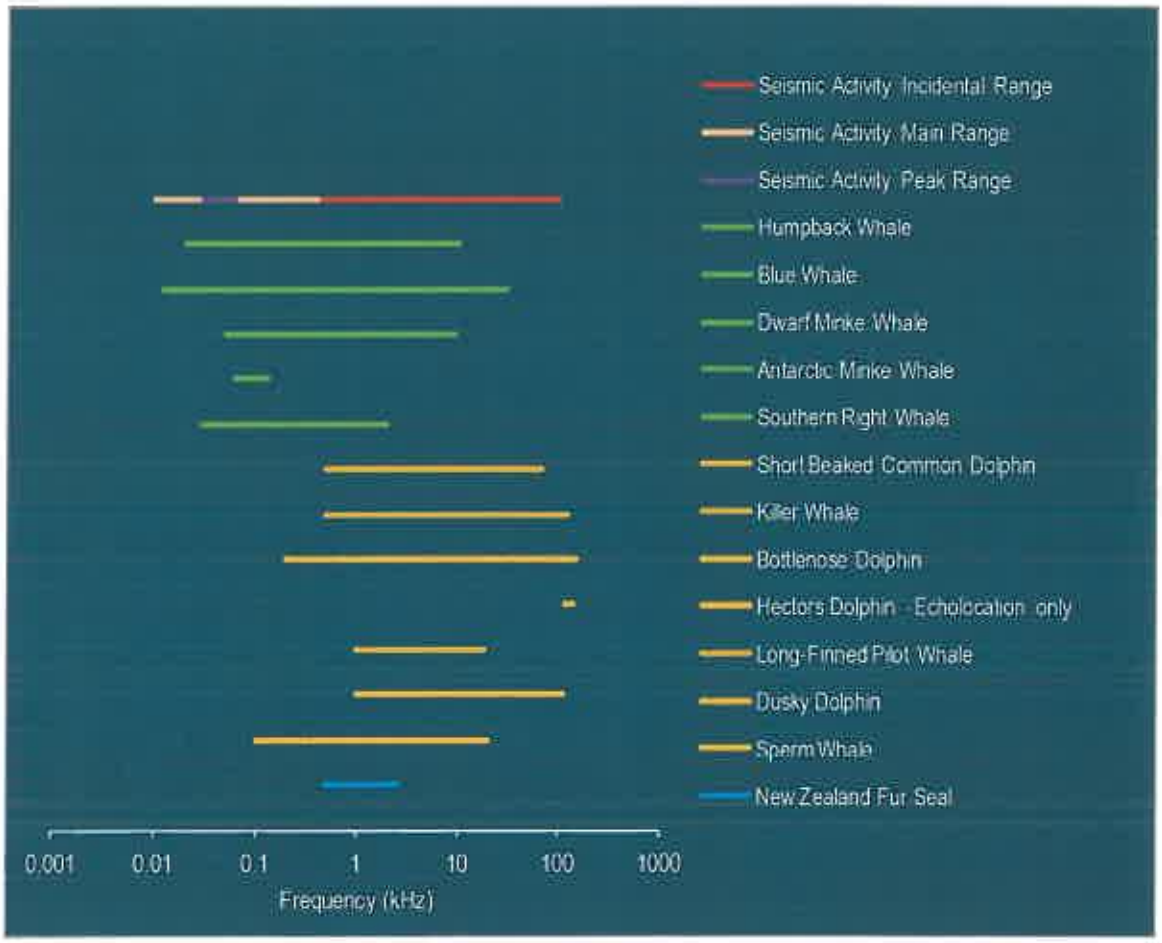

Figure 7.2 Frequency ranges of marine mammals likely to occur in the survey area and their overlap with seismic survey frequency range

Considering the results of the predictive noise modelling conducted as part of this MMIA, together with the inbuilt mitigation measures already in place, and given the low intensity of the acoustic source that will be used for this survey as well as the short period during which it will be conducted, the impacts of possible masking will not significantly impair ecologically important behaviours of marine mammals. Additionally, marine mammals are likely to exhibit avoidance behaviour therefore it can be assumed that they will move away from the zone within which their communication will be influenced (Gordon *et al.*, 2003). However, due to their sensitivity to masking, baleen whales scored a higher impact magnitude than other species. As outlined in the Table 7.6 the overall impact significance is considered to be either *minor* or *not significant*.

Table 7.6 Masking assessment

Species	Receptor Value	Impact Magnitude		Impact Magnitude	Impact Significance
		Severity	PoPA		
Baleen Whales					
Humpback whale	Medium	2	1	Low	Minor
Blue whale	High	2	1	Low	Minor
Antarctic minke whale	Medium	2	1	Low	Minor
Dwarf minke whale	Negligible	2	1	Low	Not significant
Southern right whale	Medium	2	1	Low	Minor
Toothed whales and dolphins					
Sperm whale	Medium	1	0	Negligible	Not significant
Short-beaked common dolphin	Low	1	0	Negligible	Not significant
Killer whale	Medium	1	0	Negligible	Not significant
Bottlenose dolphin	Medium	1	0	Negligible	Not significant
Hector's dolphin	Medium	1	0	Negligible	Not significant
Maui's dolphin	High	1	0	Negligible	Not significant
Long-finned pilot whale	Medium	1	0	Negligible	Not significant
Dusky dolphin	Medium	1	0	Negligible	Not significant
Seals					
New Zealand fur seal	Medium	1	0	Negligible	Not significant

7.3.3 Behavioural Disturbance

The greatest amount of information available on the responses of marine mammals to sound from seismic surveys concerns behavioural responses. The available literature on this subject is also the most varied and

highlights the lack of consensus among the scientific community on the occurrence, scale and significance of such effects (Götz *et al.*, 2009). Sounds at received levels above 120 dB re 1 µPa are believed to cause behavioural changes in 50% of all marine mammals (Richardson *et al.*, 1995).

Behavioural responses to underwater noise are dependent on a wide variety factors, for example hearing sensitivity, exposure to similar noises and behaviour at the time of exposure. Sound can impact behaviour such as dive patterns, travelling distances, or feeding behaviour. Responses such as avoidance or attraction behaviour could cause disruption of normal functioning. When assessing this impact, many factors need to be considered including the hearing ability of the species as well as the context in which the species is exposed to the acoustic source. Ultimately the extent of the impact will depend on the context in which the animal experiences the sound as well as the physical characteristics of the sound (Götz & Janik, 2011).

Existing studies have shown that many cetaceans exhibit different degrees of behavioural responses to seismic surveys (Stone & Tasker, 2006). One study on short-beaked common dolphins found populations to be temporarily disturbed (Goold, 1996) while another has found a reduction in cetacean diversity, mainly amongst members of the *Delphinidae*[6] family during an intense seismic survey (Parente & De Araujo, 2005). During seismic operations, killer whales have been shown to remain significantly further away from the source when the airguns are operating and show localised spatial avoidance (Stone & Tasker, 2006). However, no reduction in the sighting rate was found in response to operating airguns. Furthermore, Mate *et al.* (1994) reported sperm whale density in a preferred area of the Gulf of Mexico decreased to approximately 1/3 of pre-survey levels for the two days after a seismic survey had started and decreased further to zero by the fifth day of surveying. In contrast to these reports, observations have been made that suggest sperm whales to show little response and are not excluded from habitats by seismic surveys (Gordon *et al.*, 2003).

Many baleen whale species including blue, sei, minke, humpback and fin whales have shown behavioural changes in response to sound from seismic surveys (Malme *et al.*, 1985; Gordon *et al.*, 2003). Contrary to this, male humpback whales appear to show either tolerant or attraction behaviour to seismic sources, while females show avoidance behaviour (McCauley *et al.*, 1998; 1999; 2000). A group of 250 fin whales were reported to cease vocalising across an area of 10,000 square nautical miles coincident with a seismic survey (Clark & Gagnon, 2006).

The available studies on seals' reactions to seismic sound are even more contradicting. At one end of the spectrum there is avoidance behaviour, alteration of dive profiles, cession of foraging and moving away from acoustic source (Thompson, 2000; Thompson *et al.*, 1998), tighter grouping patterns between individuals, spending more time with their heads raised from the water, staring at the guns (Bain & Williams, 2006; Richardson, 2002). On the other hand there is considerable tolerance towards novel underwater sounds especially in the presence of high food concentrations (Richardson, 2002; Reeves *et al.*, 1996) and only mild localised avoidance to airguns demonstrated by arctic seals (primarily ringed seals, *Pusa hispida*), suggesting a degree of tolerance to the seismic noise produced (Harris *et al.*, 2001).

The inbuilt mitigation measures outlined in the 2013 Code will probably have the greatest influence on this impact since they are primarily designed to minimise acoustic disturbance to marine mammals from seismic operations. Considering the stringent requirements of the 2013 Code, specifically the use of soft starts, delay and shutdown of operations and the large mitigation zones, the effects of this impact will be greatly reduced. However, taking into account the available literature which suggests a certain degree of behavioural disturbance even at large distances, the precautionary severity score *low* (2) has been assigned. Therefore, the expected overall impact significance of behavioural disturbance will be *minor* or *not significant* (Table 7.7).

[6] Family *Delphinidae* includes oceanic dolphins

Table 7.7 Behavioral disturbance assessment

Species	Receptor Value	Impact Magnitude		Impact Magnitude	Impact Significance
		Severity	PoPA		
Baleen Whales					
Humpback whale	Medium	2	1	Low	Minor
Blue whale	High	2	1	Low	Minor
Antarctic minke whale	Medium	2	1	Low	Minor
Dwarf minke whale	Negligible	2	1	Low	Not significant
Southern right whale	Medium	2	1	Low	Minor
Toothed whales and dolphins					
Sperm whale	Medium	2	1	Low	Minor
Short-beaked common dolphin	Low	2	1	Low	Not significant
Killer whale	Medium	2	1	Low	Minor
Bottlenose dolphin	Medium	2	1	Low	Minor
Hector's dolphin	Medium	2	1	Low	Minor
Maui's dolphin	High	2	1	Low	Minor
Long-finned pilot whale	Medium	2	1	Low	Minor
Dusky dolphin	Medium	2	1	Low	Minor
Seals					
New Zealand fur seal	Medium	2	1	Low	Minor

7.3.4 Indirect Effects on Prey Species

Although less research has been conducted on the responses of fish/invertebrate species to seismic sound, there is the potential that sound could cause disturbance, displacement or reduction in the presence of marine

mammal prey species. Hence seismic surveys may indirectly affect marine mammals in the area by changing the accessibility of their prey species.

A few studies have indicated that there may be such a connection. An observed lack of foraging dives reported for sperm whale could have been a result of prey displacement (Weilgart, 2007). Miller *et al.* (2006) also suggested that the 'observed' foraging behaviour of sperm whales during seismic surveys might have been related to behavioural reactions of the sperm whale prey to airgun sound. These conclusions are supported by large scale changes in behaviour among fish populations exposed to seismic surveys (Götz *et al.*, 2009). Indeed, a study by Fewtrell and McCauley (2012) on marine fish and squid found that with increasing airgun noise (range between 120 and 184 dB re 1 μPa^2.s (SEL)), fish responded by moving to the bottom of the water column and swimming faster in more tightly cohesive groups. Also, a significant increase in alarm responses were observed in fish and squid exposed to airgun noise exceeding 147-151 dB re µPa SEL. Furthermore, studies by Engås *et al.* (1996) and Løkkeborg and Soldal (1993) have indicated probable declines in the catch rates for both cod *(Gadus morhua)* and haddock (*Melanogrammus aeglefinus)* (between 45 and 70%) in the vicinity of an airgun array. Fish catches were affected at distances of nearly 25 nautical miles and catch rates did not recover within five days after operations ended. A similar study showed a 52% decline in catches in a rockfish fishery exposed to a single airgun array (Skalski *et al.*, 1992). The exact reasons for such declines are presumed to be a result of changes in the swimming depth of fish or of shoaling behaviour in response to the airgun sound (Wardle, 2001).

Besides behavioural reactions, seismic surveys can have auditory impacts on fish and squid. A study on three species of fish examined threshold shifts caused by exposure to an operating 730 cu. in. airgun array (Popper *et al.*, 2005). The results showed varying degrees of threshold shift with recovery within 24 hours of exposure. André *et al.* (2011) examined the effects of low frequency sound exposure in four cephalopod species and found massive trauma in their acoustic structures.

However, due to the low intensity of the sound source for this survey (220 cu. in.) limited to a relatively small area, and its short duration, any impacts on marine mammal prey species will likely be temporary and not on a large scale, therefore severity of this impact is considered to be *negligible (1).* It is expected that a very low (1) proportion of population will be affected resulting in *negligible* impact magnitude and overall *not significant* impact significance (Table 7.8).

Table 7. 8 Indirect impact on prey species assessment

Species	Receptor Value	Impact Magnitude		Impact Magnitude	Impact Significance
		Severity	PoPA		
Baleen Whales					
Humpback whale	Medium	1	1	Negligible	Not significant
Blue whale	High	1	1	Negligible	Not significant
Antarctic minke whale	Medium	1	1	Negligible	Not significant
Dwarf minke	Negligible	1	1	Negligible	Not significant

whale					
Southern right whale	Medium	1	1	Negligible	Not significant
Toothed whales and dolphins					
Sperm whale	Medium	1	1	Negligible	Not significant
Short-beaked common dolphin	Low	1	1	Negligible	Not significant
Killer whale	Medium	1	1	Negligible	Not significant
Bottlenose dolphin	Medium	1	1	Negligible	Not significant
Hector's dolphin	Medium	1	1	Negligible	Not significant
Maui's dolphin	High	1	1	Negligible	Not significant
Long-finned pilot whale	Medium	1	1	Negligible	Not significant
Dusky dolphin	Medium	1	1	Negligible	Not significant
Seals					
New Zealand fur seal	Medium	1	1	Negligible	Not significant

8. Additional Mitigation

The MMIA identifies that all of the predicted effects are either non-significant or of minor significance. With the absence of any moderate of major significant effects no further mitigation is strictly required in order to protect marine mammal populations from the potential effects of the survey. However, using GEL's practical experience of undertaking marine mammal mitigation work the following additional mitigation will be incorporated in to the survey to further reduce risk and assist in reporting to the Director-General of DOC:

- Two Passive Acoustic Monitoring System (PAMS) Operators will be present onboard the seismic vessel throughout the survey to conduct acoustic monitoring for marine mammals. Such acoustic monitoring will cover 24 hours allowing marine mammal monitoring during hours of darkness and low visibility. Passive Acoustic Monitoring (PAM) is considered as an additional measure and is voluntary for Level 2 surveys, however STOS have requested its use in order to follow best practice measures.

- Two qualified MMOs will be on watch during all pre-start observations during daylight hours and any other key times (heath and safety permitting).

- To avoid any risk of collision with baleen whales during transit, at least one MMO is to be on the watch during transits or at any times of increased vessel speed (i.e. above usual survey speed). If any baleen whales are sighted in the vicinity ahead of the vessel and if judged by the MMO that the animal/s is/are not responsive (i.e. during times of resting, feeding, socialising), the vessel's course will be altered to avoid collision with the animal/s.

- Immediate notification of the Director-General of DOC if SoC are encountered in unusually high numbers.

- If any Hector's dolphins or Maui's dolphins are sighted at any time during the survey (including transits), the Director-General of DOC will be informed at the first possible instance. In such instances both National Office (Ian Angus, and the Taranaki Area office (Callum Lilley, or Brian Williams, should be informed.

- Ground-truthing of received sound levels at the mitigation distances is to be conducted during the survey and results presented in the final trip report. If the results of these measurements significantly differ from the noise modelling conducted as a part of this MMIA, the Director-General will be immediately notified.

9. In-Combination and Cumulative Effects

9.1 In-Combination Effects

Synergistic effects from the survey on individual receptors (e.g. collision risk + noise risk) may cause effects that, when combined, produce increased (and possibly significant) adverse effects.

The results of the assessment result in non-significant and minor levels of risk when assessed in isolation. When all potential project specific effects are viewed in-combination, the highest overall risk relates to baleen whales and specifically blue whales due to the importance of the South Taranaki Blight as their foraging ground. However, given the high level of mitigation proposed (inbuilt plus additional) it is not considered that the in-combination effects are more than minor for these species and no further mitigation is required.

9.2 Cumulative Effects

Cumulative effects can occur when other projects or developments act in concert with those arising from this survey, providing a synergistic (incremental) change on receptors either through overlap in ZoI, extending the time period for disturbance to occur or other similar mechanisms.

DOC have provided information on other seismic surveys which are programmed to take place near the Māui 8 site in early to mid-2014, including marine seismic surveys (MSS), shallow hazard surveys, and bore-hole surveys. The planned surveys are identified in Table 7.9, along with their approximate commencement date, although this is subject to change.

Table 7. 9 Other proposed Seismic Surveys

Survey Type	Level of Survey	Location	Commencement Date
2D MSS	Level 1	Permit Area 54857	March/April
2D MSS	Level 1	Permit Area 53537	March
2D Shallow hazard survey	Level 1 or 2	S. Taranaki Bight	March
Bore-hole survey	Level 2	Permit Area 38158	Late March
Bore-hole survey	Level unknown	Māui Well area	June/July

Of the five other proposed seismic surveys it is the two (possibly three) Level 1 surveys that are likely to have the greatest potential effects, due to the greater power of the acoustic source used and the subsequent noise propagation over a wider area. These surveys will take place in different permit areas with no overlap with the Māui Field. A proposed bore-hole survey is planned for the Māui well area. Compliance with the 2013 Code for this survey is assumed. Due to the normally short nature of bore-hole surveys and the fact that survey times will most likely not overlap, no significant cumulative effects are predicted. Nonetheless, it should be acknowledged that there is a potential for a cumulative effect if the surveys occur at the same time, especially if proposed bore-hole survey is classed as Level 1, as per the 2013 Code.

Considering the minor/non-significant effects identified in this MMIA it is considered that cumulative effects with other surveys are either unlikely to occur or will increase the magnitude of any effect only marginally. It is likely that the cumulative effects of the Level 1 surveys will be more important to determine than those associated with any of the Level 2 surveys given the results of this exercise.

10. Monitoring and Reporting

For the duration of the survey, two MMOs and two PAMS Operators will be present onboard the survey vessel. At least one MMO will be on watch during daylight hours while the acoustic source is in the water in the operational area and during transits from/to port. Both MMOs will be on watch during pre-start observations during daylight hours (health and safety permitting). MMOs with experience in PAM, when not required for visual observation, are allowed to undertake acoustic monitoring and allow the PAMS Operator to have a refreshment break and time off for meals. A direct line of communication will be maintained between MMOs and PAMS Operators during those times.

Acoustic monitoring will be undertaken 24 hours per day, allowing coverage of the hours of darkness and poor visibility. One PAMS Operator will be on watch at all times while the acoustic source is in the water in the operational area. If PAM equipment gets damaged or any problems occur with the system, operations may continue in the absence of PAM whilst repairs are conducted.

The maximum duration of each observer's shift will be 12 hours in any 24 hour period including time needed for reporting requirements.

Any on-duty observer has the authority to implement the mitigation measures outlined in the MMIA.

If any crew member onboard the survey vessel observes a marine mammal, he/she will promptly inform the MMO on duty who will then try to identify the animal/s and determine the distance from the acoustic source. When it is not possible to confirm the sighting, the crew member who reported the observation will provide as much information as possible for the MMO to complete the relevant recording forms. If the animal/s observed were within the relevant mitigation zone, it will be up to the MMO to decide whether to implement any mitigation measures. Observations reported by crew members will be clearly differentiated within the recording forms.

The operator will ensure that information relating to the activation of an acoustic source and the power output levels employed throughout survey operation is readily available to support the activities of the qualified observers in real time by providing a display screen for acoustic source operations.

The recording and reporting will be done as according to the requirements outlined in the 2013 Code.

All sightings/detections of marine mammals during the survey period will be recorded, including those beyond the mitigation zone and/or those during transit, in the standardised recording sheets. In addition to marine mammals, all sightings of other marine mega fauna i.e. sea turtles and sharks will be recorded too. Whilst collecting data, a clear differentiation should be made between data derived from:

- MMO and PAM Operators
- Qualified and trained observers
- Watches conducted during survey operations (ON survey) or at any other times (OFF survey).

This raw data will be submitted by the qualified observers, directly to the Director-General, at the earliest opportunity but no longer than 14 days after the completion of each deployment.

In addition to this, the Director-General is to be informed immediately when SoC are encountered in unusually high numbers. A decision whether any of the sightings or species encounters qualify for this requirement will be upon the professional judgement of the qualified MMO onboard. Moreover, any sightings of Maui's and Hector's

dolphins will be immediately reported to the Director-General. In these instances, the Director-General will determine if additional measures are necessary, and if so, they will be implemented without delay.

Furthermore, the Director-General should be notified about any non-compliance immediately. Such communication should be pursued via telephone. The first person of contact should be Ian Angus (Manager, Marine Species and Threats Alternatively, the DOC Hotline should be used: 0 800 DOC HOT.

A final trip report will be submitted by the proponent to the Director-General at the earliest opportunity but no later than 60 days after completion of the survey. Both MMO and PAM Operators will be jointly responsible for recording observation data and compiling a final trip report.

This report should include:

- The identity, qualifications and experience of those involved in observations
- Observer effort, including totals for watch effort (hours and minutes)
- Observational methods employed
- Name of the operator and any vessels/aircraft used
- Specifications of the seismic source array, and PAM array (if included)
- Position, date, start/end of survey, GPS track logs of vessel movements
- Totals for seismic source operations (hours and minutes) indicating respective durations of full-power operation, soft starts and acoustic source testing, and power levels employed, plus at least one random soft start sample per swing
- Sighting/acoustic detection records indicating:
    - method of detection
    - position of vessel/acoustic source
    - distance and bearing of marine mammals related to the acoustic source
    - direction of travel of both vessel and marine mammals
    - number, composition, behaviour/activity and response of the marine mammal group (plotted in relation to vessel throughout detection)
    - confirmed identification keys for species or lowest taxonomic level
    - confidence level of identification
    - descriptions of distinguishing features of individuals where possible
    - acoustic source activity and power at time of sighting
    - environmental conditions
    - water depth, and

- for PAM detections, time and duration heard, type and nature of sound

- General location, time, duration and reasons where observations were affected by poor sighting conditions
- Position, time and number of delays and shutdowns initiated in response to the presence of marine mammals
- Position, duration and maximum power attained where operational capacity is exceeded
- Any instances of non-compliance with the Code.

Data will be recorded in a standardised format, see: http://www.doc.govt.nz/notifications.

The data collected during this survey will be able to contribute to the knowledge on marine mammal presence/distribution within the survey area in the Taranaki Basin as well as to behaviour responses of marine mammals to this type of acoustic source.

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12. Appendix

Appendix A Consultation

Contact List for Māui 8 Site Survey MMIA Consultation

Tangata whenua

Name of Organisation	Date of correspondence/ contact	Comments received
Muaūpoko Tribal Authority	14th January 2014 20th January 2014 30th January 2014 17th February 2014	No comments received
Rangitaane O Manawatu:	14th January 2014 30th January 2014 13th February 2014 18th February 2014 19th February 2014	No comments received
Ngati Apa Iwi	14th January 2014 30th January 2014 17th February 2014	No comments received
Te Ātiawa Iwi	14th January 2014 30th January 2014 17th February 2014 18th February 2014	No comments received
Ngati Toa Iwi	14th January 2014 30th January 2014 31st January 2014 6th February 2014 17th February 2014	No comments received

Taranaki Iwi Trust	14th January 2014 30th January 2014 17th February 2014	No comments received
Ngāti Rārua Iwi	14th January 2014 30th January 2014 17th February 2014 18th February 2014	No comments received
Ngati Tama Iwi, Wellington	14th January 2014 30th January 2014 17th February 2014	No comments received
Ngati Ruanui	14th January 2014 30th January 2014 31st January 2014 7th February 2014 11th February 2014	Ngati Ruanui have no comments to make since the survey will not be taking place within their takiwa. General interest in potential ecological effects. Would like to see the final MMIA.
Ngati Koata trust	14th January 2014 30th January 2014 17th February 2014	No comments received
Ngati Kuia Iwi	14th January 2014 30th January 2014 17th February 2014	No comments received
Nga Haou o Ngaruahine Iwi	4th February 2014 17th February 2014	No comments received
Te Runanga o Ngati Mutunga	4th February 2014 5th February 2014 6th February 2014	The area affected is outside of the traditional boundary (rohe) so they feel that they do not have involvement with this issue.
Nga Ruahine	4th February 2014 17th February 2014	No comments received

	18th February 2014	
Te Ohu Kaimoana	13th Feb 2014 17th February 2014 18th February 2014	No comments received
Te Tai Hauauru Fisheries Forum	13th February 2014	No comments received

Local Councils

Name of Organisation	Date of correspondence/ contact	Comments received
Tasman District Council	14th January 2014 30th January 2014 18th February 2014	No comments to make since the proposed area is out of their jurisdiction
Taranaki Regional Council	14th January 2014 30th January 2014 18th February 2014	No comments received
Waikato Regional Council	14th January 2014 30th January 2014 3rd February 2014	The area in question lies outside their jurisdiction so they have no comments on this proposal.
Wellington Regional Council Biodiversity team	14th January 2014 30th January 2014 18th February 2014	No comments received
Wanganui District Council	14th January 2014 30th January 2014 18th February 2014	The area in question lies outside their jurisdiction so they have no comments on this proposal.
Rangitikei District Council	14th January 2014 30th January 2014 18th February 2014	The proposal has no relevance to Rangitikei District Council

Manawatu District Council	14th January 2014 30th January 2014 18th February 2014	No comments received
New Plymouth District Council	13th February 2014 19th February 2014	No comments received
South Taranaki District Council	13th February 2014 19th February 2014 21st February 2014	The area of responsibility and jurisdiction of the South Taranaki District Council does not extend off shore to the area affected by the proposed seismic survey. The South Taranaki District Council does not have any expertise relating to the effects of seismic surveys on marine mammals and would rely upon central government agencies to protect the environment when authorising such exploration. As such, the South Taranaki District Council appreciates being consulted on this programme, but is unable to offer any meaningful comment at this time.
Stratford District Council	13th February 2014 19th February 2014	There is no jurisdiction or legal interest in the Māui 8 project

Local Marine Businesses

Name of Organisation	Date of correspondence/ contact	Comments received
Seal Coast Safari, Wellington.	14th January 2014 30th January 2014 31st January 2014	They have no comments about the proposed survey
The Sea Kayak company, Abel Tasman National park	14th January 2014 30th January 2014 19th February 2014	No comments received

Wilsons, Abel Tasman National Park	14th January 2014 30th January 2014 19th February 2014	No comments received
Golden bay Kayaks	14th January 2014 30th January 2014 19th February 2014	No comments received
Abel Tasman Kayaks	14th January 2014 30th January 2014 18th February 2014	No comments received
Kahu Kayaks	14th January 2014 30th January 2014 18th February 2014	No comments received
Nelson Tasman Tourism	14th January 2014 30th January 2014 18th February 2014	No comments received
Dolphin watch ecotours	14th January 2014 30th January 2014 19th February 2014	No comments received
French Pass Sea Safaris	14th January 2014 19th January 2014 30th January 2014 2nd February 2014 3rd February 2014 6th February 2014 7th February 2014 8th February 2014	General concerns over disturbance to dolphins, whales and their habitat. Suggestions to implement independent monitoring of operations by observers, to avoid periods of seasonal migrations, and use airborne sightings.
New Plymouth sport fishing and underwater club	13th February 2014 19th February 2014	No comments received

Other NGOs and Institutions

Name of Organisation	Date of correspondence/ contact	Comments received
Victoria University Coastal Ecology Lab	14th January 2014 30th January 2014 19th February 2014	No comments received
New Zealand Whale and Dolphin Trust Otago University, Dunedin	14th January 2014 30th January 2014 18th February 2014 4th March 2014	expressed concern over voluntary implementation of the Code in the territorial waters given that this is where the most sensitive marine mammal populations are found. Regarding the survey in particular she was glad to see that PAMs will be employed during day and night, but worried about number of observers in total (2 MMOs and 2 PAM ops). She also offered her interpretation of available data on distribution of Maui's and Hector's dolphins and pointed out the need for more structured survey campaigns in order to draw more robust scientific conclusion on their distribution.
Environmental Protection Authority	14th January 2014 30th January 2014 31st January 2014	Due to EPA's role, they do not wish to be involved in the consultation process
Project Jonah, New Zealand	14th January 2014 30th January 2014 3rd February 2014 6th February 2014 12th February 2014 14th February 2014 18th February 2014	Concerns over blue whales feeding grounds Recommended extra measures: Additional MMO onboard; Use of independent qualified observers; Aerial observation at regular daily intervals;

		Use of PAM; Deployment of static PAM in all areas of the proposed survey; No operations if PAM is inoperable; Coordination with other vessels, coastguard radio and authorities; Minimum mitigation zone for all SoC to a maximum observable distance i.e. 10 km plus; Minimum pre-start observation 138 minutes; No active acoustic source during night-time or poor sighting conditions; Fund further research on marine mammals in South Taranaki Bight; Mitigation fund to cover cost of stranding response and necropsy investigation into cause of death for all stranded marine mammals in an area but not limited to the Taranaki coast (New Plymouth in the north, Wellington in the south), Marlborough Sounds, Cook Strait, Golden Bay, Tasman, west coast and neighbouring environments for a period during and for three months after the proposed survey.
Wellington Marine Conservation Trust	14th January 2014 30th January 2014 19th February 2014	No comments received
WWF New Zealand	14th January 2014 30th January 2014 19th February 2014	No comments received
National Institute of Water and Atmospheric Research (NIWA)	3rd February 2014 9th February 2014	[gave opinion on the blue whales presence in the region. Her recommendation was to move

		the survey to June-September period when fewer blue whales are in the region. However she understands that this may not be a feasible option.

Fishery Groups

Name of Organisation	Date of correspondence/ contact	Comments received
Seafood NZ	13th February 2014 18th February 2014	Seafood NZ has a long standing interest in better understanding the distribution and abundance of marine mammals in New Zealand waters. They are keen to see an improvement in the data availability for marine mammals in NZ waters, and keen to facilitate and contribute to this process as appropriate. The following was proposed: -Gardline work with the DOC to ensure that existing marine mammal observations (including observer effort data) are utilised in the assessment of cetacean distributions in Taranaki waters, and in the area of the proposed survey in particular; -Copies of the MMO and PAM data (as per Appendix 2 of the Code) together with the summary trip report (as per s3.5 of the Code) are provided to Seafood NZ as the basis for further discussion about the wider use of these, and other, sighting data in building an improved understanding of cetacean distribution and abundance in NZ waters.
Deepwater group	13th February 2014	No comments received
Sealord	13th February 2014	No comments received
Egmont Seafoods	13th February 2014	No comments received

Port Taranaki	13th February 2014 14th February 2014	No comments received
Taranaki Commercial Fishermen Federation	13th February 2014 14th February 2014	This area has no impact on Taranaki fishermen
New Zealand Federation of Commercial Fishermen	13th February 2014	No comments received
Fisheries Inshore New Zealand	13th February 2014	No comments received
Southern Inshore Fisheries Management Company	13th February 2014	No comments received
NZ Rock Lobster Industry Council	13th February 2014 18th February 2014 19th February 2014	Lobster fisheries does not have either direct or indirect interactions with marine mammals in the area of the propose survey. However, lobster industry does have concerns over potential effects of the survey on pelagic stage rock lobster larvae. These concerns can be met by way of coordination and planning of activities.

Consultation Letter and Information Sheet Sent to Consultees

GARDLINE ENVIRONMENTAL LIMITED
Endeavour House, Admiralty Road,
Great Yarmouth, Norfolk. NR30 3NG UK

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14th January 2014

Shell Todd Oil Services Ltd.
2014 Maui-8 High Resolution Seismic Site Survey
Marine Mammal Impact Assessment

Dear Sir/Madam,

We write on behalf of Shell Todd Oil Services Ltd regarding the Marine Mammal Impact Assessment (MMIA) for the Maui-8 site survey, which is currently scheduled for the first half of 2014. Shell Todd Oil Services Ltd propose to undertake an experimental drilling programme in the South Taranaki Bight and the proposed seismic survey is required to detect any shallow hazards to the drilling and safe anchoring of the proposed Maui-8 well. The seismic survey will cover three potential drill locations with on-site operations lasting approximately 1 week.

Information on the Maui-8 project can be found on the Environmental Protection Authority website http://www.epa.govt.nz/EEZ/current_activities/Reports_transitional_provisions/Pages/default.aspx . Further information regarding the survey itself and a brief explanation of the effects of underwater noise on marine mammals are provided in the accompanying summary sheet.
Gardline Environmental Ltd has recently been appointed to undertake the required MMIA in advance of the survey. The aim of the MMIA is to determine the potential impact on local marine mammal populations. The team is currently collating data and undertaking an initial consultation of all relevant stakeholders, in accordance with the requirements of the *'2013 Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations'*, published by the New Zealand Department of Conservation.

To assist us with compiling a robust MMIA, we welcome any comments or concerns you may consider relevant to either the assessment itself (including any comments on appropriate assessment methods) or the survey. We are working to a strict schedule, and would therefore be grateful if you could respond by 31st January to Maja Nimak-Wood (maja.nimak-wood@gardline.com). Please do not hesitate to contact us with any queries you may have regarding the proposal.

Yours Sincerely,

Maja Nimak-Wood

Marine Mammal Scientist
Marine Wildlife Department

THE SURVEY

Shell Todd Oil Services Ltd (STOS) requires a site survey that will employ a semi-submersible mobile offshore drilling unit to detect any potential shallow hazards to the drilling of the Maui-8 well. An additional seabed survey to detect hazards to the anchoring of the rig is required. The site is in approximately 110 m water depth within the Maui producing field between the Maui A and Maui B platforms (Figure 1) in the South Taranaki Bight. In order to acquire seabed data, this seismic survey will utilise an airgun array of operational capacity of 220 cu in.

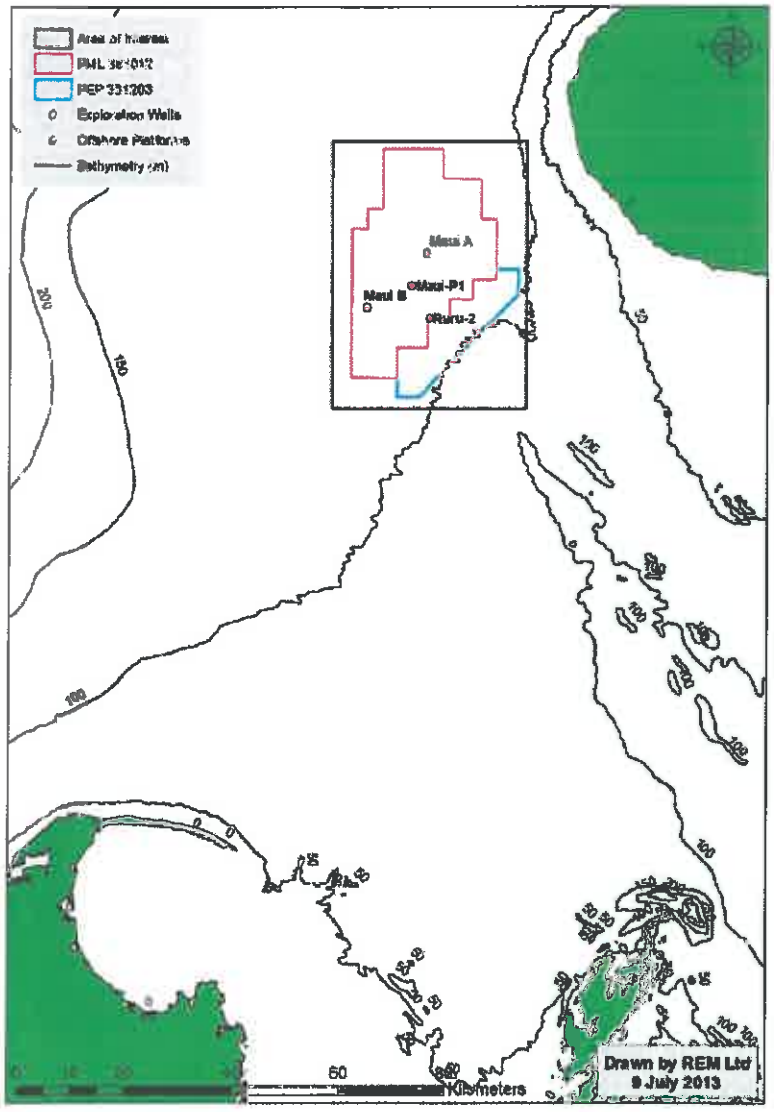

Figure 1. Location map of the survey site

The *'2013 Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations'* (The Code hereafter) defines three levels of seismic surveys based on the clear demarcation of acoustic source capacity and they are as follows:

Level 1 survey – any marine seismic survey using an acoustic source with a total combined operational capacity exceeding 427 cubic inches. These surveys are the most stringently controlled with the largest mitigation zones and highest number of observers required.
Level 2 survey – any marine seismic survey using an acoustic source with a total combined operational capacity of between 151-426 cubic inches. These surveys have less stringent measures reflecting reduced risk of potential impact from lower energy seismic surveys, mainly reflected in smaller mitigation zones.
Level 3 survey - any marine seismic survey using low-energy, high-resolution electro-mechanical sources including small seismic sources of less than 150 cubic inches capacity or sparklers, pingers and boomers. Level 3 surveys are exempt from the provisions of the Code.

Therefore, seismic activity associated with this particular survey has been classified as **"Level 2"** by the Department of Conservation, a low scale seismic operation in comparison to larger geophysical investigations.

Before this survey takes a place, a Marine Mammal Impact Assessment (MMIA) needs to be conducted with the aim of identifying the potential impacts to marine mammals in the area from these seismic operations, and determine steps to avoid, remedy or mitigate any negative effects.

SEISMIC ACTIVITY AND MARINE MAMMALS

Seismic exploration includes the input of sound into the marine environment, at frequencies that overlap with the auditory frequencies used by many marine mammals. Bubbles produced by an array of towed airguns collapse, producing a sound wave which allows visualisation of the structure of the seabed to considerable depths below its surface (Figure 2).

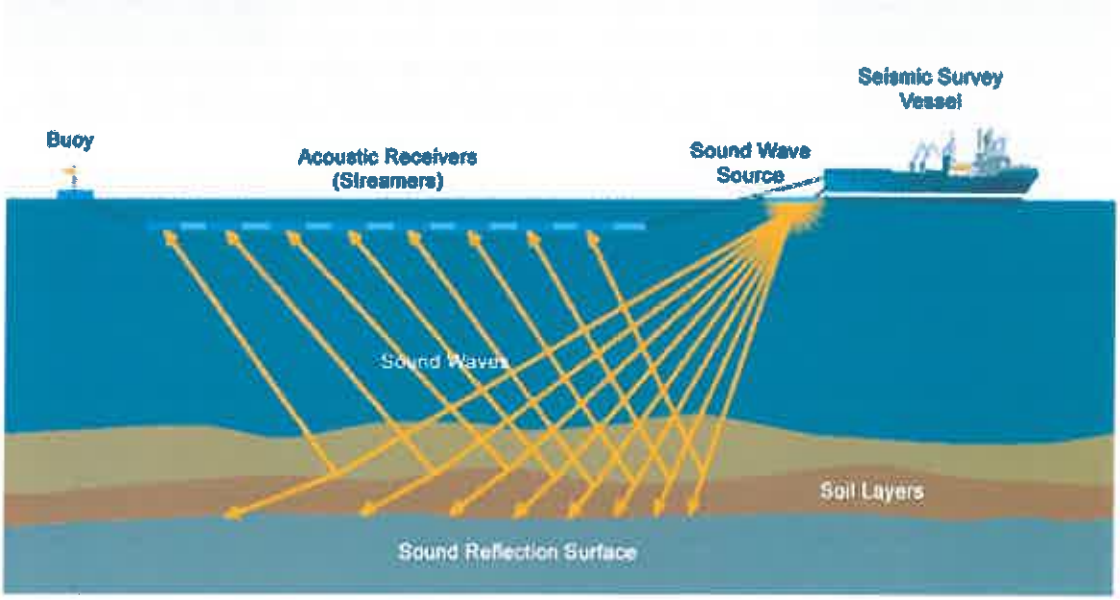

Figure 2. Seismic survey diagram *(source www.fishsafe.eu)*

It has been suggested that such sound production has the potential to impact marine mammals on several different levels (Compton *et al*, 2007):

Physiological (non-auditory) – Including damage to body tissues and the induction of gas and fat embolism.

Auditory – Including permanent and temporary shifts in hearing thresholds.

Perceptual – Masking of communication channels and other biologically important sounds

Behavioural – Including the interruption and modification of normal behaviour such as feeding, breeding and nursing, displacement from the operational area (either short or long term) and adaptive shifting of vocalisation intensity and/or frequency.

Impacts are likely to be individual specific, and rely on factors such as exposure levels and duration. In 2013 the Department of Conservation produced a robust set of guidelines for the seismic industry to minimise the impacts of operations on this important group of marine animals. This Code of Conduct is mandatory within the New Zealand Exclusive Economic Zone, and voluntary within territorial seas and the remainder of the New Zealand continental shelf.

MITIGATION APPROACHES

The 2013 Code of Conduct for level 2 surveys requires that a minimum of two Marine Mammal Observers (MMOs) are present for all daylight activity. These MMOs will be responsible for monitoring seismic activity and ensuring that operations are carried out in a safe manner for marine mammals in the area as per standards outlined in the 2013 Code of Conduct.

Passive Acoustic Monitoring (PAM) is considered as an additional measure and it is voluntary for level 2 surveys. The client has requested the additional measure of PAMS to be employed during the survey with two PAM System Operatives onboard throughout the survey to conduct acoustic monitoring for marine mammals.

Standard mitigation approaches include conducting pre-start observations before any seismic activity commences; delaying the start of operations for marine mammals within broad mitigation zones of up to 1 km; increasing the power of the acoustic array gradually to allow animals to leave the area before operations reach full power (soft starts); and performing shut-downs of operations for marine mammals identified as species of concern by the New Zealand Government. The MMIA may recommend extra mitigation approaches as necessary on a site by site case.

More information about the mitigation approaches adopted by seismic ships in New Zealand waters can be found on the Department of Conservation website (http://www.doc.govt.nz/conservation/marine-and-coastal/seismic-surveys-code-of-conduct/).

REFERENCES

Compton R, Goodwin L, Handy R, Abbott V. 2007. A critical examination of worldwide guidelines for minimising the disturbance to marine mammals during seismic surveys. Marine Policy (2007), doi:10.1016/j.marpol.2007.05.005

Written Responses Received

From:
Sent: 09 February 2014 20:00
To: Maja Nimak-Wood
Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Tena Koe Maja,

For some reason your previous email wasn't received. Ngati Ruanui have no comments to make based upon the info received. If you can provide us with a copy of the MMIA when it is ready and info of any citings following the seismic survey this would be much appreciated. Furthermore as Ngati Ruanui is largely based in South Taranaki we recognise this survey is not taking place within our takiwa (area of interest) and only make these comments because of our interest in the potential ecological effects. I am sure you are also talking to the right iwi whom have mana whenua over this area.

Nga Mihi,

Environmental Law Officer

Te Runanga o Ngaati Ruanui Trust

Sent: 05 February 2014 02:45
To: Maja Nimak-Wood
Subject: FW: Invitation for consultation- Maui-8 Seismic Site Survey

Kia ora Maja,

Thank you for your message and information. The area affected is outside of our traditional boundary (rohe) so we have no involvement with this issue.

Nga mihi,

Kaiwhakahaere

Chief Executive

Te Rūnanga o Ngāti Mutunga

w: www.ngatimutunga.iwi.nz

NGĀTI MUTUNGA

Sent: 03 February 2014 02:57
To: Maja Nimak-Wood
Subject: FW: Invitation for consultation- Maui-8 Seismic Site Survey
Importance: High

Hi Maja

Thanks for the invitation to comment on this. The area in question lies well outside our jurisdiction so we have no comments on this proposal. Our region extends to just past the Mokau river mouth on the west coast.

Regards

Senior Coastal Policy Advisor | Policy and Transport Group
Waikato Regional Council

Sent: 20 February 2014 19:51
To: Maja Nimak-Wood
Subject: Shell Todd Oil Services Ltd Seismic Survey - New Zealand

Thank you for your letter of 13th February 2014 in the matter of the proposed Shell Todd Oil Services Ltd Seismic Survey off the coast of South Taranaki, New Zealand. The area of responsibility and jurisdiction of the South Taranaki District Council does not extend off shore to the area effected by the proposed seismic survey. Our Council does not have any expertise relating to the effects of seismic surveys on marine mammals and would rely upon central government agencies to protect the environment when authorising such exploration.

As such, the South Taranaki District Council appreciates being consulted on this programme, but is unable to offer any meaningful comment at this time.

Thank you,

Group Manager Environmental Services| South Taranaki District Council

www.southtaranaki.com

Sent: 19 February 2014 22:04
To: Maja Nimak-Wood
Subject: Invitation for Consultation - Maui-8 seismic Site Survey

Hi Maja,

Sorry about the lack of response to your earlier email. Stratford District does not have any coastline – the nearest is 30km away. As a Council we therefore have no jurisdiction or legal interest in the Maui-8 project.

Kind regards,

Director Community & Environmental Services

Stratford District Council

www.stratford.govt.nz

Sent: 18 February 2014 22:00
To: Katt Preston
Subject: RE: test

Thanks Katt,

Although of personal interest I do not believe that the proposal has any relevance to us as a District Council.

Regards

Environmental Services Team Leader |

www.rangitikei.govt.nz |

Sent: 30 January 2014 21:39
To: Maja Nimak-Wood
Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

No comment

Operations Manager | Seal Coast Safari

Email: safari@sealcoast.com | **Web:** www.sealcoast.com

Sent: 08 February 2014 06:42
To: Maja Nimak-Wood
Subject: Re: Invitation for consultation- Maui-8 Seismic Site Survey

Thank you Maja

On 7/02/2014, at 4:10 AM, Maja Nimak-Wood wrote:

Dear

Thank you so much for finding time to respond to my consultation request.

I do understand your concern over the disturbance and I would like to assure you we will be putting in place a set of strict mitigation measures with the aim to reduce any disturbance to minimum levels.

For your further reassurance here are few key points:

- This survey is considered as low intensity seismic survey (Level 2 as per the Code). Airguns that will be used (220 cubic inches) are comparatively smaller than those used for high intensity surveys with airgun of few thousand cubic inches, hence negative effects will be proportionally smaller too. Also this survey should last only 7 days so if any disturbance occur, it will only be temporal.
- Our noise propagation modelling has shown that injury and behavioural disturbance can only occur within 30 m of the acoustic source while set mitigation zones range between 200 m and 1 km. Therefore, these mitigation zones are more than enough to prevent any injury or obvious behavioural changes.
- Two MMOs will be onboard during all times covering periods of operational activity as well as periods during transits to/from port. Further to this, the STOS has requested Passive Acoustic Monitoring (PAM) onboard and two PAM operators. Such acoustic monitoring will cover 24 hours including times of darkness and poor visibility allowing for marine mammals to be detected even when MMOS are not able to. All observers to act as MMOs and PAMs will have years of experience in mitigating for marine mammals during seismic surveys.
- The likelihood of any significant effects of this survey is further reduced with the fact that the timing does not overlaps with any major migrations of whales or breeding/nursing times.
- I am well aware of recent reports of blue whales presence in the area and we have identified them as high risk receptors. Due regard has therefore been taken of this species by placing an appropriately high valuation in the assessment.

I do hope this answers satisfy you and provide reassurance regarding the disturbance of marine mammals in the proposed survey area.

Should you have any further questions/comments, do not hesitate to contact me again.

Many thanks.

Kindest regards,

Maja Nimak-Wood
Marine Mammal Scientist, Gardline Environmental Limited

Sent: 02 February 2014 07:16
To: Maja Nimak-Wood
Subject: Re: Invitation for consultation- Maui-8 Seismic Site Survey

Hi Maja

thank you for the extension. We have had a few developments which have taken our time this last week so apart from sourcing DOCs guidlines I haven't had the time to spend on them.

Basically I am concerned with any disturbance to dolphins whales and marine mammals as well as their habitats.

Unfortunately due to man made activity there is an attrition in dolphin numbers generally across all species.

In my view, it would be imperative to have independent monitoring of operations by observers with integrity to make sure dolphins whales and marine mammals don't show up in the survey area. It would be good to have an idea of seasonal migration also and to use the off season periods for your surveys. You may also need to use air sightings.

Last year research highlighted above Farewell spit as being important for Blue Whales, this had not been realized and there were a good many sighted. If you were to include air surveys, collated and shared the data that could be useful.

Other than the above comment I am sorry I cannot give you more other than my genuine concern for marine mammal species.

People like Dr Liz Slooten and Prof Bernd Wursig can offer an informed view based on their own research and science. I would suspect that you will be working with these people.

Kind regards

French Pass Sea Safaris & Beachfront Villas

www.seasafaris.co.nz

Sent: 30 January 2014 20:00
To: Maja Nimak-Wood

Subject: FW: Invitation for consultation- Maui-8 Seismic Site Survey
Importance: High

Dear Maja

Thank you for your email regarding the Maui-8 Seismic Survey and the invitation to participate in the consultation process.

I would like to explain a bit about the EPA's role and kindly reject the offer to be involved in the consultation process.

The EPA administers the Exclusive Economic Zone and Continental Shelf Act 2012 (the Act) which includes regulations on Permitted Activities. Seismic Surveying has been classified as a Permitted Activity, as long as the operator complies with DOC's 2013 Seismic Code of Conduct (the Code).

DOC is responsible for administering the Code and is directly involved with operators and consultation to develop the Marine Mammals Impact Assessment etc. The EPA's role is to enforce the Act and thus the Code, which basically means deal with any non-compliance which DOC advises us of.

Our role is more of a behind the scenes approach until DOC become aware of any non-compliance.

Hopefully this explains the situation, please feel free to contact me directly if you have any further questions.

Kind regards

Advisor, EEZ

COMPLIANCE

Environmental Protection Authority

www.epa.govt.nz

From: Maja Nimak-Wood
Sent: 13 March 2014 16:00

Subject: RE: [Fwd: FW: Invitation for consultation- Maui-8 Seismic Site Survey]

Thank you so much for your email. Apologies from my side for late replay though.

Your knowledge and input on this matter is much appreciated. I will definitely endeavour to contact you much earlier in the consultation process for next MMIA so we can discuss baseline data in more detail.

In regards to your comments about voluntary application of the Code in the territorial waters, I can only forward that to the DOC as we are not able to address it during this process.

However, I can offer you my point of view in regards to number of observer. As you are probably aware, PAMS is not mandatory requirement for Level 2 surveys, such as this one, but only presence of MMOs onboard. Therefore, there will be four observers instead of two prescribed by the Code. As ex-MMO/PAMS op and MMO trainer (JNCC, BOEM and DOC) I can assure you that four experienced observers will be enough to provide credible observation and good 24 coverage. All observers will be experienced both in PAMS and MMO roles and able to rotate between different roles to provide 24 coverage, credible observation and implement appropriate mitigation measures. Hence daylight hours will be covered with 2 MMOs and 1 PAM op and night times with one PAM op.

You mentioned a need for systematic survey in the region in order to collect robust data sets on cetacean presence and distribution. Can you please tell me is there an interest among scientific community to undertake such surveys in the near future? If scientific community would need a support for such research, we could potentially be able to help by bringing scientists and industry together.

Many thanks once again for your input.

I am sure we will stay in touch.

Kindest regards,

Maja Nimak-Wood

Marine Mammal Scientist

Gardline Environmental Limited

Sent: 22 February 2014 03:47
To: Maja Nimak-Wood
Subject: Re: [Fwd: FW: Invitation for consultation- Maui-8 Seismic Site Survey]

Dear Maja,

Here are some preliminary comments, in order to get this to you before you go on leave. I'm happy to make more detailed comments, but would need more time to do so.

It is surprising that the Code of Conduct is still voluntary in New Zealand's territorial waters (within 12 nautical miles from shore), given that this is where the most sensitive marine mammal populations are found - in particular the endemic New Zealand dolphin (Hector's and Maui's dolphin). As I'm sure you know, the mining industry has played a very active role in the development of these guidelines and lobbying government in terms of where and when they apply. The fact that they are voluntary damages the credibility of the guidelines and makes the system of monitoring and safeguards ineffective.

This may have been done in the interests of keeping the information sheet short, but I was surprised to see only one reference at the end of the info sheet.

It's good to see that MMOs will be present for all daylight activities and PAMS will be employed day and night. However, it's difficult to see how two MMOs and two PAMS operators can possibly keep credible observations. This would mean that the MMOs would potentially work on the order of 6-8 hours a day and the PAMS operators 12 hours a day, and there would only be one of each on watch at any one time.

The info sheet does not provide any information on the field protocols or level of training of either MMOs or PAMS operators. What equipment will these people be using (sound equipment, hydrophone arrays, big-eye binoculars, etc). What is the watch schedule? What is the range of sensitivity of the PAMS array (in the presence/absence of air guns)? What is the sighting probability and acoustic probability for species like sperm whales, beaked whales, blue whales, Hector's dolphins?

There are some unusual omissions in the NIWA report on marine mammals off Taranaki (link in second para of your consultation letter):

* There is no mention of the Risk Analysis for Maui's dolphins carried out by the NZ government.

The risk analysis (Currey et al. 2012) was carried out by a panel of 9 New Zealand and international experts, and concluded that Maui's dolphins range south to at least Whanganui. Currey et al. (2012) also discuss the existing threats to Maui's dolphins, and estimate that more than one human-caused mortality every 10-23 years would cause a serious risk to Maui's dolphins.
They are of course already listed as Critically Endangered, and therefore by definition at "extremely high risk of extinction".

* Some of the sightings in the attached map are missing from the NIWA report

* Several of the conclusions drawn in the report do not match the scientific data

For example, a statement that it is "currently believed that Hector's dolphins move regularly between the Marlborough Sounds and Taranaki regions (Callum Lilley, DoC, pers. comm.) seems to be one person's opinion. If this is supported by any scientific data, those data should be included in the report." Likewise the statement that during winter Hector's dolphins "move offshore with greater distribution throughout their depth range (Slooten et al. 2005, Slooten et al. 2006b)."
This refers to my research, but is a mis-interpretation of the data. The Maui's dolphin sightings made from the Oanui or Maui A oil platforms were made in winter. However, it would be inappropriate to conclude that Maui's dolphins are absent from the area around these platforms in summer as there is no "shift" offshore in Hector's or Maui's dolphin sightings.
There is certainly no clear indication that dolphins are absent from deeper waters in summer and clear evidence from South Island sightings that the maximum offshore distance is the same in summer and winter.

As pointed out in the NIWA report, most of the data used is "presence only" information, essentially incidental sightings made by members of public rather than scientists. It's not clear what conclusions can be drawn from these data. As the authors point out in the section on research recommendations, a systematic survey carried out by qualified marine mammal scientists is needed in order to provide a scientifically robust assessment of the likely impacts the proposed petroleum extraction.

In summary, the documents provided fall a long way short of credible scientific information. These documents may have been aimed at the general public, but more scientifically robust information should be made available for the marine mammal science community. The local science community will be essential in gathering credible information about the environmental impacts of your activities. It will be very difficult to obtain such data from the seismic survey vessel itself and of course local scientists have long term datasets of "before" information that would be very useful in terms of detecting effects. Therefore, it would make sense for Gardline to interact with local scientists at a scientifically credible level.

In haste,

Zoology Department, Otago University, Dunedin, New Zealand

On 19/02/14 10:54 PM, "Maja Nimak-Wood" <maja.nimak-wood@gardline.com> wrote:

I am glad we have managed to get in touch with you. Katt and I split the task of making phone calls and she is currently working in NZ hours so we can accommodate to everyone engaged in the consultation process.
I would really appreciate if you could get back to me ASAP. I will be out of office next week and would like to add your comments, if you would have any, before my leave.

I am looking forward to hearing back from you soon.

Kind regards,

Maja Nimak-Wood
Marine Mammal Scientist
Gardline Environmental Limited

----Original Message----

Sent: 19 February 2014 01:41
To: Maja Nimak-Wood
Subject: Re: [Fwd: FW: Invitation for consultation- Maui-8 Seismic Site Survey]
Importance: High

Dear Maja,

Thanks for your phone call! I got your message when I woke up this morning and rang back on the off chance someone at your end would still be awake.
Pleasantly surprised to find Katt Preston at the other end of the phone. She explained that you email had gone to the whale and dolphin trust. Have found it, and will have a read over the materials you emailed and will get back to you later today or tomorrow.

Thanks,

Zoology Department, Otago University, Dunedin, New Zealand

Sent: 09 February 2014 01:20
To: Maja Nimak-Wood
Subject: RE: Seismic site survey in Taranakin Basin and blue whales

Hi Maja,

Sorry for my delayed response. I have been wrapping up the research project on blue whales in the STB.
It is very difficult to say if your survey will encounter a significant number of blue whales or not. We have not surveyed in that area, nor at that time of year, so data is lacking to give you the guidance you are after. However, we did encounter about ~50 blue whales just south of your survey region (we did not survey in that exact area) in the past few weeks. Also, I think it was a Todd Energy seismic survey last March/April that did encounter a significant number of blue whales. This was further south again from your current area of interest. Attached is a small analysis I did for a conference on the current blue whale sightings data I held relative to temperature and chlorophyll a satellite imagery data. It may be of interest to you in depicting trends in distribution in space and time. Please do not distribute this widely as it is unpublished, but if you do use the information please cite it appropriately. (I plan to publish this work soon.)
In summation, its very hard to say at this time how many blue whales (or any marine mammal) you may encounter during your seismic survey since there has not been adequate survey effort across the region at all times of year. This is what I hope the next step will be because I know this information is needed. My best advice, would be to move the survey to June - Sep when it appears that the fewest number of blue whales are in the STB. I realize this may not be a feasible option.

I hope this was helpful. Feel free to stay in touch.
Cheers,

From: Maja Nimak-Wood [maja.nimak-wood@gardline.com]
Sent: Monday, February 03, 2014 10:29 PM

Subject: Seismic site survey in Taranakin Basin and blue whales

I am compiling a Marine Mammal Impact Assessment for the Maui-8 site survey which is currently scheduled for late March (but most likely April 2014). Gardline has been appointed to undertake the required assessment on behalf of Shell Todd Oil Services Ltd (STOS). STOS propose to undertake an experimental drilling programme in the South Taranaki Bight and the proposed seismic survey is required to detect any shallow hazards to the drilling and safe anchoring of the proposed Maui-8 well. The seismic survey will cover three potential drill locations with on-site operations lasting approximately 1 week. The seismic activity associated with this particular survey will be Level 2 (220 cu in). More information can be found in the info sheet attached. I have referenced your paper from 2012 on marine mammal sightings in the Bight and I am aware of your latest survey that has been conducted on blue whales, hence would you be able to tell me can we expect significant number of blue whales at the time of proposed seismic survey. Any other comments you may have in relations to the survey and marine mammals in South Taranaki Bight would be much appreciated.

I am looking forward to hearing back from you.

Kindest regards,

Maja Nimak-Wood
Marine Mammal Scientist
Gardline Environmental Limited

From: Maja Nimak-Wood
Sent: 18 February 2014 10:11

Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Yes, you are right, the proposed mitigation measures for this survey will exceed the requirements set for Level 2 surveys in the Code.

In regards to your query about blue whales, based on Dr Torres's papers from 2012 and 2013, June is the month with the peak numbers of blue whales, and this month will be avoided according to the current survey schedule. However, I have been in contact with Dr Torres since and she kindly sent me the results of her latest research (still unpublished). Based on data collected between 1979 and 2013, March seems to be the peak month, followed by June, November, and February. Moreover, Dr Torres stated that even though there have been many recent sightings in South Taranaki Bight, all of them occurred south of our area of interest. Since there has not been adequate survey effort across whole region at all times of the year, saying how many blue whales will be seen is very hard. Based on the available data and Dr Torres's advice, period July-September looks like the period with the least number of blue whales but moving the survey to winter months does not seem feasible – for one, the timing of the survey is linked to other activities that are scheduled to follow, and secondly, winter months are usually accompanied by far worse weather which is likely to extend the duration of the survey.

Sound transmission loss modelling is a requirement for all surveys planned for Areas of Ecological Importance. In accordance to this requirement, a dedicated noise propagation modelling study was completed by our acoustic scientist in order to predict expected received levels and impact ranges on marine mammals from a 220 cu.in. airgun array. Widely accepted noise propagation modelling method (Collins, 1993) were employed and the propagation loss model results and the impact criteria for marine mammals outlined in Southall *et al.* (2007) was used to estimate ranges over which marine mammals may be impacted during the Maui-8 seismic site survey. We ascertained that the mitigation zones detailed in the Code of Conduct for Level 2 surveys will be more than sufficient to prevent injury or disturbance to marine mammals. The full methodology and results of this modelling are included in the MMIA which will be made publicly available once approved by DOC.

And here are the further clarifications to concerns you raised in your previous email:

- Additional Marine Mammal Observers (MMOs) on board and operating on additional platforms/vessels in the area, to provide a wider range of observation
  Considering that there will be 2 PAMS operatives and 2 MMOs, which is more than a minimum number of observers for this level of survey, we do not see the need for an extra MMO. Based on years of offshore experience providing mitigation, we deem two experienced MMOs are enough to cover a wide observation area.
- Only **independent** qualified observers **(as defined** by the code) are to operate as MMOs or PAM equipment operators
  According to the Code, independent observers (qualified or trained) are those observers conducting solely an observer role. For level 1 surveys crew members, irrespective of their training and experience, cannot act as qualified observers, while they are allowed to do so for level 2 surveys. Despite that, survey crew members will not be employed as observers for the STOS survey, but dedicated, independent observers will be used as per standards of the Code. The MMOs and PAMS personnel planned for this survey are adequately trained according to the standards of the Code and approved by

DOC, and as such are recognised as independent observers. As I said before, all observers are expected to have offshore experience and act professionally making independent judgment and implementing all needed mitigation measures regardless of the company they are working for.

- Aerial observation at regular daily intervals to monitor and track marine mammals
  There needs to be a hierarchy of mitigation measures from small, short term, low intensity surveys to long term, high intensity ones. This additional measure would be more appropriate to long, term, high intensity surveys which are predicted to have major negative impacts.
- Use Passive Acoustic Monitoring (PAM) equipment at all times in addition to the use of MMOs
  This is already added as additional mitigation measure.
- Deployment of static PAM equipment in all areas of the proposed survey
  Static acoustic equipment is usually a part of long term projects and does not allow real-time monitoring, hence it would not be appropriate for mitigation purposes and for such a short survey. Although it is a great idea to have static acoustics recording devices in the Taranaki region recording whole year around, it would be very costly and it would require cooperation of different research organisations and industry. I would definitely like to see something like that happening one day.
- If the PAM equipment is inoperable, then seismic surveying to **cease** immediately until such time as this equipment is again operable.
  As per Code, this is not necessary for level 2 surveys. However, if DOC deems that this measure is necessary, it will be adequately incorporated in the mitigation plan.
- Co-ordinate with other vessels, coastguard radio and authorities to increase chances of detection of marine mammals in the potential observable area
  If a chase vessel is accompanying the survey, crew members onboard this vessel will be required to report marine mammal sightings to the dedicated observers onboard the survey vessel.
- Increase the minimum mitigation zone for ALL species of concern to a maximum observable distance – i.e. 10 kilometres plus, to minimise the long range propagation of acoustic disturbance.
  This would be a bit excessive as it is virtually impossible to identify species at such great distances and deem if are they species of concern or not. Also, based on our noise modelling, extending mitigation zones to this distance is not necessary.
- Increase the minimum pre-start observation time from 30 minutes to a minimum of 138 minutes (based on the maximum length of recorded dives of sperm whales (physeter macrocephalus) (Watkins, Moore, Tyack 1985)). This species of concern has been recorded in the area (Gaskin 1968) by the Department of Conservation in the Code
  Sperm whales are deep diving species but such long dives are performed in areas of very deep water (several thousand metres) and underwater canyons while foraging on their deep water prey. The depth of the proposed survey area is only around 100m therefore not an usual sperm whale habitat, and even if any sperm whales are to be encountered, due to the shallowness of the water, such long dives are not expected. Based on that, we cannot justify the increase in the pre-start observation time.
- No active acoustic source during night-time or poor sighting conditions
  According to the Code, if PAM is onboard, operations may continue during night and poor sighting conditions during level 2 surveys. Moreover, stopping during those hours will double the survey time from 7 to 14 or more days, which would in turn result in greater negative effects overall. There is a general consensus that the quicker the survey can be performed, the less its potential impact on the marine environment.
- Fund further research into the use of the South Taranaki Bight by marine mammals, to provide a greater understanding of seasonal population levels, behaviours and potential impacts of seismic surveying
  This is a good recommendation for long term study and it is up to our client to make a decision on it. As a company, we encourage our clients to publish any data collected during surveys that we believe will contribute to scientific knowledge. Seismic vessels provide a chance for opportunistic data collection in

areas where dedicated research is often not conducted, and with experienced observers onboard, useful data can be collected.

- Put in place a mitigation fund to cover the cost of stranding response (by agencies including Department of Conservation, Project Jonah, Whale Rescue)and necropsy investigation (by recognised research institutions) into cause of death for all stranded marine mammals in an area not limited to the Taranaki coast (New Plymouth in the north, Wellington in the south), Marlborough Sounds, Cook Strait, Golden Bay, Tasman, west coast and neighbouring environments for a period during and for three months after the proposed survey.
  I am aware that some other companies are willing to consider funding such activities on a case by case basis in consultation with DOC. This request has been forwarded to STOS.

Thank you again for participating in the consultation. All your recommendations have been documented within the MMIA and you will be able to view it after the DOC's approval and when it becomes publicly available.

My kindest regards,

Maja Nimak-Wood
Marine Mammal Scientist
Gardline Environmental Limited

Sent: 12 February 2014 21:17
To: Maja Nimak-Wood

Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Dear Maja,

Thank you for your response to our email of 3 February.

We note that the activities STOS will carry out beyond the minimum requirements set out in the code.

You state that "*The survey is planned to occur between April and May 2014 which is probably the most suitable season to limit the impact to as few species as possible*". Can you please provide the evidence for this statement? While April and May are possibly the months where the least number of species may be impacted, in "Evidence for an unrecognised blue whale foraging ground in New Zealand" (Torres, 2013), May is the third most populous month for sightings in this area, of the species of concern, blue whales (*balaenoptera musculus*). This is critical in light of your comment that this species "has been identified as high risk receptors". Can you please elaborate on the research that was used to make this decision.

You state that the MMO's and PAM operators are all experienced. Can you please confirm whether these will be independent, or will be employed by the vessel operator or other agencies performing the survey.

We are keen to understand your 'noise propagation modelling' and on what research/observations this is based upon? You do not cite any research or papers.

We still have a number of concerns that, while you have acknowledged that they have been carefully considered, have not been addressed.

Again, we thank you for the opportunity for dialogue in this area.

Kind regards,

General Manager

Project Jonah New Zealand

Sent: Friday, 7 February 2014 4:43 a.m.

Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Thank you so much for finding time to respond to my consultation request. I want to assure you that all the recommendations you made were carefully considered.

I do understand your concerns and I will try to offer you some answers.

Unfortunately, it is not possible to consider alternative locations as this survey is a pre-requirement of future drilling at the Maui-8 well. Therefore, the location of the seismic survey is pre-determined and there is no possibility to change it. The survey is planned to occur between April and May 2014 which is probably the most suitable season to limit the impact to as few species as possible. The likelihood of any significant effects of this

survey is therefore reduced with the fact that the timing does not overlaps with any major migrations of whales or breeding/nursing times. The seismic survey will last approximately one week which is the shortest period over which the data can be collected hence if any disturbance occur, it will only be temporal. This survey is considered to be a low intensity seismic survey (Level 2 as per the Code). Airguns that will be used (220 cubic inches) are comparatively smaller than those used for high intensity surveys (Level 1) with airguns of few thousand cubic inches, hence negative effects will be proportionally smaller too.

Two MMOs will be onboard during all times covering periods of operational activity as well as periods during transits to/from port. Further to this, the STOS has requested Passive Acoustic Monitoring (PAM) onboard and two PAM operators. Such acoustic monitoring will cover 24 hours including times of darkness and poor visibility allowing for marine mammals to be detected even when MMOS are not able to. All observers to act as MMOs and PAMs will be highly experienced and skilled with years of experience in mitigating for marine mammals during seismic surveys.

Our noise propagation modelling has shown that injury and behavioural disturbance can only occur between 10 and 30 metres of the acoustic source while set mitigation zones range between 200 m and 1 km. Therefore, these mitigation zones are more than enough to prevent any injury or obvious behavioural changes. Further to this a ground-truthing of noise modelling will be undertake during the survey and if measurements are significantly different that those predicted, Department of Conservation will be immediately informed and additional mitigation implement if deemed necessary.

I am well aware of recent reports of blue whales presence in the area and we have identified them as high risk receptors. Due regard has therefore been taken of this species by placing an appropriately high valuation in the assessment.

I do hope this answers satisfy you and provide reassurance regarding the disturbance of marine mammals in the proposed survey area.

Should you have any further questions/comments, do not hesitate to contact me again.

Many thanks.

Kindest regards,

Maja Nimak-Wood
Marine Mammal Scientist
Gardline Environmental Limited

Sent: 03 February 2014 04:48
To: Maja Nimak-Wood
Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Dear Maja,

Thank you for emails of 14 & 30 January 2014.

In reply to your request for a robust Marine Mammal Impact Assessment (MMIA) for the proposed Maui 8 Seismic Site Survey in the Taranaki Basin by Shell Todd Oil Services Limited, we now respond accordingly.

As a marine mammal welfare organisation, we would prefer to see the marine environment remain undisturbed by anthropological activities. I refer to the 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations (the Code) which states:

"... under normal circumstances marine seismic surveys will not be planned in any sensitive, ecologically important areas or during key biological periods where Species of Concern are likely to be breeding, calving, resting, feeding or migrating"

In light of ongoing research by the National Institute of Water and Atmospheric Research (NIWA) and Dr. Leigh Torres, the South Taranaki Bight may be a feeding ground for species of concern, namely the blue whale (*balaenoptera musculus*). The following press release dated 3 February 2014 http://www.sst.niwa.cri.nz/news/scientists-spot-rare-blue-whales-off-new-zealand-coast-0 provides details. In light of this potential feeding ground, and as per the Code, are we to assume that this survey has been deemed necessary and unavoidable?

If this is the case, we recommend further measures than those minimum requirements detailed in the Code be put in place to reduce potential impact on species of concern. These recommendations are:

- Additional Marine Marine Observers (MMOs) on board and operating on additional platforms/vessels in the area, to provide a wider range of observation
- Only **independent** qualified observers (as defined by the code) are to operate as MMOs or PAM equipment operators
- Aerial observation at regular daily intervals to monitor and track marine mammals
- Use Passive Acoustic Monitoring (PAM) equipment at all times in addition to the use of MMOs
- Deployment of static PAM equipment in all areas of the proposed survey
- If the PAM equipment is inoperable, then seismic surveying to cease immediately until such time as this equipment is again operable
- Co-ordinate with other vessels, coastguard radio and authorities to increase chances of detection of marine mammals in the potential observable area
- Increase the minimum mitigation zone for ALL species of concern to a maximum observable distance – i.e. 10 kilometres plus, to minimise the long range propagation of acoustic disturbance
- Increase the minimum pre-start observation time from 30 minutes to a minimum of 138 minutes (based on the maximum length of recorded dives of sperm whales (physeter macrocephalus) (Watkins, Moore, Tyack 1985)). This species of concern has been recorded in the area (Gaskin 1968) by the Department of Conservation in the Code
- No active acoustic source during night-time or poor sighting conditions
- Fund further research into the use of the South Taranaki Bight by marine mammals, to provide a greater understanding of seasonal population levels, behaviours and potential impacts of seismic surveying
- Put in place a mitigation fund to cover the cost of stranding response (by agencies including Department of Conservation, Project Jonah, Whale Rescue)and necropsy investigation (by recognised research institutions) into cause of death for all stranded marine mammals in an area not limited to the Taranaki coast (New Plymouth in the north, Wellington in the south), Marlborough Sounds, Cook Strait, Golden Bay, Tasman, west coast and neighbouring environments for a period during and for three months after the proposed survey

While this list is long, we appreciate the opportunity to provide input into this operation and are happy to discuss further. We look forward to seeing your final MMIA.

Your sincerely,

General Manager

Project Jonah New Zealand

W. www.projectjonah.org.nz

Sent: 13 February 2014 23:49
To: Maja Nimak-Wood
Subject: Re: Invitation for consultation- Maui-8 Seismic Site Survey

Hello Maja,

This area has no impact on Taranaki fishermen.

President

Taranaki Commercial Fishermens Assoc

From: Maja Nimak-Wood
Sent: 19 February 2014 12:24

Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Thank you for your email and the info provided. I feel that I have learned a lot about lobsters just from your email and I will acknowledge it accordingly in the MMIA document.

A certain level of negative impact from underwater noise upon marine creatures such as lobster larvae is to be expected but its extend and significance will depend on the intensity of that sound. Since the proposed survey will utilise low intensity acoustic source and last only several days, I cannot predict any effects further away than the imminent vicinity of the acoustic source. Having said that, it is unlikely to assume that there will be any major effects to lobsters near Cape Egmont due to its distance from the survey site. To support that, we had conducted a sounds transmission loss modelling for the proposed survey and you will be able to read about the results when the MMIA becomes publicly available.

In regards to the article you copied below, I have heard of the Oceana and their campaigning work. As a scientist, I like to read articles where statements are backed up by facts from peer reviewed scientific papers/studies. Nonetheless, given the fact that the survey in question is a long term and high intensity survey over a huge area using several thousand cubic inches airguns, expected negative impacts across a wide range of marine species are highly likely. Having said, there needs to be a clear differentiation between effects of such grand scale surveys and effects of small scale and low intensity ones, such as the proposed one, since a clear parallel cannot be drawn between them.

Thank you again for finding time to respond to my request. Will be in touch and as I said previously, your comments have been passed to our client.

Your sincerely,

Maja Nimak-Wood
Marine Mammal Scientist
Gardline Environmental Limited

Sent: 18 February 2014 19:20
To: Maja Nimak-Wood
Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Good morning from New Zealand Maja

Thank you for your very thorough and sympathetic response to my email in regards to seismic impacts on larval rock lobsters. I know the reference document you have used but there are (as always) some interesting aspects to the life cycle of rock lobsters. The Chiswell/Booth paper looks at the oceanic larval phases whereas our possible concerns are related to the final phase of that journey – which is the settlement of the late stage larvae known as puerulus.

I have attached a photo to show you what they are.

I will source the literature for you in due course but these animals are the seasonal 'recruits' to the wild lobster fisheries around the coastline of New Zealand. There is an interesting association with the New Plymouth area because it was at the New Plymouth power station where scientists first postulated that these puerulus (plural puerulii) seemed to be attracted to the hum of machinery emanating from the sea water intake of the power station cooling system. Large quantities of puerulii were clogging the water intake screens in some seasons.

You may be able to see in the attached photo the many fine 'hairs' / sensory receptors on the antennae and carapace – the generally accepted theory is that puerulii drift/swim to the coastline and there are one or two seasonal pulses of puerulus settlement observed in every year.

These things are fragile, vulnerable to predation as you might expect, and seasonal settlement strengths are very dependent on environmental conditions. There is a view across industry that strengths of settlement are reliable indices of future stock abundance. The notion that some 'artificial'/introduced mortality over and above natural occurrences is what is of concern in this instance.

You reference 'four main geographic areas' for lobster larvae – those are areas where larvae are held in eddies during the early stages of development. There are 11 'in-star' stages of lobster growth from egg to first moult juvenile and the extended oceanic phase can run 15 to 17 months of more dependent upon general location and environmental conditions. But the late stage or 'settlement' phase is much more extensive and localised.

The oceanography of the New Plymouth coastline is not something I am any expert on; but it is a reasonable presumption I think that late stage larval lobsters (puerulii) will be present in reasonable numbers and some will settle to recruit to the adult population in the vicinity of Cape Egmont south to Patea.

I have appended a recent media article to this email – it is one which has raised some alarm even though none of us here have yet been able to substantiate the report.

You and I should keep corresponding – as I noted in my previous email, the NZ RLIC does not generally seek to disrupt or obstruct economic development opportunities. However the lobster fisheries along the Taranaki coastline although small in assessed stock size/biomass compared to other regions of New Zealand, are valuable culturally and economically and it is definitely not in the interests of my industry to see any mechanical interruption to natural processes if that can be avoided.

Yours sincerely

NZ Rock Lobster Industry Council

<lobster@seafood.co.nz>

THE NOISE OF THE SEISMIC SURVEYS BETWEEN CATALONIA AND THE BALEARIC ISLANDS WILL AFFECT AN AREA ALMOST 5 TIMES AS BIG AS BOTH REGIONS

Published: 30 January, 2014

The roar of the "airguns", with an intensity 100,000 times greater than a jet engine, will be repeated some 10,000 times over 5 months

Tourism and the vast majority of the fishing grounds will be affected.

More than 17 million marine hectares, 82 protected areas and nearly 200 protected or regulated species are endangered by the seismic oil prospecting projects between Catalonia and the Balearic Islands. This is the summary of the report that Oceana has presented to the government to prevent the oil and gas prospecting work that the company Spectrum hopes to carry out in the waters of the Mediterranean.

"We ask the Government to stop this madness. Not only is it against the law, but it will also affect a huge area with very important and protected ecosystems. It will also harm economies that depend on the resources that will be damaged, like fishing and tourism, given that many species will be driven away by the racket of the seismic surveys," said Ricardo Aguilar, Director of Research for Oceana in Europe.

Through the use of "airguns", the company Spectrum wants to scan 10 million marine hectares at depths of between 200 and 3,000 metres, emitting sounds of more than 200 dB every few seconds, 24 hours a day and for 22 weeks. This new project joins the existing threat of the oil company Cairn, which aims to sample 1.3 million marine hectares between the regions of Valencia and the Balearic Islands in the same way.

The Spectrum project would involve a continuous bombardment of sounds 100,000 times more intense than a jet engine and comparable to a nuclear explosion. Cetaceans, sea turtles, fish, molluscs, crustaceans and many other marine organisms would be affected by these seismic surveys.

Similar proposals are generating much controversy in other parts of the world. The U.S. Department of the Interior reported that, if similar studies were carried out in the Atlantic waters belonging to that country, one cetacean would be damaged per 6 km2, and many hundreds of thousands would be affected regarding different aspects of their behaviour, breeding or feeding. If these figures are extrapolated to the Mediterranean, we are talking about 16,000 cetaceans being damaged and many tens of thousands more suffering disruption.

Some species are particularly sensitive to noise pollution, such as the sperm whale, an endangered species in the Mediterranean that could be affected at a distance of more than 300 km from the emitting source. The Balearic Islands is a key area, one of the most important for this species in the Mediterranean.

The damage would also affect fishing and tourism, since the impact of sound in the sea extends to areas very distant from the focus of the noise pollution. Even a kilometre away, the sound intensity would be similar to a nuclear explosion like Hiroshima, and effects have been verified at tens or even hundreds of kilometres further away. For this reason, Oceana believes that the affected area would cover more than 17 million marine hectares, when the Hydrocarbons Sector Act establishes that no surveys can be authorised that exceed 100,000 hectares.

Research on the impact of seismic surveys on fishing in the North Atlantic showed that some commercial species were affected even more than 30 kilometres away, causing losses in the catches of fishermen that could be greater than 70%-80%. In other words, the vast majority of the fishing grounds, marine reserves and protected areas in the region would be impacted by the bombardment of the seismic testing.

From: Maja Nimak-Wood
Sent: 18 February 2014 11:00
To
Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Thank you so much for finding time to respond to my request.

I understand your concerns regarding the potential effects of Level 2 surveys on pelagic stage rock lobster larvae. I must admit that we did not specifically asses the impacts of lobsters but impact on fish and their eggs and larvae in general. In relations to that, we cited report from Gausland (2003) when he found that mortality of fish eggs and larvae due the impact of airguns was insignificant compared to the natural mortality for most species at this life stage. Taking into an account the characteristics of the proposed survey (low intensity and short duration) we have concluded that there will not be major impacts as egg and larvae and that mortality is only likely to occur in direct vicinity of the airgun array.

Reading about lobster pelagic larvae, it seems that they are prevalent offshore beyond continental slope (Booth et al 1998; Jeff et al, 2001) and in areas of high productivity often associated with continental shelf breaks and inshore margins of oceanic eddies and currents (Phillips and McWilliam, 2009). Based on Chiswell and Booth (2008) there are four major geographic areas for lobster larvae- the east coast of the North Island, the east and south coast of the South Island, the far north of the North Island and the Chatham islands.

Given the location and characteristics of the proposed survey area, it seems there will not be overlap with the key lobster larvae areas.

However, I would like to address the issue on lobsters in more details so would you be so kind to tell me are there any important lobster habitats in the vicinity of the Maui-8 field and what are the key periods in the life stage of lobsters that we need to be aware of and if possible avoided?

I am afraid that there is no other communication process available at the moment so please do communicate through me, however your concerns and recommendations for coordination and planning of activates will be forwarded to STOS accordingly.

Many thanks,

Maja Nimak-Wood
Marine Mammal Scientist
Gardline Environmental Limited

[illegible] February 2014 22:58
To: Maja Nimak-Wood
Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Hello Maja

Many thanks for taking the initiative to contact the NZ Rock Lobster industry Council.

The fisheries which I work for do not have either direct or indirect interactions with marine mammals in the areas where the proposed Level 2 seismic surveys will take place and I am not sure how I might better assist in contributing to the required assessment.

However you need to note please that the rock lobster industry does have concerns as to the potential effects of Level 2 surveys on pelagic stage rock lobster larvae. Interruptions to natural larval settlement patterns and/or large scale mortalities of larval rock lobsters even at a localised level do have possible implications for future stock abundance. The lobster industry is generally not opposed to infrastructure exploration and development around the New Zealand coastline because our few concerns about impacts on lobster fisheries can generally be met by way of coordination and planning of activities.

So I am writing now to ask whether or not issues other than marine mammals have been raised with your client and whether or not there is a process available through which we might exchange more detailed information about the timing of survey work and the larval rock lobster settlement 'season'.

Yours sincerely

<*lobster@seafood.co.nz*>

Sent: 18 February 2014 18:32
To: Maja Nimak-Wood
Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Hi Maja

Thanks for your email – I'll look forward to hearing the outcome of your discussions.

Regards

From: Maja Nimak-Wood
Sent: 18 February 2014 11:44

Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Thank you so much for finding time to respond to my request. Your input is much appreciated.

Besides iwi groups, we indeed have contacted other fishery groups with the interest in the Taranaki area as recommended by the DOC.

I understand your concerns and they will be addressed accordingly. I will open a discussion with the DOC and STOS regarding your request on observer data use and circulation of the final report.

Will keep you informed on any development.

In the mean time, please feel free to contact me again should you have any other concerns.

Kindest regards,

Maja Nimak-Wood
Marine Mammal Scientist
Gardline Environmental Limited

Sent: 16 February 2014 03:32
To: Maja Nimak-Wood

Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Dear Maja

Thank you for the invitation for Seafood New Zealand to participate in the consultation on the development of a Marine Mammal Impact Assessment for the Maui-8 Seismic Site Survey; we appreciate being included in this process.

Seafood NZ is the national representative body for the New Zealand seafood industry. It will also be appropriate to consult with seafood industry groups, quota owners, and fishers with interests in the Taranaki area. Please could you advise us whether you have already done so? We would be happy to advise on relevant contacts if this would be helpful.

Because of the potential for interactions between fisheries and marine mammals, Seafood NZ has a long standing interest in better understanding the distribution and abundance of marine mammals in New Zealand waters. The rare presence of Cephalorhynchus hectori ssp. Dolphins (Hector's or Maui dolphins) in Taranaki waters has been of particular concern in recent years.

Our view is that all users of the marine environment have a responsibility to provide data that contributes to the body of information available to assess the impacts of their activities on the environment. We note that it is intended that the planned Maui-8 survey will be conducted in accordance with the Department of Conservations "Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations" (the Code). As a result, the operations will yield data from both Marine Mammal Observers, and from passive acoustic monitoring, both of which must be provided to the Department of Conservation. However, the code currently states (s3.5) that "Only data on marine mammal detections will be made publicly available, primarily in summary form".

The limited availability of these data is a deficiency of the Code. We note that the NZ Environmental Protection Authority recently noted, in the context of cetacean distribution modelling carried out for the Taranaki region, that "historic datasets used to characterise the environment with respect to cetaceans only relate to presence data, and no information is available on observation effort or absence data. This is an issue because it means that the data may not provide a completely accurate depiction of the species present and relative abundance" (http://www.epa.govt.nz/Publications/EPA_staff_report_10_February_2014_%E2%80%93_including_appendices_1_and_2.pdf, para. 98).

Given the long history of seismic surveys in the Taranaki region, it is surprising that the more detailed data – in particular that on associated observer effort - is not available for assessing cetacean distribution. Seafood NZ is keen to see an improvement in the data availability for marine mammals in NZ waters, and is keen to facilitate and contribute to this process as appropriate.

In the context of the development of a Marine Mammal Impact Assessment for the Maui-8 Seismic Site Survey we would propose the following steps:

- Gardline work with the Department of Conservation to ensure that existing marine mammal observations (including observer effort data) are utilised in the assessment of cetacean distributions in Taranaki waters, and in the area of the proposed survey in particular;

- Copies of the MMO and PAM data (as per Appendix 2 of the Code) together with the summary trip report (as per s3.5 of the Code) are provided to Seafood NZ as the basis for further discussion about the wider use of these, and other, sighting data in building an improved understanding of cetacean distribution and abundance in NZ waters.

Please feel free to contact me if you'd like to discuss this issue further.

Regards

From: Maja Nimak-Wood
Sent: 19 February 2014 10:05

Subject: RE: Invitation for consultation- Maui-8 Seismic Site Survey

Thank you again for your effort.

I will acknowledge this response in the MMIA document unless I hear otherwise from you before the end of this week.

Thank you for your offer but we have already contacted a substantial number of consulates from various interested groups.

Many thanks once again for your help on this matter.

Kind regards,

Marine Mammal Scientist
Gardline Environmental Limited

Sent: 19 February 2014 01:07
To: Maja Nimak-Wood
Subject: Re: Invitation for consultation- Maui-8 Seismic Site Survey

I have consulted with my client, Te Ohu Kaimoana, and unfortunately they really do not have the time to devote to this, although they are supportive of your efforts to work through the MMIA as quickly as possible.

I can provide you with some other options and/or experts if you need further assistance.

Regards,

Prepared For

Project

Marine Mammal Impact Assessment
Māui 8 Site Survey, Offshore Taranaki,
New Zealand

Date

February 2014

Published by

Gardline Environmental Ltd
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UK

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Executive Summary

- This appendix has been prepared by Gardline Environmental Ltd. (GEL) under the scope of work of the MMIA (Marine Mammal Impact Assessment), for the seismic survey operations proposed for Māui 8 site survey, Offshore Taranaki, New Zealand.

- In order to address the Code (2013 - Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations) requirements, noise prediction modelling was conducted to assess the potential effects that the seismic survey would have on marine mammals, and to assess the suitability of the mitigation measures proposed.

- The impact ranges were predicted based on the source characteristics and physical parameters given by the client, for eight different radial transects (N, NE, E, SE, S, SW, W, NW).

- The predicted impact ranges were computed for low, medium and high frequency cetaceans and pinnipeds in water groups mentioned in Southall, *et al.* (2007), for injury and behavioural disturbance.

- The results confirm that there is no need to either extend the radius of the mitigation zone or limit the acoustic source power, as the impact ranges obtained are all lower than 30 m.

Contents

Executive Summary 164

1. Introduction 168

1.1 Scope of Work 168

1.2 Survey Area and Parameters 168

1.3 Report Structure 168

2. Basics of Underwater Acoustic Metrics and Propagation 170

2.1 Underwater Noise Metrics 170

2.1.1 Sound Pressure 170

2.1.2 Sound Levels 170

2.2 Underwater Acoustic Model 172

2.2.1 Source Level (SL) 172

2.2.2 Propagation/Transmission Loss 172

2.2.3 Received Level (RL) 173

3. Sound Source 173

3.1 Directionality 176

3.2 Sound Frequency Bands 176

4. Underwater Noise Propagation Modelling 177

4.1 Parameters and Assumptions Considered 177

4.1.1 Bathymetry Data 177

4.1.2 Sound Speed Profile 179

4.1.3 Geo-acoustic Parameters 180

4.1.4 Sound Source Parameters 180

4.2 Propagation Loss Modelling Results 180

5. Seismic Noise and Marine Animals - Impact Assessment 182

5.1 The Code 182

5.2 Marine Mammal Criteria 182

5.3 Un-weighted Sound Levels 183
5.4 M-weighted Sound Levels 184
5.5 Impact Ranges 185
6. Conclusions 188
7. References 190

List of Figures

Figure 1.1 Location of Māui 8 site survey (in green) 169

Figure 3.1 Far-field acoustic signature for a 220 cu. in. airgun array (Acoustic pressure in bar at 1 m) 174

Figure 3.2 The peak noise spectrum (in dB re 1 $\mu Pa^2/Hz$) for a 220 cu. in. airgun array (Acoustic pressure in bar at 1 m) 175

Figure 3.3 The peak noise spectrum (in dB re 1 $\mu Pa^2/Hz$) for a 220 cu. in. airgun array (Acoustic pressure in bar at 1 m) until 250 Hz 175

Figure 4.1 Bathymetry at the Māui 8 site and transects chosen for the propagation modelling 178

Figure 4.2 Sound Speed Profile at Māui 8, measured in April 2004 179

Figure 4.3 Temperature Profile at Māui 8, measured in April 2004 180

Figure 4.4 Modelled propagation loss obtained for the East transect, for 80 Hz frequency (seafloor - represented with a black line) 181

Figure 4.5 Predicted propagation loss in dB over the East transect from 50 to 1000 Hz frequency 181

Figure 5.1 Predicted zero-to-peak, RMS SPL and un-weighted SEL for the 220 cu. in. airgun array, over the North-West transect 184

Figure 5.2 M-weighting filters for marine mammals 185

Figure 5.3 M-weighting SEL and zero-to-peak SPL as function of range for transect NW regarding the injury threshold values 186

Figure 5.4 M-weighting SEL and zero-to-peak SPL as function of range for transect NW regarding the behavioural threshold values 186

List of Tables

Table 3.1 Spectral estimation for a 220 cu. in. airgun array, based on 1/3 octave band centre frequencies, in units of Hz 176

Table 4.1 List of modelled 1/3 octave band centre frequencies, in units of Hz 178

Table 5.1 Injury and behavioural criteria according to Southall *et al.* (2007) 183

Table 5.2 Injury impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses) 187

Table 5.3 Behavioural impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses) 188

1. Introduction

1.1 Scope of Work

This present appendix has been prepared by Gardline Environmental Ltd. (GEL) under the scope of work of the MMIA (Marine Mammal Impact Assessment). This report provides the results of noise propagation modelling and the assessment of underwater noise from seismic survey operations proposed for Māui 8 site survey, Offshore Taranaki, New Zealand.

The purpose of the study is to provide supporting information for the mitigation plan for the area in accordance with DOC, 2013 (Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations) requirements, Appendix 1:

"Where activities are planned in Areas of Ecological Importance or Marine Mammal Sanctuaries, sound transmission loss modelling will be incorporated into the MMIA methodology and ground-truthed during the course of the survey by appropriate means. Such modelling will indicate predicted sound levels within the various mitigation zones and potential impacts on species present. If sound levels are predicted to exceed either 171 dB re 1 µPa²s (SEL) at distances corresponding to the relevant mitigation zones for Species of Concern or 186 dB re 1 µPa²s at 200 m (SEL), consideration will be given to either extending the radius of the mitigation zone or limiting acoustic source power accordingly."

1.2 Survey Area and Parameters

The survey site is to located 35 km off the Taranaki coastline, New Zealand (see Figure 1.1- in green) in an area of water approximately 110 m deep.

The survey will comprise of 2D high resolution seismic (HRS) work as well as analogue and environmental data acquisition and processing.

The 2D HRS survey will consist of a source of 220 cu. in Tuned Bolt Airgun Array at 2.5 m tow depth.

1.3 Report Structure

The present report will comprise the following sections:

- Introduction to the basics of underwater acoustic metrics and propagation
- Source description
- Underwater noise propagation modelling including parameters, assumptions and results
- Impact assessment
- Conclusions

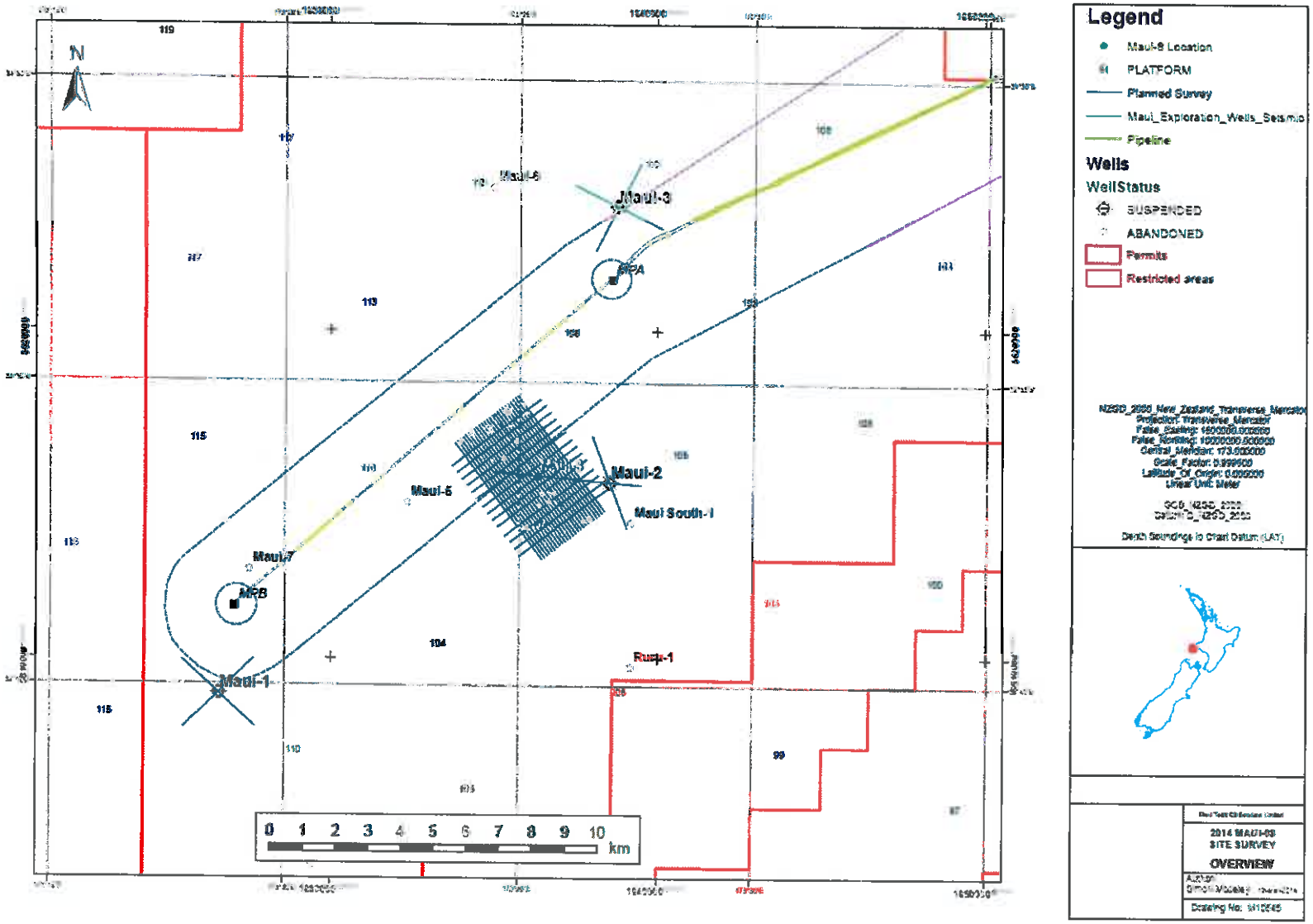


Figure 1.2 Location of Māui 8 site survey

2. Basics of Underwater Acoustic Metrics and Propagation

This section outlines some of the relevant concepts in underwater acoustics.

2.1 Underwater Noise Metrics

It is very important to state correct acoustic metrics in a clear and unambiguous way. There are guidance documents available such as TNO (2011), which provide detailed reviews of the metrics to measure and assess the impact of underwater noise in the marine environment. A detailed review has not therefore been provided here, although a brief overview is provided to assist the reader.

Sound results from the propagation of a mechanical disturbance in a compressible medium, which are associated fluctuations in pressure and density due to particle motion.

Water is denser and less compressible than air therefore the sound propagates faster in water than in air: sound speed on average in water is ~1521 m/s while in air ~344 m/s, and the absorption is generally less. The sound waves are thereby propagated from the sound source at the speed of sound (Urick, 1983).

2.1.1 Sound Pressure

Underwater sound can be described as a pressure wave travelling through the water. The low absorption in water (Kaye & Laby, 2004; Kinsler *et al.*, 1982) allows sound to travel large distances in the ocean, particularly low frequency sound. A number of quantities may be used to describe a sound wave, but the most common is sound pressure.

The sound pressure can be described as the difference between instantaneous total pressure and pressure that would exist in the absence of sound ("equilibrium" pressure). This quantity is in effect the quantity that is being represented when a sound pressure waveform is plotted. The unit of sound pressure is the Pascal (Pa), which is equivalent to a Newton per metre squared, or N/m^2, as defined by the International System of Units (S.I.) (BIPM, 2006).

2.1.2 Sound Levels

In acoustics, it is common to express sound levels in decibels (dB) relative to a fixed reference pressure commonly 1 µPa for measurements made underwater, not the 20 µPa familiar from airborne acoustics.

Sound Pressure Level (RMS SPL)

The most common convention in underwater acoustics for expressing Sound Pressure Level (SPL) is for it to be expressed as a root mean square (RMS) value. The RMS value is a time-averaged pressure value, which allows the SPL to be related to the time-averaged acoustic power (the original use of the decibel notation is for expressing power ratios) (Carey, 2006).

The convention in acoustics for expressing RMS SPL is calculated by the expression:

$$SPL = 20 \log \left[\frac{P_{RMS}}{P_0} \right]$$

where P is the RMS sound pressure and P_0 is the reference pressure of 1 μPa.

Peak-to-peak Sound Pressure Level

For a pulse waveform, or sound of impulsive nature, peak-to-peak sound level or zero-to-peak sound level is commonly used.

For a specific pulse, the peak-to-peak pressure, $P_{pk\text{-}pk}$, is calculated from the pressure, p, by the expression:

$$P_{pk-pk} = \max(p) - \min(p)$$

where max(p) and min(p) are the peak positive and peak negative pressures in the waveform respectively.

Since the peak negative pressure has a negative value, the peak-to-peak pressure is equivalent to the sum of the magnitudes of the peak positive and peak negative pressures. The value is expressed as the peak-to-peak pressure level in dB re 1 μPa. This is calculated from:

$$L_{pk-pk} = 20 \log \left[\frac{P_{pk-pk}}{P_0} \right]$$

where P_0 is the reference pressure of 1 μPa.

Zero-to-peak Sound Pressure Level

The maximum absolute sound pressure during a stated time interval is referred to as the zero-to-peak SPL. A peak sound pressure may arise from a positive or negative sound pressure.

For a symmetric waveform, the zero-to-peak amplitude is half the value of the peak-to-peak amplitude. However usually the waveforms encountered in measurements sometimes exhibit significant asymmetry, and so the zero-to-peak values have been more commonly used as well.

$$L_{pk} = 20 \log \left[\frac{P_{pk}}{P_0} \right]$$

where P_{peak} maximum absolute sound pressure and P_0 is the reference pressure of 1 μPa.

Sound Exposure Level (SEL)

The Sound Exposure Level is a measure of the pulse energy content. The SEL for a single pulse is calculated by integrating the square of the pressure waveform over the duration of the pulse. The duration of the pulse is defined as the region of the waveform containing the central 90% of the energy of the pulse. The calculation is given by:

$$E_{90} = \int_{t_5}^{t_{95}} p^2(t)\,dt$$

The value is then expressed in dB re 1 μPa²s and is calculated from:

$$SEL = 10 \log \left[\frac{E_{90}}{E_0} \right]$$

where E_0 is the reference value of 1 μPa²s.

Note also that the definition above uses the central 90% of the energy in the pulse. This is because it can be difficult to determine the exact start of the pulse when the waveform contains noise.

2.2 Underwater Acoustic Model

The basic approach to the acoustic model adopted in air-borne acoustics is also valid in the underwater environment:

- a source (characterised by the Source Level)
- a sound transmission medium (which will be influenced by boundary conditions and environmental conditions)
- a receiver (characterised by the Receive Level)

2.2.1 Source Level (SL)

SL is a metric used in underwater acoustics to describe the source output amplitude. The decibel units for this quantity may be written as dB re 1 μPa².m². It should be noted that Source Level is an idealised acoustic far-field parameter and is not necessarily equal to the acoustic pressure or received level measured at a distance of 1 m from the source. However, it is an idealised acoustic far-field parameter. It may be considered as the sound pressure level that would exist at a range of 1 m from the acoustic centre of an equivalent simple source, which radiates the same acoustic power into the medium as the source in question.

In general, source level (SL) may be given by:

$$SL = RL + TL,$$

where RL is the received level in the acoustic far-field and TL is the transmission loss.

2.2.2 Propagation/Transmission Loss

Propagation Loss (PL) or Transmission Loss (TL) is the term used to describe the reduction of the sound level as a function of distance from an acoustics source. The mechanisms by which the sound intensity reduces are primarily geometrical spreading, sound absorption in the water and losses into the seabed or other boundaries. It is normal for propagation/ transmission loss to be stated as a positive number in dB representing the loss for the total range between the reference distance (1 m for Source Level) and the receiver location.

The accurate estimation of the transmission loss accurately requires a precise model for the transmission of the sound and its interaction with the seabed and sea surface.

By the equation, the transmission loss may be modelled separately from the source or receiver, since the transmission loss is assumed to be independent.

Ocean acoustic propagation models may be divided into four classes, based on the technique that is used to solve the wave equation: ray-theory, normal modes, wave-number integration and parabolic equation. Each class of models employs a different set of approximations and are applicable under different circumstances.

2.2.3 Received Level (RL)

The received level (RL) is the acoustic pressure which arrives at any acoustic receptor (e.g. marine fauna or hydrophone) which is exposed to a sound. The received level might be expressed in a number of ways, for example as a sound pressure level (dB re 1 μPa^2) or a SEL (dB re 1 $\mu Pa^2 \cdot s$). When predicting received levels from estimated source levels, the received level is simply determined by subtracting the transmission loss in dB from the source level in dB, RL = SL - TL, where the TL is estimated using a transmission loss model.

3. Sound Source

During a seismic survey an array of airguns is used as the main acoustic source to provide imagery of the seabed and subsurface characteristics.

The airguns are characterised by emitting high intensity and low frequency noise. Most of the energy produced by a seismic array is under 200 Hz frequency band with a broad peak around 20-120 Hz (Breitzke *et al.* 2008). The acoustic signal of airguns is characterised by being impulsive, with a short time duration of each pulse.

The acoustic source at Māui 8 site survey, under assessment through this report, consists of a source of 220 cu. in Tuned Bolt Airgun Array and at a likely tow depth of 2.5 m.

The data provided by Gardline CGG and as shown in Figure 3.1 indicates a zero-to-peak pressure of 7.1 bar-m (237 dB re 1 $\mu Pa^2.m^2$) and a peak-to-peak pressure of 13.7 bar-m (243 dB re 1 $\mu Pa^2.m^2$) for a tow depth of 3.0 m.

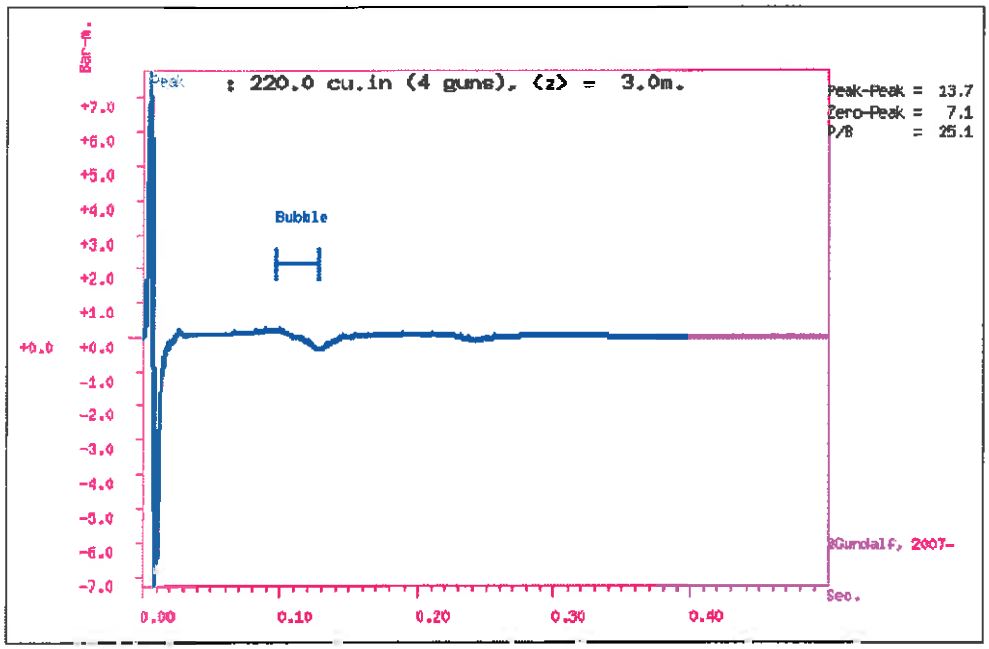


Figure 3.1 Far-field acoustic signature for a 220 cu. in. airgun array (Acoustic pressure in bar at 1 m)

The source frequency spectrum (Figure 3.2 and 3.3) indicates considerable acoustic energy over the frequency range from 10 to 160 Hz and a rapid decrease with frequency above 250 Hz. The measurements in this case were only undertaken to a maximum frequency of 1000 Hz (Figure 3.2).

It should be noted that the presented frequency spectrum is just an estimate based on Gundalf software, and therefore the actual source frequency of the array is unknown until in-field measurements are made.

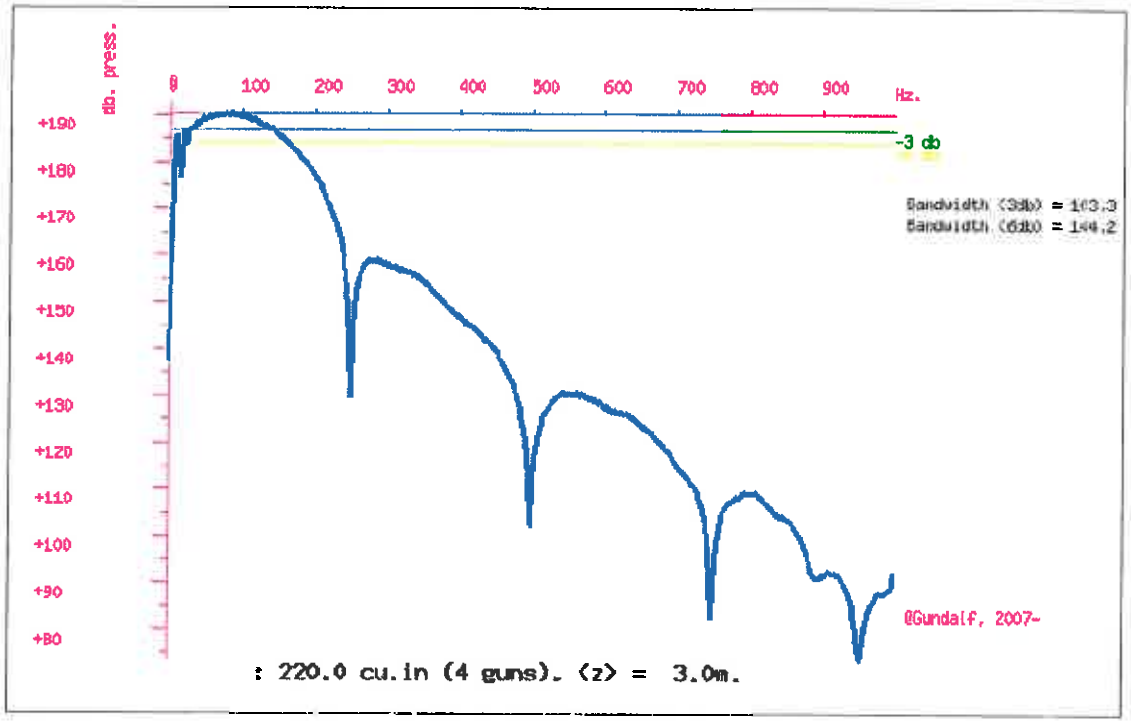


Figure 3.2 The peak noise spectrum (in dB re 1 µPa²/Hz) for a 220 cu. in. airgun array (Acoustic pressure in bar at 1 m)

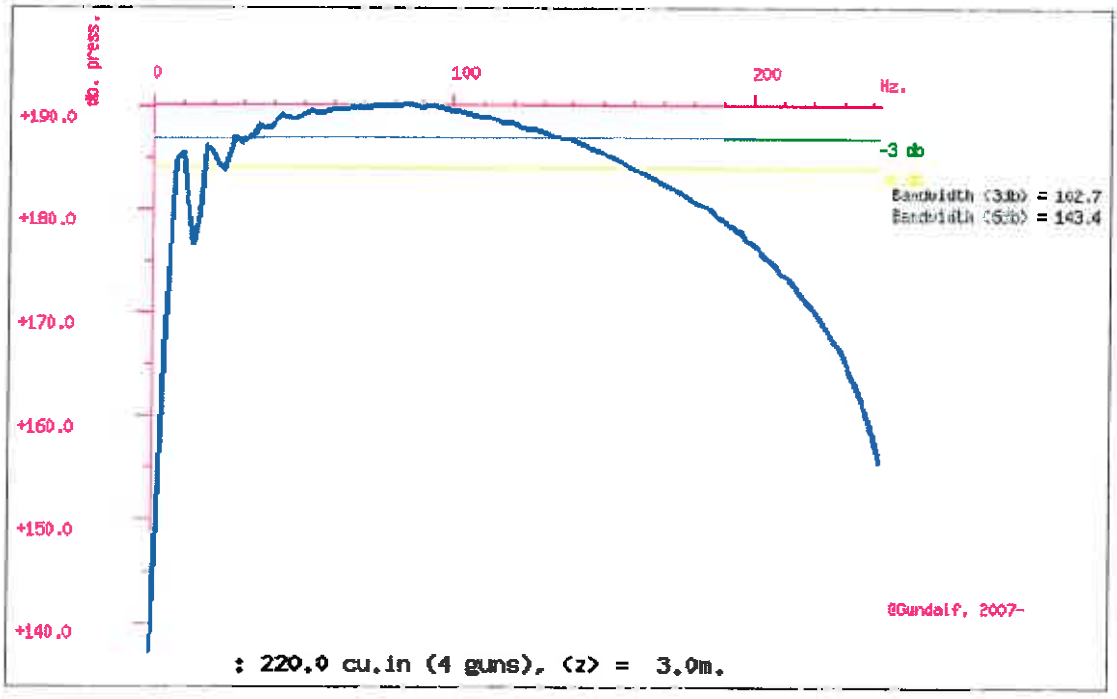


Figure 3.3 The peak noise spectrum (in dB re 1 µPa²/Hz) for a 220 cu. in. airgun array (Acoustic pressure in bar at 1 m) until 250 Hz

3.1 Directionality

The source level of a seismic airgun array varies considerably in both the horizontal and vertical directions, due to the complex configuration of guns comprising the array.

Previous studies indicate that spectral levels may be reduced as much as 6 dB in the endfire direction compared with the vertical (Simpkin, 2003). Similarly, broadside spectral levels can be reduced by at least the same amount compared with those in the vertical direction at frequencies up to 500 Hz and approaching 20 dB at frequencies up to 2 kHz (MacGillivray & Chapman, 2005).

The propagation model used here has assumed that the source behaves as a single point source that radiates in all directions in the same way, thereby adopting a worst case approach.

3.2 Sound Frequency Bands

The estimated spectral level in 1/3 octave bands from 25 to 400 Hz is given by Gundalf (Table 3.1).

Table 3.1 Spectral estimation for a 220 cu. in. airgun array, based on 1/3 octave band centre frequencies, in units of Hz

1/3 octave band Frequency (Hz)	Spectral Level (dB re 1 $\mu Pa^2/Hz$
25	184.65
31.5	186.29
40	187.48
50	188.44
63	189.11
80	189.45
100	189.23
125	188.26
160	185.99
200	180.41
250	163.51
315	172.62
400	162.38

4. Underwater Noise Propagation Modelling

The current study has employed the acoustic propagation model RAM (Collins, 1993) which it is bases on the parabolic equation solution to the wave equation, based on AcTUP V2.2L. Parabolic equation models are an efficient class of models for low-frequency problems in range-dependent environments. The RAM variant which has been utilised in the current study was RAMGeo. RAMGeo implements a stratified seabed model in which multiple bottom layers run parallel to the bathymetry.

The accuracy of the propagation model is limited by the quality and resolution of the available environmental data, such as:

- Bathymetry data - Accurate bathymetry data are especially important in shallow water environments (in the acoustic point of view: less than 200 m depth), where acoustic propagation is strongly influenced by interaction of the sound with the sea bottom and surface.
- Sound speed profiles in the water column - The sound speed is a function of temperature, salinity and depth. The sound speed profile can strongly influence long-range acoustic propagation by refracting and trapping sound energy in the water column.
- Geo-acoustic profiles of the ocean sub-bottom - Geo-acoustic properties of the ocean bottom materials, which include the compressional speed, shear speed, density and attenuation, influence how sound is reflected and absorbed at the seabed.

4.1 Parameters and Assumptions Considered

In order to be able to estimate the propagation loss, a review of the existing data/parameters and assumptions were conducted as described below.

4.1.1 Bathymetry Data

Māui 8 is characterized by shallow water and almost flat bathymetry with water depths around 100 m, as shown in Figure 4.1.

In order to assess the propagation loss in radial from the source point, eight transects were chosen (N, NE, E, SE, S, SW, W, NW) (Figure 4.1). Depth points along each modelling radial were taken from the bathymetry data supplied by the client.

Transmission loss was computed in 1/3 octave bands from 10 Hz to 1 kHz — this frequency range contains the large majority of acoustic energy radiated by an airgun array.

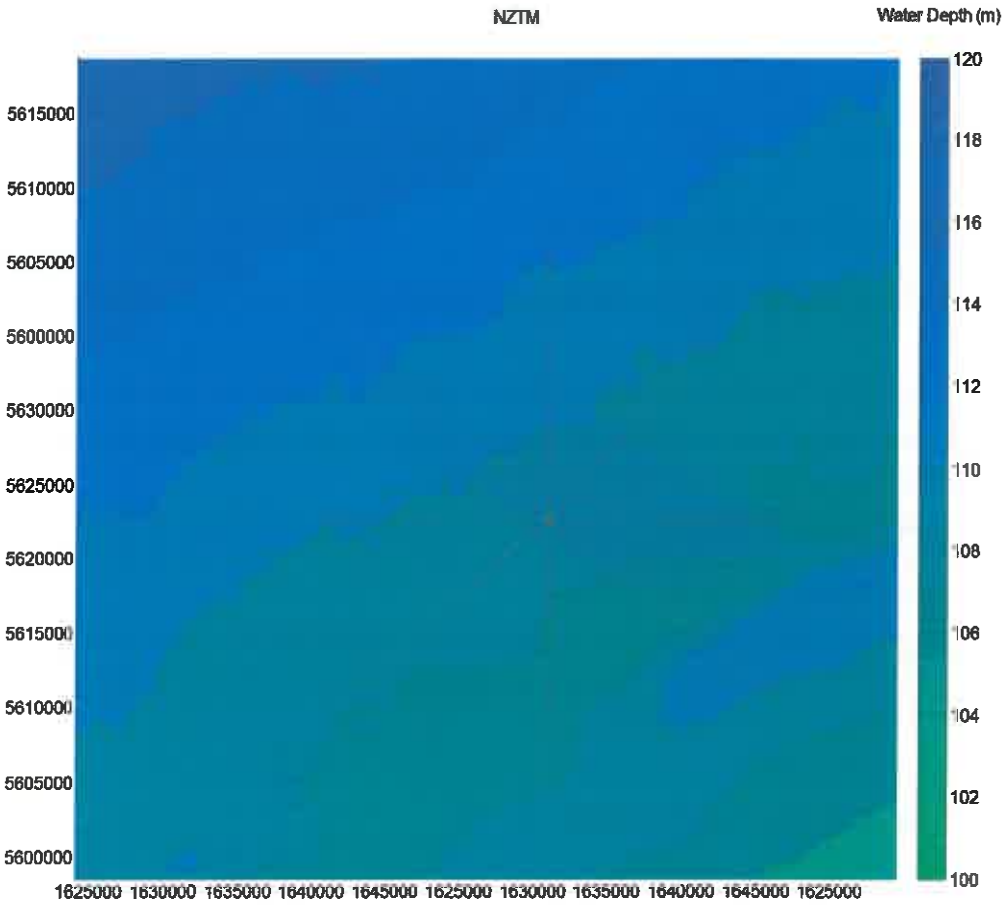


Figure 4.1 Bathymetry at the Māui 8 site and transects chosen for the propagation modelling

Table 4.1 List of modelled 1/3 octave band centre frequencies, in units of Hz

Band Centre Frequency (Hz)		
10	50	250
12.5	63	315
16	80	400
20	100	500
25	125	630
31.5	160	800
40	200	1000

Since each model run generated a very large volume of transmission loss data, the output grids were subsampled to a constant resolution of 100 m in range and 5 m in depth. The maximum range from the source point assumed was 5000 m.

4.1.2 Sound Speed Profile

Within the Greater Cook Strait and offshore Taranki region, thermal stratification of the water column occurs during the spring and summer months (REM, 2013). The stratification is diminished in late autumn as a result of turbulent mixing of the water column and less solar radiation creating an isothermal water column. A seasonal thermocline occurs at the mid-water level which breaks down in winter and spring

The sound speed profile data were obtained through the client from a previous site survey in the area in April 2004 (Figure 4.2) with an overall mean sound speed of 1506.33 m/s and a mean temperature of 14.52°C (Figure 4.3). Running the model with both parameters - the sound speed profile (Figure 4.2) and the temperature profile (Figure 4.3), allows all values measured though the water column to be incorporated hence the presence of thermocline in the sound profile is automatically taken into account by the model and included in the results obtained.

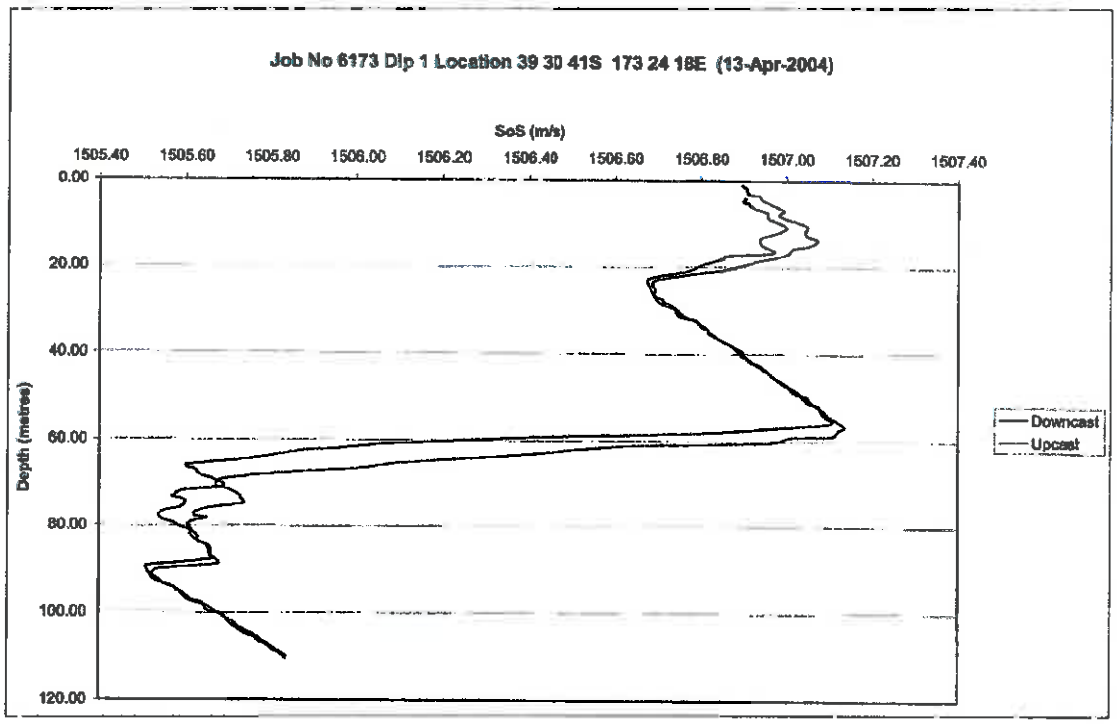


Figure 4.2 Sound Speed Profile at Māui 8, measured in April 2004

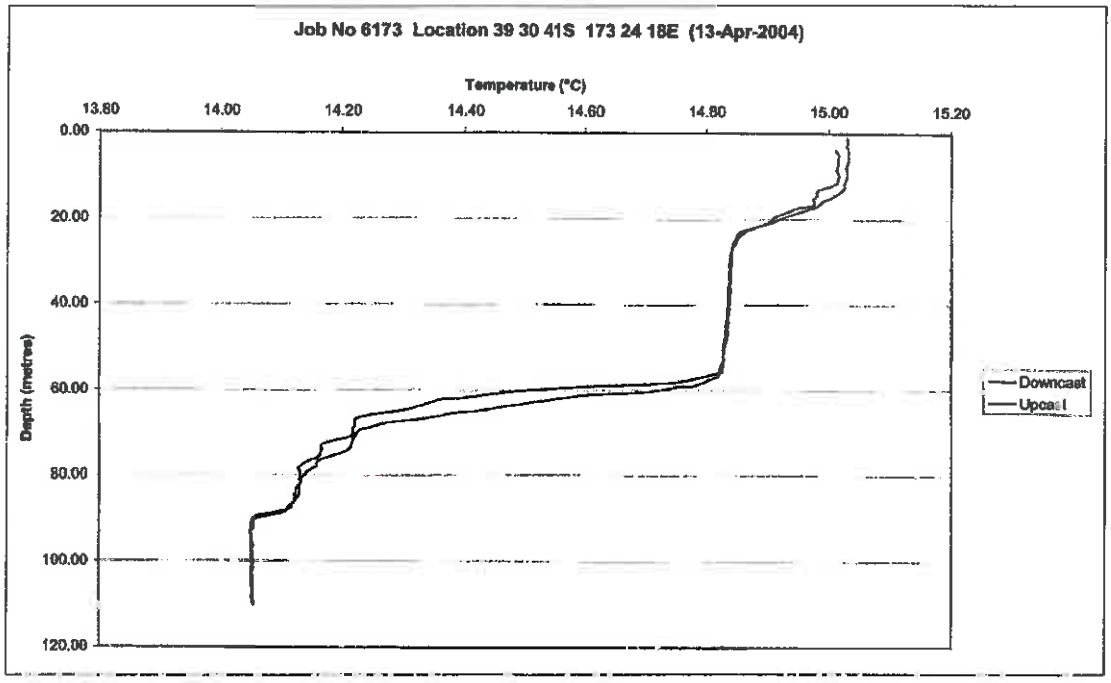


Figure 4.3 Temperature Profile at Māui 8, measured in April 2004

4.1.3 Geo-acoustic Parameters

The Taranaki Basin is a Cretaceous and Tertiary sedimentary basin along the western side of the North Island. The Taranaki shelf consists of sandy silts to silt and mud further offshore. Superficial sediments at the Māui A platform predominantly consist of mud sized particles, whereas at Māui B sediments were grading towards the finer grain sizes, with silt and clay accounting for the bulk sediment type (Johnston & Forrest, 2012). To run the model a clayey - silt seabed with a sound speed of 1535 m/s, density of 1380 kg/m^3 and absorption between 1.25-1.5 dB/wavelength (Hamilton, 1970; Hamilton & Bachman, 1982) was assumed.

4.1.4 Sound Source Parameters

The sound source was assumed to be a point source located at 2.5 m depth, with the characteristics of sound levels and spectrum described in Section 3. There is a discrepancy between the expected towed depth (2.5 m) and the modelled airgun assumed depth (3.0 m), as described in Section 3. However it was chosen to consider 2.5 m towed depth as 0.5 m difference will not lead to significant changes as it can accounted to the roughness of the sea surface, due to wave or wind.

4.2 Propagation Loss Modelling Results

The acoustic propagation model RAMGeo was executed taking into account the assumptions and parameters described above for all the eight transect directions chosen (N, NE, E, SE, S, SW, W, NW).

To illustrate the results obtained Figure 4.4 shows the modelled propagation loss obtained for the transect with an East orientation for 80 Hz, and Figure 4.5 shows the predicted propagation loss in dB over the East transect (as an example).

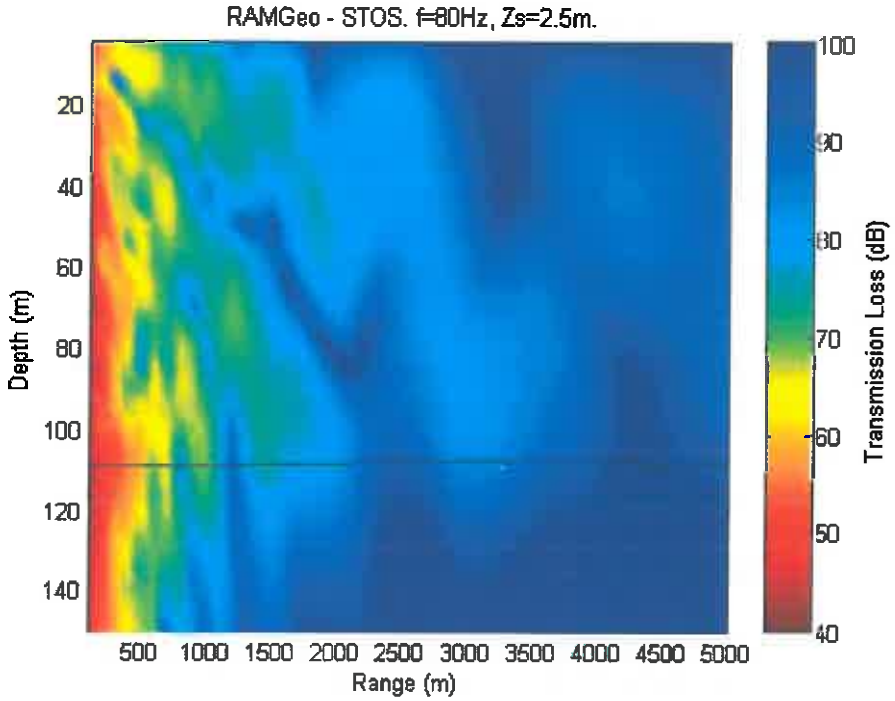


Figure 4.4 Modelled propagation loss obtained for the East transect, for 80 Hz frequency (seafloor - represented with a black line)

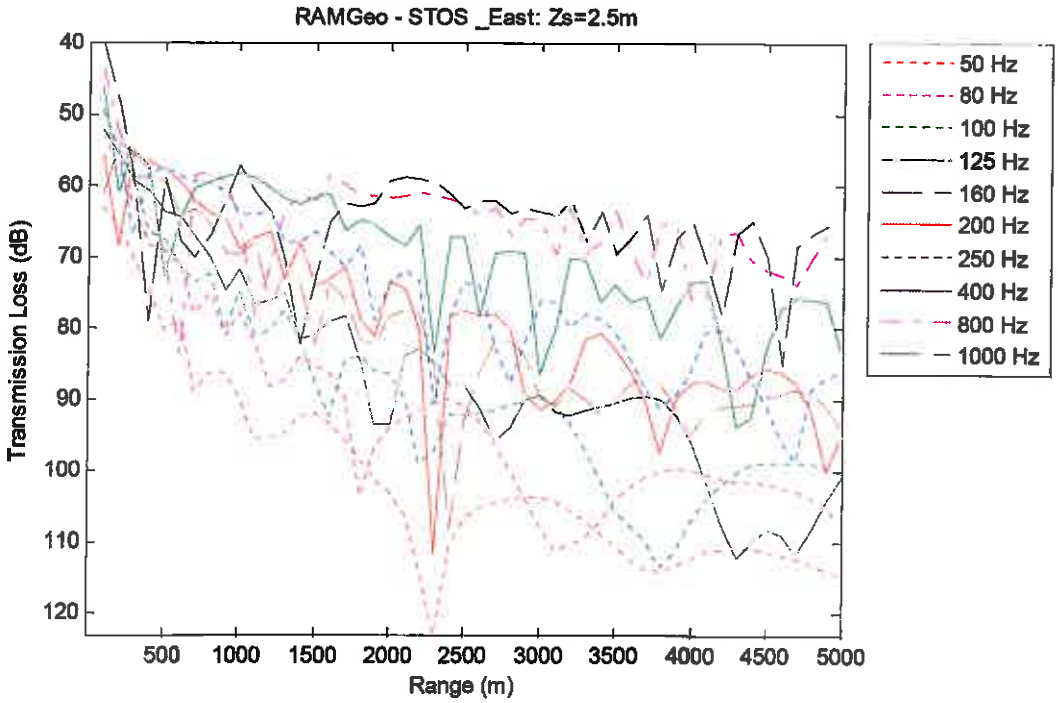


Figure 4.5 Predicted propagation loss in dB over the East transect from 50 to 1000 Hz frequency

5. Seismic Noise and Marine Animals - Impact Assessment

5.1 The Code

In order to provide supporting information for the mitigation plan for the area in accordance with DOC, 2013 requirements (see Section 1.1), an estimation of instantaneous impact and behavioural disturbance ranges was conducted.

The criteria in the Code are based on M-weighted values (Southall *et al.*, 2007) for pinnipeds in water. In order to present a more comprehensive study in this report the impact range estimation also covered the cetacean group based on Southall *et al.* (2007) and described in Section 5.2.

It should be noted that estimations are based on the best currently available methods, developed using existing data for species.

Using the propagation loss model in Section 4 and the impact criteria for marine mammals outlined in Section 5.2, ranges over which marine mammals may be impacted during the Māui 8 seismic site survey have been estimated (see Section 5.4).

5.2 Marine Mammal Criteria

The US Marine Mammal Criteria Group of the NMFS (National Marine Fisheries Service part of the National Oceanic and Atmospheric Administration (NOAA)) have proposed the 'M-weighting' model (Southall *et al.*, 2007), as part of the Marine Mammal Noise Exposure Criteria. The authors delineated five groups of marine mammals based on similarities in hearing: three for cetaceans: low, mid and high-frequency and two for pinnipeds: water and air (Southall *et al.*, 2007).

The Marine Mammal Noise Exposure Criteria was developed through the agreement of an expert committee. The criteria are peer-reviewed and now the most widely accepted exposure criteria for marine mammals.

The Southall *et al.* (2007) criteria are a dual – criteria approach based on zero-to-peak SPL and energy (SEL). In this method the signal is weighted relative to hearing abilities of species under test and the SEL are then calculated (Southall *et al.*, 2007).

The likely impacts were assessed on the basis of the risk of physical injury (hearing damage) and behavioural response for a single pulse.

A summary of the criteria adopted for marine mammals in this report is given in Table 5.1.

Table 5.1 Injury and behavioural criteria according to Southall *et al.* (2007)

Criteria	Injury Threshold Values (Single Pulse)	Behavioural Threshold Values (Single Pulse)
High Freq. Cetaceans		
Peak SPL (dB re 1 µPa².m²)	230	224
SEL (dB re 1 µPa².m².s)	198	183
Mid Freq. Cetaceans		
Peak SPL (dB re 1 µPa².m²)	230	224
SEL (dB re 1 µPa².m².s)	198	183
Low Freq. Cetaceans		
Peak SPL (dB re 1 µPa².m²)	230	224
SEL (dB re 1 µPa².m².s)	198	183
Pinnipeds in water		
Peak SPL (dB re 1 µPa².m²)	218	212
SEL (dB re 1 µPa².m².s)	186	171

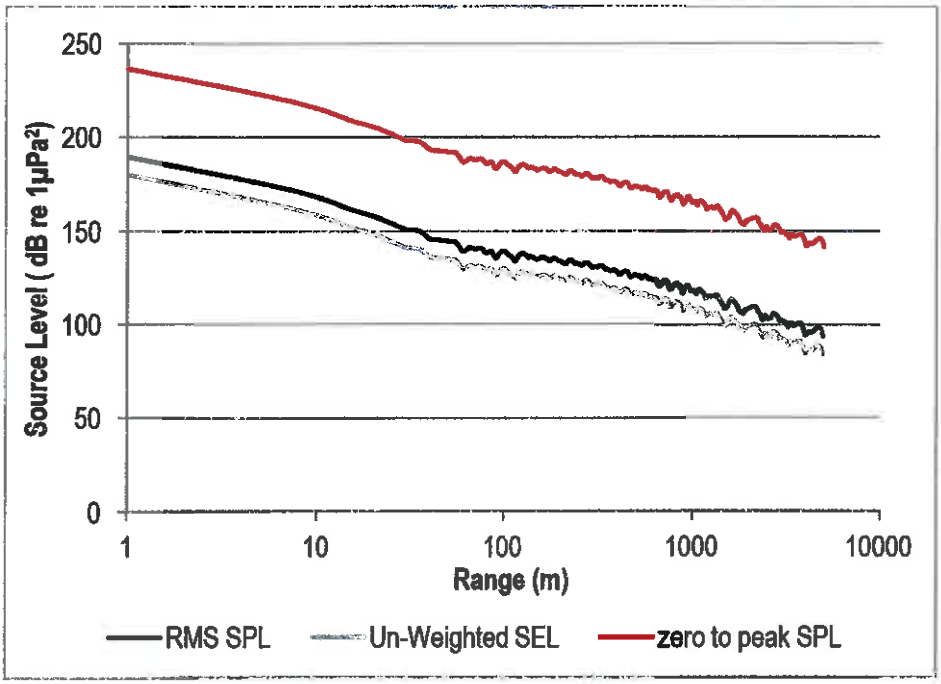
5.3 Un-weighted Sound Levels

The un-weighted noise has also been calculated using the 1/3 octave band propagation modelling described in Section 4. This process involves calculating the 1/3 octave band levels of source noise from the spectral levels presented in Figure 3.3, and then calculating the corresponding levels at range from the source by subtracting the propagation loss in each frequency band.

To estimate the variation in zero-to-peak sound level with range, the propagation loss has been applied to the zero-to-peak source level provided (zero-to-peak level of 237 dB re 1µPa².m²).

The un-weighted SEL levels assumed a pulse duration of 0.1 seconds.

Figure 5.1 illustrates as an example the zero-to-peak, RMS SPL and un-weighted SEL at 2.5 m for transect North-West.



and

Figure 5.1 Predicted zero-to-peak, RMS SPL and un-weighted SEL for the 220 cu. in. airgun array, over the North-West transect.

5.4 M-weighted Sound Levels

In the case of SEL, the signal was first weighted relative to hearing abilities of the species under test (M-weighting). The advantage is that for signals containing multiple frequency components, measurements of energy contributions well outside the hearing band of the species will be removed from the overall exposure estimate.

M-weighting filters were developed for the five groups mentioned above based on current knowledge and interpolation of appropriate hearing data (Southall *et al.*, 2007). The 'M-weighting' filters are plotted in Figure 5.2. As outlined in Southall *et al.* (2007), M-weighting is only applied to the SEL values, and is used in this report within the instantaneous injury assessments appropriately for the relevant marine mammal functional hearing groups.

The source characteristic data provided in this study is limited to 500 Hz; however this encompasses the main source energy output for the seismic airgun array. The source data does not fully cover the frequency range required to fully implement the M-weighting scale filters proposed by Southall *et al.* (2007) (i.e. from 10 Hz to 100 kHz and greater).

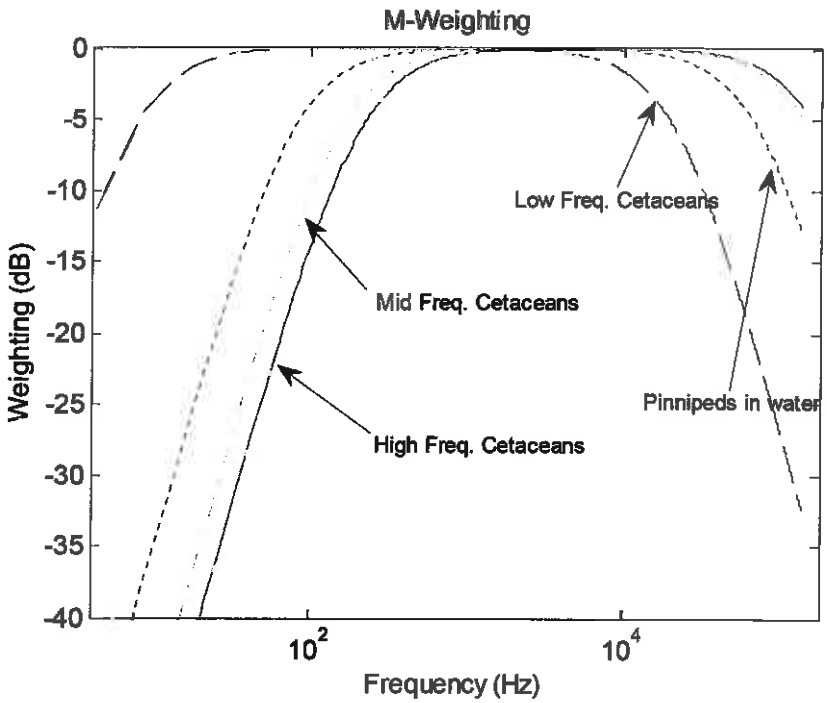


Figure 5.2 M-weighting filters for marine mammals

5.5 Impact Ranges

Figure 5.3 and Figure 5.4 present an example of M-weighted SEL and zero-to-peak SPL as function of range, for transect NW, regarding the injury and behavioural threshold values, respectively, by Southall *et al.* (2007).

The M-weighted SEL filters were applied to the high, medium and low frequency cetaceans and for pinnipeds in water. The M-weighted SEL values vary with the dominant frequency components in the signal. As expected, the un-weighted SEL has the highest levels at each range, with M-weighted filters removing a proportion of either the high or low frequency sound energy according the characteristics of each marine mammal group.

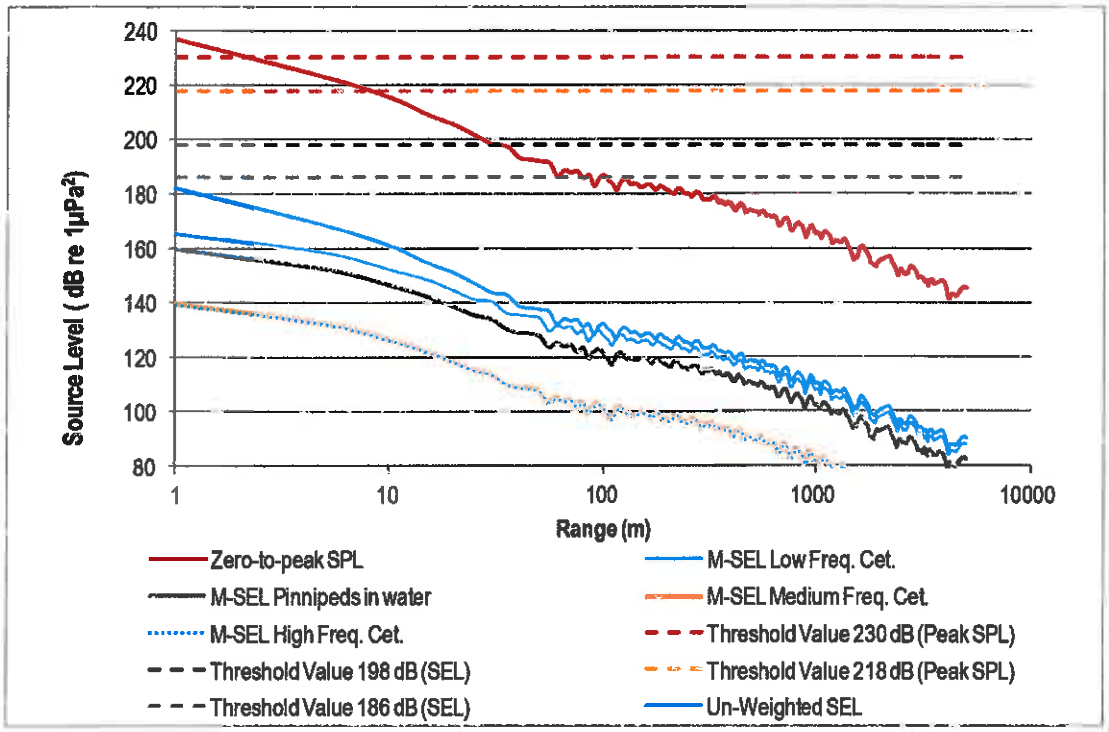


Figure 5.3 M-weighting SEL and zero-to-peak SPL as function of range for transect NW regarding the injury threshold values

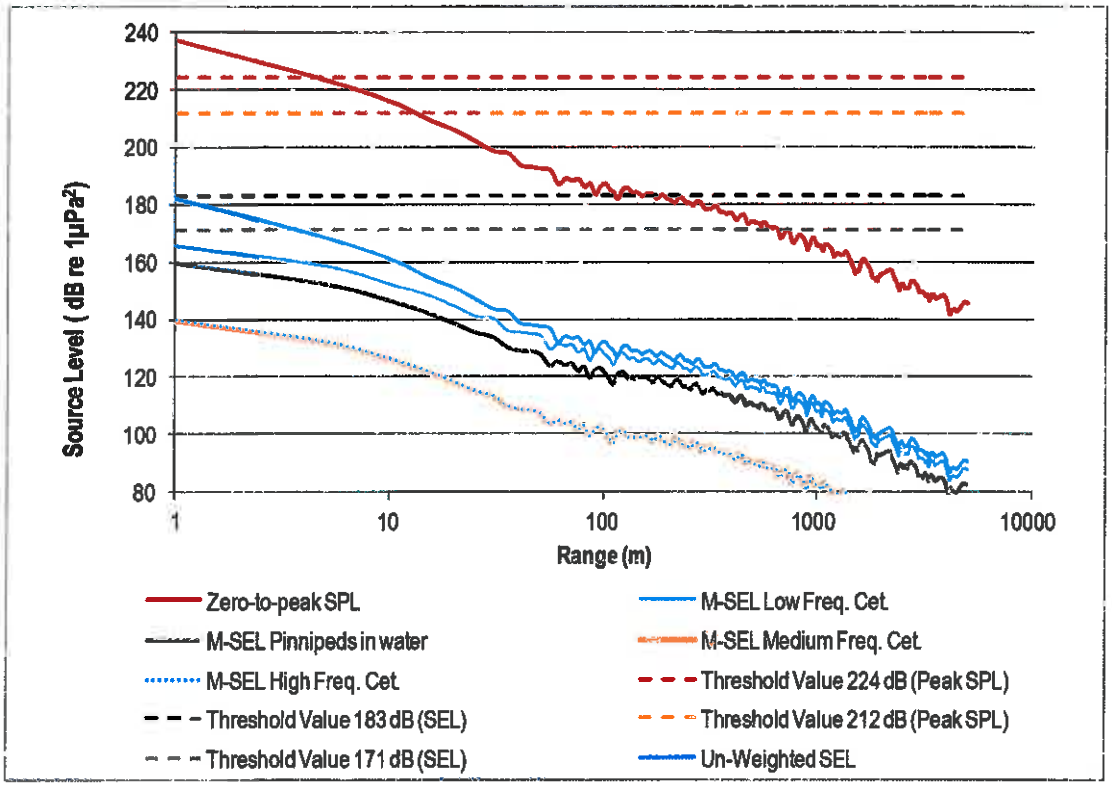


Figure 5.4 M-weighting SEL and zero-to-peak SPL as function of range for transect NW regarding the behavioural threshold values

Table 5.2 and 5.3 summarise the impact ranges predicted based on the criteria mentioned above at the Māui 8 site.

Due to the bathymetric characteristics of the area being similar across the different transects and in the Māui 8 area as a whole, the impact ranges for the different transects are the same.

A precautionary approach was assumed when comparing the zero-to-peak SPL and M-weighted SEL with the injury and behavioural threshold criteria, and consequently the impact ranges presented could be slighter higher than the results obtained through direct comparison, as can be observed in Figure 5.3 and 5.4.

Based on the peak noise criteria by Southall *et al.* (2007) injury in cetaceans is only likely to occur within 10 m of the airgun array source, and in pinnipeds within 20 m. Behavioural disturbance based on peak levels is only likely to occur within 10 m in cetaceans and within 30 m in pinnipeds.

The predicted single pulse auditory injury ranges for high, medium and low frequency hearing cetaceans are within the near field of the acoustic emissions from the airgun array. Based on the M-weighted SEL noise criteria the injury and behavioural impact ranges are only likely to occur within 5 m of the airgun array source, for cetaceans and pinnipeds.

Table 5.2 Injury impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses)

Species Group /Injury Threshold Values (Single Pulse)	All Transects (N, NE, E, SE, S, SW, W, NW)
	Range (m)
High Freq. Cetaceans	
Peak SPL 230 dB re 1 µPa².m²	<10
SEL 198 dB re 1 µPa².m².s	<5
Mid Freq. Cetaceans	
Peak SPL 230 dB re 1 µPa².m²	<10
SEL 198 dB re 1 µPa².m².s	<5
Low Freq. Cetaceans	
Peak SPL 230 dB re 1 µPa².m²	<10
SEL 198 dB re 1 µPa².m².s	<5
Pinnipeds in water	
Peak SPL 218 dB re 1 µPa².m²	<20
SEL 186 dB re 1 µPa².m².s	<5

Table 5.3 Behavioural impact range for marine mammals based on Southall *et al.* (2007) criteria (single pulses)

Species Group / Behavioural Threshold Values (Single Pulse)	All Transects (N, NE, E, SE, S, SW, W, NW)
	Range (m)
High Freq. Cetaceans	
Peak SPL 224 dB re 1 µPa².m²	<10
SEL 183 dB re 1 µPa².m².s	<5
Mid Freq. Cetaceans	
Peak SPL 224 dB re 1 µPa².m²	<10
SEL 183 dB re 1 µPa².m².s	<5
Low Freq. Cetaceans	
Peak SPL 224 dB re 1 µPa².m²	<10
SEL 183 dB re 1 µPa².m².s	<5
Pinnipeds in water	
Peak SPL 212 dB re 1 µPa².m²	<30
SEL 171 dB re 1 µPa².m².s	<5

6. Conclusions

The current study was undertaken to model the generation and propagation of underwater noise from a 220 cu. in. seismic airgun array during a survey at Māui 8 site. Additionally, this study was conducted in order assess the potential effects that the seismic survey would have on marine mammals in this region and assess the suitability of the mitigation measures proposed.

The impact ranges were predicted based on the source characteristics and physical parameters given by the client and applied to a propagation model.

Propagation models were computed for frequencies between 10 Hz and 1 kHz, and for eight different radial transects (N, NE, E, SE, S, SW, W, NW) assuming a source point at 2.5 m depth.

The propagation loss results were therefore applied to the source levels, given by the client, and the received levels were computed for each transect.

Due to the flat bathymetry characteristics of the area, the propagation loss results were very similar across the different transects, and consequently the received levels as well.

In accordance with 2013 Code, an impact assessment was carried out in order to predict if the sound levels would exceed either 171 dB re 1 μPa^2s (SEL) at distances corresponding to the relevant mitigation zones for Species of Concern or 186 dB re 1 μPa^2s at 200 m (SEL).

Both sound levels mentioned in the Code are based on the threshold criteria values for injury and behavioural disturbance for pinnipeds according Southall *et al.* (2007), however it was decided to extend the assessment also for low, medium and high frequency cetaceans groups.

Based on the peak noise criteria by Southall *et al.*, (2007) injury in cetaceans is only likely to occur within 10 m of the airgun array source, and in pinnipeds within 20 m, while behavioural disturbance is only likely to occur within 10 m and 30 m, for cetaceans and pinnipeds respectively. Based on the M-weighted SEL noise criteria the injury and behavioural impact ranges are only likely to occur within 5 m of the airgun array source, for cetaceans and pinnipeds.

As a result, the sound levels during the survey will not exceed 171 dB re 1 μPa^2s (SEL) at distances corresponding to the relevant mitigation zones for Species of Concern nor the 186 dB re 1 μPa^2s at 200 m (SEL). Consequently, there is no need to either suggest an extension of the radius of the mitigation zone or limit the acoustic source power.

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Appendix C Proposed Survey Lines Coordinates

LINE	X_NZTM	Y_NZTM	LENGTH
STOS2014-101			4400
SOL	1633814.20	5616532.83	
EOL	1636464.22	5613020.37	
STOS2014-102			4400
SOL	1633894.03	5616593.06	
EOL	1636544.05	5613080.60	
STOS2014-103			4400
SOL	1633973.85	5616653.29	
EOL	1636623.88	5613140.83	
STOS2014-104			4400
SOL	1634053.68	5616713.52	
EOL	1636703.71	5613201.06	
STOS2014-105			4400
SOL	1634133.51	5616773.74	
EOL	1636783.53	5613261.28	
STOS2014-106			4400
SOL	1634213.34	5616833.97	
EOL	1636863.36	5613321.51	
STOS2014-107			4400
SOL	1634293.17	5616894.20	
EOL	1636943.19	5613381.74	
STOS2014-108			4400
SOL	1634373.00	5616954.43	
EOL	1637023.02	5613441.97	
STOS2014-109			4400
SOL	1634452.83	5617014.65	
EOL	1637102.85	5613502.19	

STOS2014-110			4400
SOL	1634532.65	5617074.88	
EOL	1637182.68	5613562.42	
STOS2014-111			4400
SOL	1634612.48	5617135.11	
EOL	1637262.51	5613622.65	
STOS2014-112			4400
SOL	1634692.31	5617195.34	
EOL	1637342.34	5613682.88	
STOS2014-113			4400
SOL	1634772.14	5617255.57	
EOL	1637422.16	5613743.11	
STOS2014-114			4400
SOL	1634851.97	5617315.79	
EOL	1637501.99	5613803.33	
STOS2014-115			4400
SOL	1634940.08	5617382.27	
EOL	1637590.10	5613869.81	
STOS2014-116			4400
SOL	1635011.63	5617436.25	
EOL	1637661.65	5613923.79	
STOS2014-117			4400
SOL	1635091.45	5617496.48	
EOL	1637741.48	5613984.02	
STOS2014-118			4400
SOL	1635171.28	5617556.70	
EOL	1637821.31	5614044.24	
STOS2014-119			4400
SOL	1635251.11	5617616.93	
EOL	1637901.14	5614104.47	

STOS2014-120			4400
SOL	1635330.94	5617677.16	
EOL	1637980.96	5614164.70	
STOS2014-121			4400
SOL	1635410.77	5617737.39	
EOL	1638060.79	5614224.93	
STOS2014-122			4400
SOL	1635490.60	5617797.62	
EOL	1638140.62	5614285.16	
STOS2014-123			4400
SOL	1635570.43	5617857.84	
EOL	1638220.45	5614345.38	
STOS2014-124			4400
SOL	1635650.25	5617918.07	
EOL	1638300.28	5614405.61	
STOS2014-125			4400
SOL	1635730.08	5617978.30	
EOL	1638380.11	5614465.84	
STOS2014-201			3400
SOL	1633716.19	5615832.55	
EOL	1636430.37	5617880.30	
STOS2014-202			3400
SOL	1633866.76	5615632.98	
EOL	1636580.94	5617680.72	
STOS2014-203			3400
SOL	1634017.33	5615433.41	
EOL	1636731.50	5617481.15	
STOS2014-204			3400
SOL	1634167.90	5615233.83	
EOL	1636882.07	5617281.58	

STOS2014-205			3400
SOL	1634318.47	5615034.26	
EOL	1637032.64	5617082.01	
STOS2014-206			3400
SOL	1634469.04	5614834.69	
EOL	1637183.21	5616882.44	
STOS2014-207			3400
SOL	1634654.40	5614589.00	
EOL	1637368.58	5616636.75	
STOS2014-208			3400
SOL	1634804.98	5614389.43	
EOL	1637519.15	5616437.17	
STOS2014-209			3400
SOL	1634955.54	5614189.86	
EOL	1637669.72	5616237.61	
STOS2014-210			3400
SOL	1635106.11	5613990.29	
EOL	1637820.28	5616038.04	
STOS2014-211			3400
SOL	1635313.92	5613714.85	
EOL	1638028.09	5615762.60	
STOS2014-212			3400
SOL	1635464.49	5613515.28	
EOL	1638178.66	5615563.03	
STOS2014-213			3400
SOL	1635615.06	5613315.71	
EOL	1638329.23	5615363.46	
STOS2014-214			3400
SOL	1635765.63	5613116.14	
EOL	1638479.80	5615163.88	

STOS2014-301			5150
SOL	1634968.98	5615665.26	
EOL	1640095.99	5615179.21	
STOS2014-302			3000
SOL	1638384	5613856	
EOL	1638667	5616842	
STOS2014-303			3000
SOL	1627657	5609965	
EOL	1625536	5607844	
STOS2014-304			3000
SOL	1627657	5607844	
EOL	1625536	5609965	
STOS2014-305			3000
SOL	1639853	5624844	
EOL	1637732	5622722	
STOS2014-306			3000
SOL	1639853	5622722	
EOL	1637732	5624844	

Gardline

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Shell Todd Oil Services Limited

Project

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Māui 8 Site Survey, Offshore Taranaki, New Zealand

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Contents

1. **Introduction** 199

2. **Observers** 199

3. **Observer Effort** 201

4. **Observers Authority** 202

5. **PAM** 202

6. **Operational Area** 202

7. **Soft Starts** 203

8. **Pre-start Procedures** 203

9. **Delays and Shutdowns** 203

9.1 Species of Concern (SoC) with calves within a mitigation zone of 1 km 204

9.2 Species of Concern (SoC) within a mitigation zone of 600 m 204

9.3 Other Marine Mammals within a mitigation zone of 200 m 205

10. **Species of Concern** 205

11. **Seismic Source Tests** 205

12. **Line Turns** 205

13. **Communication** 207

13.1 Pre-job meeting 207

13.2 Communication with DOC 208

14. **Monitoring and Reporting** 208

15. **Non-compliance** 210

16. **Ground-truthing of Sound Transmission Loss Modelling** 211

List of Figures

Figure 9.1 Summary flow diagram of the mitigation procedures during the Māui 8 site survey 204
Figure 13.1 Summary flow diagram of the communication procedure during daylight hours for the Māui 8 site survey 207
Figure 13.2 Summary flow diagram of the communication procedure during the hours of darkness and poor visibility during the Māui 8 site survey 208

List of Tables

Table 10.1 The list of New Zealand Species of Concern (SoC) 206

1. Introduction

The purpose of this document is to outline the detailed mitigation procedures and protocols for the Māui 8 site survey[7] in order to reduce any adverse impact on marine mammals and to achieve compliance in accordance with the Department of Conservation (DOC) *2013 Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations'* (hereafter "the 2013 Code").

During the entire duration of the survey, the 2013 Code will be fully adhered to and all mitigation measures outlined for the Level 2 survey will be fully implemented with the addition of the extra measures recommended within the Marine Mammal Impact Assessment (MMIA):

- Two Passive Acoustic Monitoring System (PAM) Operators will be present onboard the seismic vessel throughout the survey to conduct acoustic monitoring for marine mammals. Such acoustic monitoring will cover 24 hours allowing marine mammal monitoring during the hours of darkness and low visibility. Passive Acoustic Monitoring (PAM) is considered as an additional measure and is voluntary for Level 2 surveys; however Shell Todd Oil Services Ltd (STOS) have requested its use in order to follow best practice measures.

- Two qualified MMOs will be on watch during all pre-start observations during daylight hours and any other key times (heath and safety permitting);

- To avoid any risk of collision with baleen whales during transit, at least one qualified Marine Mammal Observer (MMO) is to be on the watch during transits or at any times of increased vessel speed (i.e. above usual survey speed). If any baleen whales are sighted in the vicinity ahead of the vessel and if judged by the MMO that the animal/s is/are not responsive (i.e. during times of resting, feeding, socialising), the vessel's course will be altered to avoid collision with the animal/s.

- Immediate notification of the Director-General of DOC if Species of Concern (SoC) are encountered in unusually high numbers.

- If any Hector's dolphins or Maui's dolphins are sighted at any time during the survey (including transits), the Director-General of DOC will be informed at the first possible instance. In such instances both National Office (Ian Angus, and the Taranaki Area office (Callum Lilley, or Brian Williams, should be informed.

- Ground-truthing of received sound levels at the mitigation distances is to be conducted during the survey and results presented in the final trip report. If the results of these measurements significantly differ from the noise modelling conducted as a part of this MMIA, the Director-General will be immediately notified.

2. Observers

There will be four qualified observers onboard throughout the survey meeting the requirements of the 2013 Code and approved by DOC. They will undertake designated roles during the survey as MMO and PAM Operators.

As per the standards outlined the 2013 Code, the duties of the MMO will be to:

[7] For more details about the survey please refer to the associated MMIA document

- Give 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 (not the vessel) for presence of marine mammals, using a combination of the naked eye and high-quality binoculars, from optimum vantage points for unimpaired visual observations with minimum distractions
- Use Global Positioning System (GPS), sextant, reticule binoculars, compass, measuring sticks, angle boards, or any other appropriate tools to accurately determine distances/bearings and plot positions of marine mammals whenever possible throughout the duration of 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 the Director-General to clarify any uncertainty or ambiguity in application of the 2013 Code, and
- Record and report any instances of non-compliance with the 2013 Code.

While undertaking the PAM Operator role, the observer will:

- Give effective briefings to crew members, and establish clear lines of communication and procedures for onboard operations
- Deploy, retrieve, test and optimise hydrophone arrays
- While on duty concentrate on continually listening to received signals and/or monitoring PAM display screens in order to detect vocalising cetaceans, except for when required to attend to PAM equipment. 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.
- Use appropriate sample analysis and filtering techniques
- Record and report all cetacean detections, including, if discernible, 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 the Director-General to clarify any uncertainty or ambiguity in application of the 2013 Code, and
- Record and report any instances of non-compliance with the 2013 Code.

All observers will have the appropriate training certificates and relevant experience for their designated roles. Additionally, all observers will hold appropriate sea survival and medical certificates and will have suitable offshore Personal Protective Equipment (PPE) for their role.

Each MMO will be equipped with the following: reticule binoculars, laptop, digital camera, range finder stick, angle board, compass, recording forms, deck forms, and GPS. A sextant will be available onboard for MMOs to use.

Acoustic monitoring will be conducted with a purposely built tow array and specialised software (PAMGUARD package). This will allow acoustic detection and monitoring for the presence of vocalising marine mammals. PAM Operators are encouraged to familiarise themselves with acoustic recordings of New Zealand species identified as likely to be in the operational area.

The operator will ensure that information relating to the activation of an acoustic source and the power output levels employed throughout survey operation is readily available to support the activities of the qualified observers in real time by providing a display screen for acoustic source operations. The qualified observers should be able to specify where such a screen should be located for their convenience, rather than this being determined solely by the vessel operator.

3. Observer Effort

For the duration of the survey, two MMOs and two PAM Operators will be present onboard the survey vessel.

At least one MMO will be on watch during daylight hours while the acoustic source is in the water in the operational area and during transits from/to port. Two qualified MMOs will be on watch during pre-start observations during daylight hours or at any other key time where practical and possible (health and safety permitting). The MMOs will observe from a suitable viewing platform such as the bridge or bridge wings. MMOs with experience in PAM, when not required for visual observation, are allowed to undertake acoustic monitoring and allow the PAM Operator to have refreshment breaks. A direct line of communication will be maintained between MMOs and PAM Operators during all times.

Two qualified PAM Operators will be utilised and at least one of these will remain on watch at all times while the source is in the water. Such acoustic monitoring will cover 24 hours allowing marine mammal monitoring during hours of darkness and low visibility. If PAM equipment gets damaged or any problems occur with the system, operations may continue in the absence of PAM whilst repairs are conducted.

If the acoustic source is in the water but inactive, such as while waiting for bad weather conditions to pass, the qualified observers have the discretion to stand down from active observational duties and resume at an appropriate time prior to recommencing seismic operations. This strictly limited exception must only be used for necessary meal or refreshment breaks or to attend to other duties directly tied to their observer role onboard the vessel, such as adjusting or maintaining PAM or other equipment, or to attend mandatory safety drills.

To avoid any risk of collision with baleen whales, at least one MMO is to be on the watch during transits or at any times of increased vessel speed (i.e. above usual survey speed). If any baleen whales are sighted in the vicinity ahead of the vessel and if judged by the MMO that the animal/s is/are not responsive (i.e. during times of resting, feeding, socialising), the vessel's course will be altered to avoid collision with the animal/s.

The maximum duration of each observer's shift will be 12 hours in any 24 hour period including time needed for reporting requirements.

If any crew member onboard the survey vessel observes a marine mammal, he/she will promptly inform the MMO on duty who will then identify the animal/s where possible and determine the distance from the acoustic source. When it is not possible to confirm the sighting, the crew member who reported the observation will provide as much information as possible for the MMO to complete the relevant recording forms. If the animal/s observed were within the relevant mitigation zone, it will be up to the MMO to decide whether to implement any mitigation measures. Observations reported by crew members will be clearly differentiated within the recording forms.

4. Observers Authority

Any qualified observer on duty has the authority to delay the start of operations or shutdown an active source according to the provisions of the 2013 Code and procedures outlined within this document.

5. PAM

During daylight hours if any marine mammals are acoustically detected, the PAM Operator will notify the MMO on duty of the detection. The MMO will then attempt to locate the animal/s and provide the estimate of distance and bearing and species identification.

If operating in an area where calves are anticipated to be present or have been visually observed during the survey, then vocalisations detected by PAM are assumed to be produced from a cow/calf pair and as such the most stringent mitigation zones will be applied unless a sighting by the MMO can confirm otherwise. Furthermore, any ultra-high frequency cetacean vocalizations (30 – 180 kHz) will require an immediate shut down or delay (as per procedures described below) unless the MMO can confirm that the species detected falls under the 'other marine mammal' category.

When MMOs are not on duty (e.g. night time) and therefore not able to confirm sightings and assist with species identification and distance, a precautionary approach will be applied when determining appropriate mitigation protocols and consider factors such as recent sighting frequency of Species of Concern (SoC).

Acoustic recordings and screen shoots will be saved for each detection and backed up on external hard drive.

6. Operational Area

As per the requirements of the 2013 Code, an operational area must be designated outside of which the acoustic source will not be activated, including soft starts and acoustic source tests. The operational area for this survey is defined within the MMIA (see Section 2 of the MMIA).

On duty observers need to be aware of the vessels' location at all times in regards to the zone of operational area.

7. Soft Starts

Soft starts are required whenever the acoustic source to be activated, with the exception of certain tests(see below) and breaks in firing that are less than 10 minutes in duration immediately following normal operations at full power. In the case of the latter, the acoustic source may start at full power provided the qualified observers have not detected marine mammals in the relevant mitigation zones (as per Section 4.2.4 of the 2013 Code). Soft starts should gradually increase the acoustic source power output, starting with the lowest capacity gun, over a minimum of 20 minutes and should not exceed 40 minutes in duration. On completion of the soft start, operations should be planned so that the survey line starts shortly after. Soft starts give any mobile marine mammals in the area time to move away from the source before full power is reached.

The maximum operational capacity of 220 cu. in. will not be exceeding during any time of the soft start.

8. Pre-start Procedures

The acoustic source can only be activated once the vessel is within the specified operational area (see Section 2 of the MMIA) and no marine mammals have been detected in the respective mitigation zones.

Operations can then commence with a soft start provided the following:

DAY TIME

- At least one qualified MMO has made continuous visual observations all around the source for the presence of marine mammals, from the bridge (or preferably an even higher vantage point) using both binoculars and the naked eye, and no marine mammals have been observed in the respective mitigation zone for at least 30 minutes.
- A qualified PAM Operator has conducted acoustic monitoring for at least 30 minutes before activation of the acoustic source and no vocalising cetaceans have been detected in the respective mitigation zones.

NIGHT TIME / POOR SIGHTING CONDITIONS

- A qualified PAM Operator has conducted acoustic monitoring for at least 30 minutes before activation of the acoustic source and no vocalising cetaceans haven been detected in the respective mitigation zones.

The acoustic source cannot be activated at night or poor sighting conditions when arriving at the survey location for the first time. This should be accounted for during the pre-survey planning.

9. Delays and Shutdowns

Qualified observers have the authority to shutdown or delay seismic operations if a marine mammal is detected in the following mitigation zones:

- *1000 m for Species of Concern with calves*
- *600 m for Species of Concern without calves*
- *200 m for any other marine mammal.*

Figure 9.1 provides a summary of the delay and shutdown process.

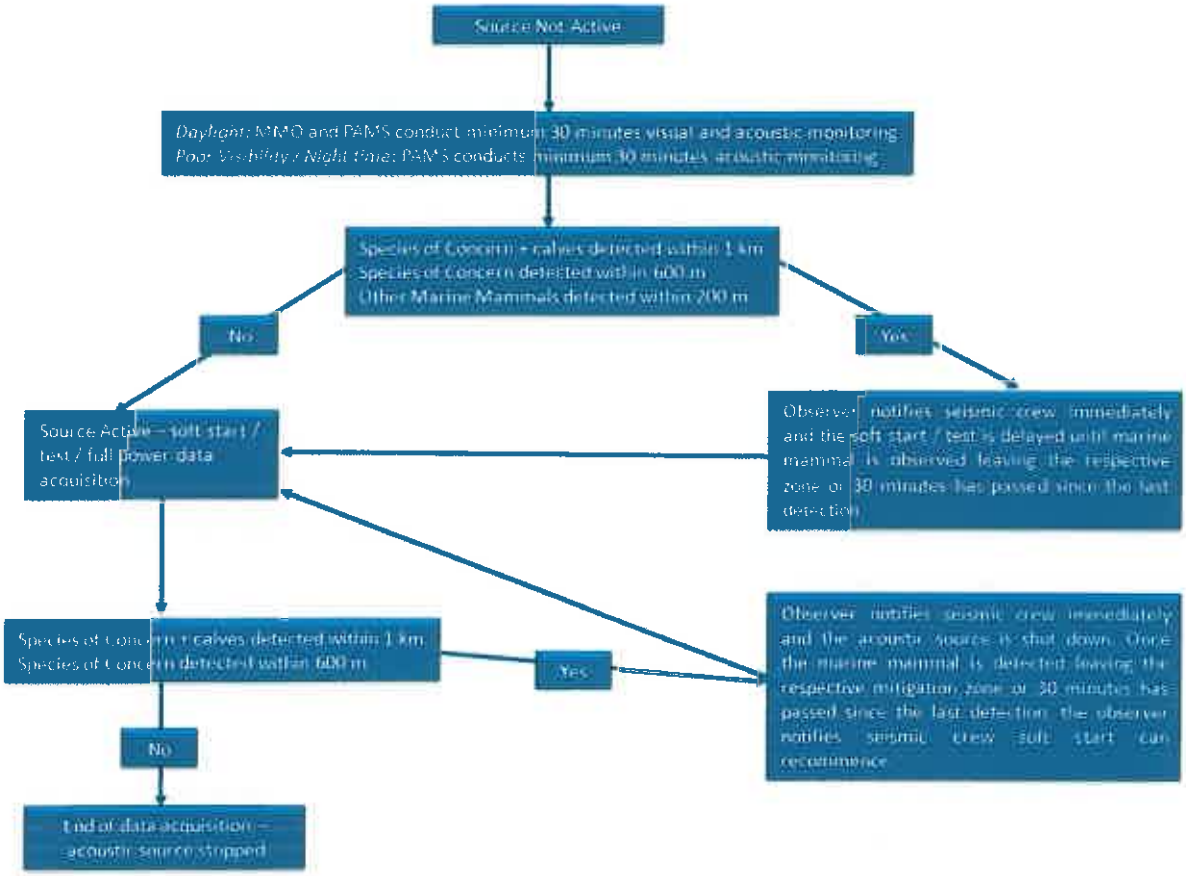

Figure 9.1 Summary flow diagram of the mitigation procedures during the Māui 8 site survey

9.1 Species of Concern (SoC) with calves within a mitigation zone of 1 km

If, during pre-start observations or while acoustic source is activated (including soft starts), a qualified observer detects at least one SoC (see section 10) with a calf within 1 km of the source, start up will be delayed or the source will be shutdown and not be reactivated until:

- A qualified observer confirms the group has moved to a point that is more than 1 km from the source, or
- Despite continuous observation, 30 minutes has elapsed since the last detection of the group within 1 km of the source, and the mitigation zone remains clear.

9.2 Species of Concern (SoC) within a mitigation zone of 600 m

If, during pre-start observations or while acoustic source is activated (including soft starts), a qualified observer detects a SoC within 600 m of the source, start up will be delayed or the source will be shut down and not reactivated until:

- A qualified observer confirms the animal/s has/have moved to a point that is more than 600 m from the source, or
- Despite continuous observation, 30 minutes has elapsed since the last detection of a SoC within 600 m of the source, and the mitigation zone remains clear.

9.3 Other Marine Mammals within a mitigation zone of 200 m

If, during pre-start observations prior to initiation of acoustic source soft start, a qualified observer detects any other marine mammal within 200 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 200 m from the source, or
- Despite continuous observation, 10 minutes has passed since the last detection of a New Zealand fur seal within 200 m of the source and 30 minutes has elapsed since the last detection of any other marine mammal within 200 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.

10. Species of Concern

All marine mammal species are protected under the 2013 Code however certain species are designated as 'Species of Concern' (Table 10.1). These species are afforded a higher level of protection due to their conservation status or particular sensitivity to the seismic noise disturbance.

11. Seismic Source Tests

Before each test, a pre-start observation needs to be conducted. All tests require soft starts, with the exception of tests below a total volume of 150 cu in. In this instance, tests can commence without a soft start provided the relevant pre-start observations have been made. For all other tests above 150 cu in, the soft start must not exceed the rate of a normal soft start but can be less than the 20 minute in duration. Tests can commence provided the qualified observer has confirmed no marine mammals are present in the relevant mitigation zones.

Acoustic source tests cannot be used for mitigation purposes or to avoid implementation of soft start procedures.

12. Line Turns

At the end of each survey line the acoustic source will be shut down and reactivated with a soft start according to the pre-start observation procedures prior to commencement of the next survey line.

Table 10.1 The list of New Zealand Species of Concern (SoC)

Scientific name	Common name
Eubalaena australis	Southern right whale
Balaenoptera acutorostrata subsp.	Dwarf minke whale
Balaenoptera bonaerensis	Antarctic minke whale
Balaenoptera borealis	Sei whale
Balaenoptera edeni	Bryde's whale
Balaenoptera musculus	Blue whale
Balaenoptera musculus brevicauda	Pygmy blue whale
Balaenoptera physalus	Fin whale
Megaptera novaeangliae	Humpback whale
Caperea marginata	Pygmy right whale
Berardius arnuxii	Arnoux's beaked whale
Hyperoodan planifrons	Southern bottlenose whale
Mesoplodon bowdoini	Andrew's beaked whale
Mesoplodon densirostris	Blainville's beaked whale
Mesoplodon ginkgodens	Ginkgo-toothed beaked whale
Mesoplodon grayi	Gray's beaked whale
Mesoplodon hectori	Hector's beaked whale
Mesoplodon layardii	Strap-toothed whale
Mesploden peruvianus	Pygmy beaked whale
Tasmacetusshepherdi	Shepherd's beaked whale
Ziphius cavirostris	Cuvier's beaked whale
Mesoplodon mirus	True's beaked whale
Physeter macrocephalus	Sperm whale
Kogia breviceps	Pygmy sperm whale
Kogia simus	Dwarf sperm whale
Cephalorhynchus hectori	Hector's dolphin
Cephalorhynchus hectori maui	Maui's dolphin
Orcinus orca	Killer whale
Pseudorca crassidens	False killer whale
Feresa attenuata	Pigmy killer whale
Peponocephala electra	Melon-headed whale
Tursiops truncatus	Bottlenose dolphin
Globicephala macrorhynchus	Short-finned pilot whale
Globicephala melas edwardii	Long-finned pilot whale
Lissodelphis peronii	Southern right whale dolphin
Phocarctos hookeri	New Zealand sea lion

13. Communication

Strict communication protocols are to be followed to ensure the effectiveness of the mitigation.

13.1 Pre-job meeting

The lead observer will meet prior to the survey with the Client Representative and relevant onboard personnel (i.e. Party Chief, Chief Engineer, Chief Navigator/Surveyor, Captain, etc) to discuss the mitigation protocol and its implementation during the survey. During this meeting a Senior Contact Person (SCP) will be identified to whom all marine mammal sightings causing delays or shutdowns will be reported to, normally the Navigator / Seismic Observer on duty who in turn will notify the MMO on the commencement and ceasing of the acoustic source. During this pre-job meeting, all procedures for soft starts, start-up delays and shutdowns should be defined and agreed. Figure 13.1 provides a summary of the communication procedures during daylight hours and Figure 13.2 of the procedure during the hours of darkness or poor visibility.

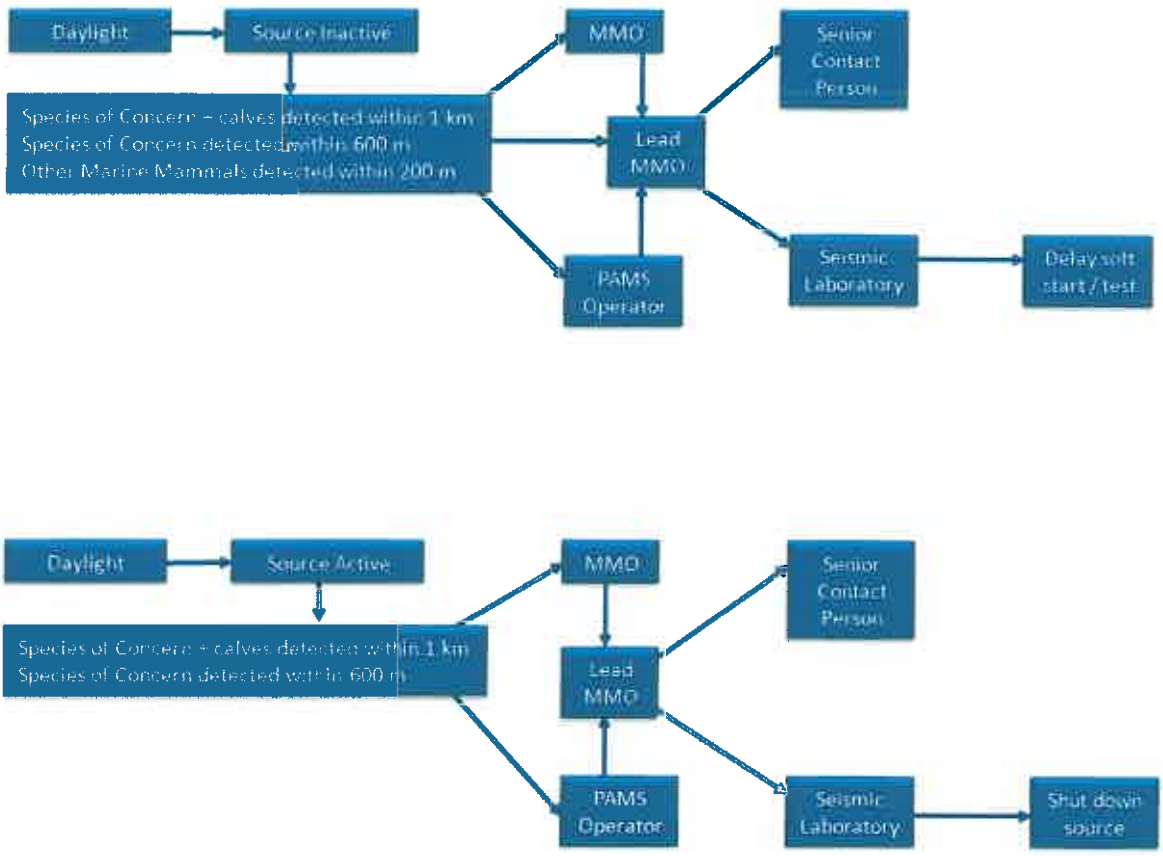

Figure 13.1 Summary flow diagram of the communication procedure during daylight hours for the Māui 8 site survey

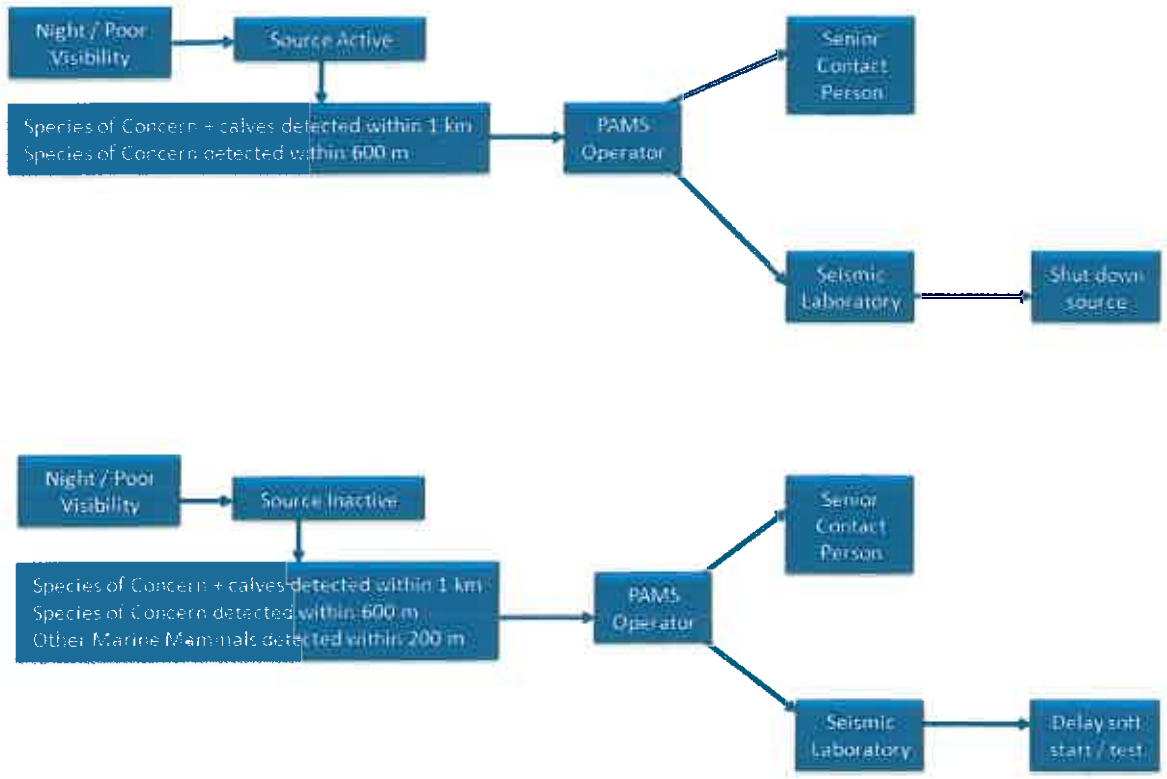

Figure 13.2 Summary flow diagram of the communication procedure during the hours of darkness and poor visibility during the Māui 8 site survey

13.2 Communication with DOC

Any urgent communication with DOC, will go though the Lead Observer by email or phone. In such circumstances, the Lead Observer must inform the Client Representative onboard and any other SCP defined during the pre-job meeting. In addition, the onshore Project Manager must be kept informed of all communications with DOC.

14. Monitoring and Reporting

Observers will be responsible for recording and reporting (in detail) all marine mammal sightings or detections, sighting conditions, seismic source operations and non-compliances. In the case of non-compliances the observer will report such instances immediately to the Director-General of DOC.

The recording and reporting will be done as according to the requirements outlined in the 2013 Code.

All sightings/detections of marine mammals during the survey period will be recorded, including those beyond the mitigation zone and/or those during transit, in the standardised recording sheets: http://www.doc.govt.nz/notifications. In addition to marine mammals, all sightings of other marine mega fauna i.e. sea turtles and sharks will be recorded too. Whilst collecting data, a clear differentiation should be made between data derived from:

- MMO and PAM Operators
- Qualified and trained observers
- Watches conducted during survey operations (ON survey) or at any other times (OFF survey).

This raw data will be submitted by the qualified observers, directly to the Director-General, at the earliest opportunity but no longer than 14 days after the completion of each deployment.

In addition to this, the Director-General is to be informed immediately when SoC's are encountered in unusually high numbers. A decision whether any of the sightings or species encounters qualify for this requirement will be upon the professional judgement of the qualified MMO onboard. Moreover, any sightings of Maui's and Hector's dolphins will be immediately reported to the Director-General. In these instances, the Director-General will determine if additional measures are necessary, and if so, they will be implemented without delay.

Furthermore, the Director-General should be notified about any non-compliance immediately. Such communication should be pursued via telephone. The first person of contact should be Ian Angus (Manager, Marine Species and Threats) Alternatively, the DOC Hotline should be used: 0 800 DOC HOT.

A final trip report will be submitted by the proponent to the Director-General at the earliest opportunity but no later than 60 days after completion of the survey. Both MMO and PAM Operators will be jointly responsible for recording observation data and compiling a final trip report.

This report will include:

- The identity, qualifications and experience of those involved in observations
- Observer effort, including totals for watch effort (hours and minutes)
- Observational methods employed
- Name of the operator and any vessels/aircraft used
- Specifications of the seismic source array, and PAM array (if included)
- Position, date, start/end of survey, GPS track logs of vessel movements
- Totality of seismic source operations (hours and minutes) indicating respective durations of full-power operation, soft starts and acoustic source testing, and power levels employed, plus at least one soft start sample per swing
- Sighting/acoustic detection records indicating:
    - method of detection
    - position of vessel/acoustic source
    - distance and bearing of marine mammals related to the acoustic source
    - direction of travel of both vessel and marine mammals

- number, composition, behaviour/activity and response of the marine mammal group (plotted in relation to the vessel throughout detection)
- confirmed identification keys for species or lowest taxonomic level
- confidence level of identification
- descriptions of distinguishing features of individuals where possible
- acoustic source activity and power at time of sighting
- environmental conditions
- water depth, and
- for PAM detections, time and duration heard, type and nature of sound

- General location, time, duration and reasons where observations were affected by poor sighting conditions
- Position, time and number of delays and shutdowns initiated in response to the presence of marine mammals
- Position, duration and maximum power attained where operational capacity is exceeded
- Any instances of non-compliance with the 2013 Code.

15. Non-compliance

The following will be considered as non-compliance and the Director-General of DOC will be immediately informed as per Section 14. Monitoring and Reporting above:

- If operational capacity of the acoustic source exceeds the stated volume (i.e. 220 cu. in.)
- If recommendation for the delay or shutdown due to presence of marine mammals in the respective zones is not followed
- Soft starts are longer or shorter than 20 or 40 minutes respectively
- Acoustic source is activated outside of the operational area
- Acoustic source tests exceeding total volume of 150 cu. in. are not conducted after an appropriate soft start
- A break in firing more than 10 minutes is not followed by a soft start
- Acoustic source is active during line turns
- Acoustic source is activated before MMO or PAM Operator have conducted their pre-start observation

16. Ground-truthing of Sound Transmission Loss Modelling

For all surveys taking place in the Areas of Ecological Importance (AEI), sound transmission loss modelling is required (Appendix B of the MMIA) as well as the ground-truthing of the model during the survey. Therefore, ground-truthing of received sound levels at the mitigation distances (i.e. 200 m, 600 m and 1000 m) will be conducted during the survey and results presented in the final trip report. If the results of these measurements significantly differ from the noise modelling conducted as a part of this MMIA, the Director-General will be immediately notified.