PROPOSED ACTION:	Issuance of an Incidental Harassment Authorization to the Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to Marine Geophysical Surveys in the Southwest Pacific Ocean, 2017/2018
TYPE OF STATEMENT:	Environmental Assessment
LEAD AGENCY:	U.S. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service
RESPONSIBLE OFFICIAL:	Donna S. Wieting, Director, Office of Protected Resources, National Marine Fisheries Service
FOR FURTHER INFORMATION:	Jordan Carduner National Marine Fisheries Service Office of Protected Resources Permits and Conservation Division 1315 East West Highway Silver Spring, MD 20910 301-427-8401
LOCATION:	Southwest Pacific Ocean
ABSTRACT:	This Environmental Assessment analyzes the environmental impacts of the National Marine Fisheries Service, Office of Protected Resources' proposal to issue an Incidental Harassment Authorization to the Lamont-Doherty Earth Observatory, for takes of small numbers of marine mammals by Level A and Level B harassment incidental to Marine Geophysical Surveys in the Southwest Pacific Ocean from 2017 to 2018
DATE:	October 2017

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List of Acronyms and Abbreviations

µPa	microPascal
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
dB	decibel
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
FONSI	Finding of No Significant Impact
FR	Federal Register
IHA	Incidental Harassment Authorization
Km	kilometer
L-DEO	Lamont-Doherty Earth Observatory
m	meter
MMPA	Marine Mammal Protection Act
MSFCMA	Magnuson-Stevens Fishery Conservation Management Act
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
OPR	Office of Protected Resources
OMB	Office of Management and Budget
PAM	Passive Acoustic Monitoring
PSAO	Protected Species Acoustic Observer
PSO	Protected Species Observer
rms	root-mean-square
USFWS	US Fish and Wildlife Service

Chapter 1 Introduction and Purpose and Need

1.1. Background

The Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1631 et seq.) prohibits the incidental taking of marine mammals. The incidental take of a marine mammal falls under three categories: mortality, serious injury or harassment (i.e., injury and behavioral effects). Harassment[1] is any act of pursuit, torment or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment) or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns (Level B harassment). Disruption of behavioral patterns includes, but is not limited to, migration, breathing, nursing, breeding, feeding or sheltering. However, there are exceptions to the prohibition on take in Sections 101(a)(5)(A) and (D) of the MMPA that gives the National Marine Fisheries Service (NMFS) the authority to authorize the incidental but not intentional take of small numbers of marine mammals by harassment, provided certain determinations are made and statutory and regulatory procedures are met. Refer to Chapter 2 for details regarding this exception and NMFS' incidental harassment authorization (IHA) criteria.

NMFS also promulgated regulations to implement the provisions of the MMPA governing the taking and importing of marine mammals, 50 Code of Federal Regulations (CFR) Part 216 and produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures necessary to apply for permits. All applicants must comply with these regulations and application instructions in addition to the provisions of the MMPA.

1.1.1. Applicant's Incidental Take Authorization Request

With funding from the U.S. National Science Foundation (NSF), Lamont-Doherty Earth Observatory of Columbia University (L-DEO), in conjunction with researchers from California State Polytechnic University, California Institute of Technology, Pennsylvania State University, University Southern California, University of Southern Mississippi, University of Hawaii at Manoa, University of Texas, and University of Wisconsin Madison, requested an Incidental Take Authorization (ITA) for take of marine mammals, by harassment, incidental to conducting marine seismic surveys in the southwest Pacific Ocean in the austral spring and summer of 2017 and the austral summer and fall of 2018. This will comprise of three high-energy seismic surveys from the research vessel (R/V) *Marcus G. Langseth* (*Langseth*) in waters off the coast of New Zealand.

The seismic surveys being proposed include: (1) a two-dimensional (2-D) survey along the Hikurangi margin off the North Island, (2) a deep penetrating three-dimensional (3-D) seismic reflection acquisition over a 15 × 60 kilometer area offshore at the Hikurangi trench and forearc off the North Island, and (3) a 2-D survey along the Puysegur margin off the South Island. Each of the proposed surveys would occur within the Exclusive Economic Zone (EEZ) and Territorial Waters of New Zealand. The proposed North Island 2-D survey is proposed to occur within ~37–43°S between 180°E and the east coast of the North Island, and the proposed North Island 3-D survey would occur within ~38–39.5°S, ~178–179.5°E (Fig. 1). The proposed South Island 2-D survey would occur within ~163–168°E between 50°S and the south coast of the South Island (Fig. 2).

[1] As defined in the MMPA for non-military readiness activities (Section 3 (18)(A))

Survey protocols generally involve a predetermined set of survey, or track lines. The seismic acquisition vessel (source vessel) travels down a linear track for some distance until a line of data is acquired, then turn and acquire data on a different track. Representative survey tracklines are shown in Figures 1 and 2; however, some deviation in actual track lines could be necessary for reasons such as science drivers, poor data quality, inclement weather, or mechanical issues with the research vessel and/or equipment. The surveys would take place in water depths from ~50 to >5000 m. In total, the three proposed surveys would entail of approximately 13,299 kilometers of track lines.

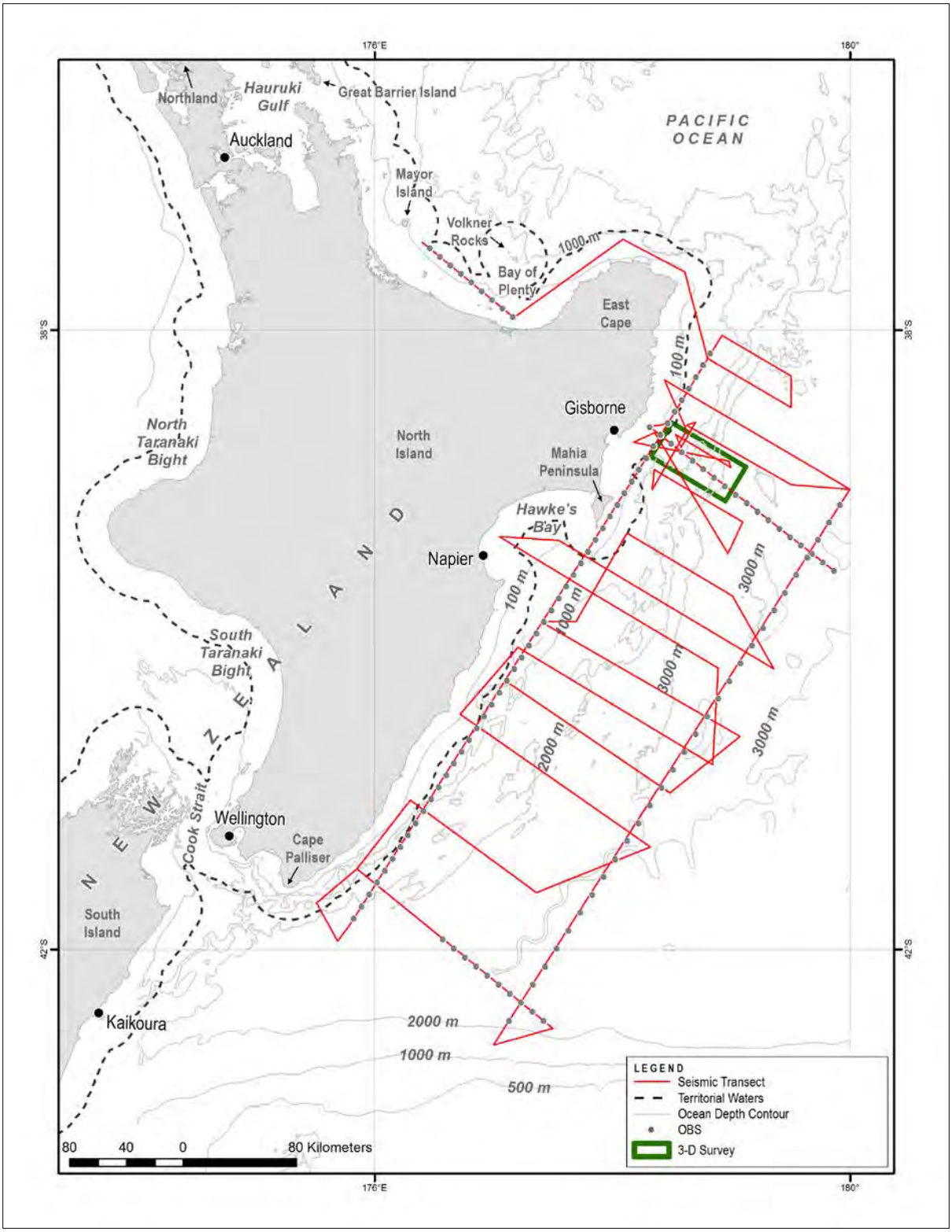

Figure 1 Location of the proposed 2017/2018 3-D and 2-D seismic surveys off New Zealand's North Island in the southwest Pacific Ocean.

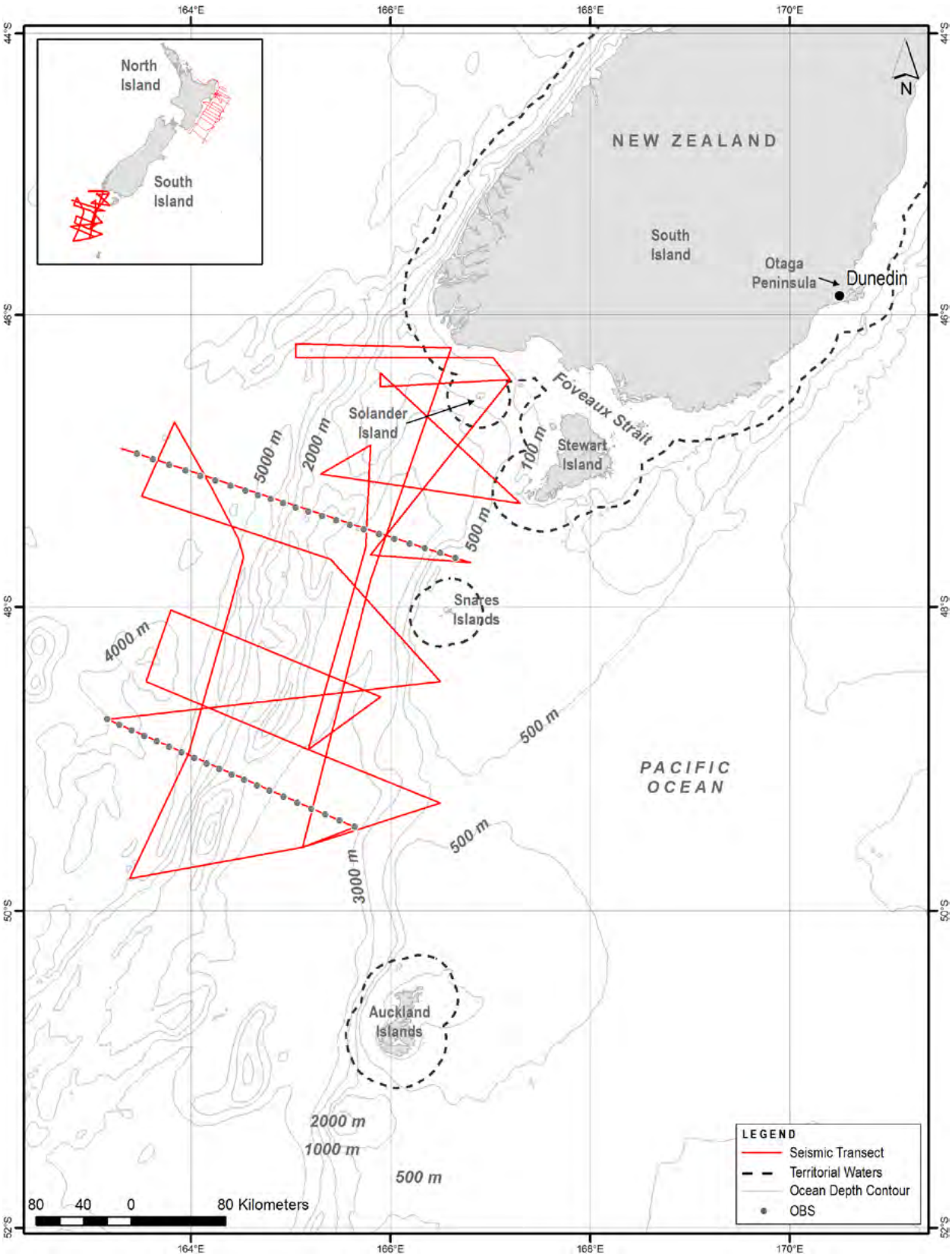

Figure 2 Location of the proposed 2018 2-D seismic survey off New Zealand's South Island in the southwest Pacific Ocean.

1.1.2. Marine Mammals in the Proposed Action Area

There are 38 marine mammal species with confirmed or potential occurrence in the area of the proposed seismic survey in the southwest Pacific Ocean, including seven cetacean species that are listed under the U.S. Endangered Species Act (ESA) as endangered: southern right whale, fin whale, sei whale, blue whale, sperm whale, humpback whale, and Hector's dolphin. These marine mammal species are listed below:

- Southern right whale (*Eubalaena australis*)
- Humpback whale (*Megaptera novaeangliae*)
- Bryde's whale (*Balaenoptera edeni*)
- Common minke whale (*Balaenoptera acutorostrata*)
- Antarctic minke whale (*Balaenoptera bonaerensis*)
- Sei whale (*Balaenoptera borealis*)
- Fin whale (*Balaenoptera physalus*)
- Blue whale (*Balaenoptera musculus*)
- Pygmy right whale (*Caperea marginata*)
- Sperm whale (Physeter microcephalus)
- Pygmy sperm whale (*Kogia breviceps*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Arnoux's beaked whale (*Berardius arnuxii*)
- Shepherd's beaked whale (*Tasmacetus shepherdi*)
- Hector's beaked whale (*Mesoplodon hectori*)
- True's beaked whale (*Mesoplodon mirus*)
- Southern bottlenose whale (*Hyperoodon planifrons*)
- Gray's beaked whale (*Mesoplodon grayi*)
- Andrew's beaked whale (*Mesoplodon bowdoini*)
- Strap-toothed beaked whale (*Mesoplodon layardii*)
- Blainville's beaked whale (*Mesoplodon densirostris*)
- Spade-toothed beaked whale (*Mesoplodon traversii*)
- Common bottlenose dolphin (*Tursiops truncates*)
- Short-beaked common dolphin (*Delphinus delphis*)
- Dusky dolphin (*Lagenorhynchus obscurus*)
- Hourglass dolphin (*Lagenorhynchus cruciger*)
- Southern right whale dolphin (*Lissodelphis peronii*)
- Risso's dolphin (*Grampus griseus*)
- Hector's dolphin (*Cephalorhynchus hectori*)
- False killer whale (*Pseudorca crassidens*)
- Killer whale (*Orcinus orca*)
- Long-finned pilot whale (*Globicephala melas*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)
- Spectacled porpoise (*Phocoena dioptrica*)
- New Zealand fur seal (*Arctocephalus forsteri*)
- New Zealand sea lion (*Phocarctos hookeri*)
- Leopard seal (*Hydrurga leptonyx*)
- Southern elephant seal (*Mirounga leonina*)

1.2. Purpose and Need

1.2.1. Description of Proposed Action

NMFS proposes to issue an IHA to L-DEO pursuant to Section 101(a)(5)(D) of the MMPA and 50 CFR Part 216. The IHA would be valid from October 27, 2017 through October 26, 2018 and would authorize takes of marine mammals, by Level A harassment and Level B harassment, incidental to the proposed seismic surveys being conducted by L-DEO from the *R/V Langseth*. NMFS's proposed action is a direct outcome of L-DEO requesting an IHA to take marine mammals incidental to seismic surveys.

1.2.2. Purpose

The purpose of NMFS's proposed action is to authorize take of marine mammals incidental to L-DEO's marine seismic surveys. Acoustic stimuli from use of airguns during the seismic surveys have the potential to result in marine mammals in and near the survey areas being injured and behaviorally disturbed and thus the activity warrants an IHA from NMFS.

The IHA, if issued, would provide an exemption to L-DEO from the take prohibitions contained in the MMPA. To authorize the incidental take of small numbers of marine mammals, NMFS will evaluate the best available scientific information to determine whether the take would have a negligible impact on marine mammals or stocks and whether the activity would have an unmitigable impact on the availability of affected marine mammal species for subsistence use. NMFS cannot issue this IHA if it would result in more than a negligible impact on marine mammals or stocks or would result in an unmitigable impact on subsistence uses. In addition, NMFS must prescribe the permissible methods of taking and other means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat, paying particular attention to rookeries, mating grounds, and other areas of similar significance. If appropriate, we must prescribe means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. IHAs must also include requirements or conditions pertaining to monitoring and reporting, in large part to better understand the effects of such taking on the species.

1.2.3. Need

U.S. citizens seeking to obtain authorization for the incidental take of marine mammals under NMFS's jurisdiction must submit such a request to NMFS, in the form of an application. On May 17, 2017, L-DEO submitted an application demonstrating the need and potential eligibility for an IHA under the MMPA. Therefore, NMFS has a corresponding duty to determine whether and how to authorize take of marine mammals incidental to the activities described in L-DEO's application. NMFS's responsibilities under section 101(a)(5)(D) of the MMPA and its implementing regulations establish and frame the need for NMFS' proposed action.

1.3. The Environmental Review Process

In accordance with the Council on Environmental Quality (CEQ) Regulations and agency policies for implementing the National Environmental Policy Act (NEPA), NMFS, to the fullest extent possible, integrates the requirements of NEPA with other regulatory processes required by law or by agency practice so that all procedures run concurrently, rather than consecutively. This includes coordination within National Oceanic Atmospheric Administration (NOAA), (e.g., the Office of the National Marine Sanctuaries) and with other regulatory agencies (*e.g.*, the U.S. Fish and Wildlife Service), as appropriate, during NEPA reviews prior to implementation of a proposed action to ensure that requirements are met. Regarding the issuance of IHAs, we rely

substantially on the public process required by the MMPA for preparing proposed IHAs to develop and evaluate relevant environmental information and provide a meaningful opportunity for public participation when we prepare corresponding NEPA documents. We fully consider public comments received in response to the publication of proposed IHAs during the corresponding NEPA review process.

1.3.1. The National Environmental Policy Act

NEPA requires federal agencies to examine the potential environmental impacts of their proposed major Federal actions. A NEPA analysis is a public document that provides an assessment of the potential effects a major federal action may have on the human environment, which includes the natural and physical environment. Major federal actions include activities that federal agencies fully or partially fund, regulate, conduct or approve. NMFS' issuance of an IHA allows for the taking of marine mammals, albeit consistent with provisions under the MMPA and incidental to the applicant's activities, and is considered a major federal action. Therefore, NMFS analyzes the environmental effects associated with authorizing incidental takes of protected species and prepares the appropriate NEPA documentation.

1.3.2. Scoping and Public Involvement

The NEPA process is intended to enable NMFS to make decisions based on an understanding of the environmental consequences and take actions to protect, restore, and enhance the environment. An integral part of the NEPA process is public involvement. Early public involvement facilitates the development of an environmental assessment (EA) and informs the scope of issues to be addressed in the EA. Although agency procedures do not require public involvement prior to finalizing an EA, NMFS determined the publication of the proposed IHA and EA was the appropriate step to involve the public to understand any potential concerns with the proposed action, identify significant issues related to the proposed action and obtain the necessary information to complete an analysis.

The public was given the opportunity to submit comments during a 30-day comment period that began the date that the notice of the proposed IHA was filed for public inspection in the *Federal Register* (82 FR 45116, September 27, 2017). The notice included a detailed description of the proposed action resulting from the MMPA incidental take authorization process; consideration of environmental issues and impacts of relevance related to the proposed issuance of the IHA; and potential mitigation and monitoring measures to avoid and minimize potential adverse impacts to marine mammals and their habitat. The *Federal Register* notice of the proposed IHA, the draft EA and the corresponding public comment period are instrumental in providing the public with information on relevant environmental issues and offering the public a meaningful opportunity to provide comments for our consideration in both the MMPA and NEPA decision-making processes.

During the 30-day public comment period following the filing of the proposed IHA in the *Federal Register* (82 FR 45116, September 27, 2017), NMFS received comment letters from the Marine Mammal Commission (Commission), and the Marine Seismic Research Oversight Committee (MSROC) as well as one comment from a member of the general public. The Commission expressed concerns regarding L-DEO's method to estimate Level A and Level B harassment zones and numbers of incidental takes; rounding of estimated takes; mitigation measures including power downs of the airgun array; some of the density estimates used to estimate take; and the extent to which monitoring requirements result in accurate reporting of the types of taking and the numbers of animals taken by the proposed activity. The comment

received from the MSROC affirmed that there is significant support from the MSROC for the IHA to be issued for the proposed surveys and for the surveys to be conducted. A private citizen expressed concern that animals should not be harmed in the process of surveying or studying them. NMFS has posted the comments online at: *http://www.nmfs.noaa.gov/pr/permits/incidental*. A more detailed summary of the comments, and NMFS' responses to those comments, will be included in the *Federal Register* notice for the issued IHA, if NMFS determines the IHA should be issued.

1.4. Other Environmental Laws or Consultations

NMFS must comply with all applicable federal environmental laws, regulations, and Executive Orders (EO) necessary to implement a proposed action. NMFS' evaluation of and compliance with environmental laws, regulations and EOs is based on the nature and location of the applicant's proposed activities and NMFS proposed action. Therefore, this section only summarizes environmental laws and consultations applicable to NMFS' issuance of an IHA to L-DEO for the proposed activities. There are no other environmental laws, regulations, EOs, consultations, federal permits or licenses applicable to NMFS' issuance of an IHA to L-DEO for the proposed activities.

1.4.1. The Endangered Species Act

The ESA established protection over and conservation of threatened and endangered species (T&E) and the ecosystems upon which they depend. An endangered species is a species in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The USFWS and NMFS jointly administer the ESA and are responsible for the listing of species (designating a species as either threatened or endangered) and designating geographic areas as critical habitat for T&E species. The ESA generally prohibits the "take" of an ESA-listed species unless an exception or exemption applies. The term "take" as defined in section 3 of the ESA means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat of such species. When a federal agency's action may affect a listed species, that agency is required to consult with NMFS and/or the USFWS, based on which agency has jurisdiction over the listed species that may be affected, under procedures set out in 50 CFR Part 402. NMFS and USFWS can also be action agencies under section 7. Informal consultation is sufficient for species the action agency determines are not likely to be adversely affected if NMFS or USFWS concurs with the action agency's findings, including any additional measures mutually agreed upon as necessary and sufficient to avoid adverse impacts to listed species and/or designated critical habitat.

NMFS' issuance of an IHA is a federal action that is also subject to the requirements of section 7 of the ESA. As a result, we are required to ensure that the issuance of an IHA to L-DEO for the proposed activities is not likely to jeopardize the continued existence of any T&E species or result in the destruction or adverse modification of designated critical habitat for these species. There are seven marine mammal species under NMFS's jurisdiction listed as endangered or threatened under the ESA with confirmed or possible occurrence in the proposed project area: the southern right whale, fin whale, sei whale, blue whale, sperm whale, South Island Hector's dolphin and Maui dolphin. The NMFS OPR Interagency Cooperation Division initiated consultation with the NMFS OPR Permits and Conservation Division on the proposed issuance

of the IHA to L-DEO, pursuant to section 7 of the ESA, on September 27, 2017. The NMFS OPR Interagency Cooperation Division issued a Biological Opinion on October 26, 2017 which determined the action would not jeopardize the continued existence of any marine mammal species and would not destroy or adversely modify critical habitat.

1.4.2. E.O. 12114: Environmental Effects Abroad of Major Federal Actions

The requirements for Executive Order (E.O.) 12114 are discussed in NSF and USGS's 2011 Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research (NSF and USGS, 2011). Briefly, the provisions of E.O. 12114 apply to major federal actions that occur or have effects outside of U.S. territories (the United States, its territories, and possessions). Accordingly, NSF prepares environmental analyses for major federal actions, which could have environmental impacts anywhere beyond the territorial jurisdiction of the United States. NOAA, as a matter of policy, prepares NEPA analyses for proposed major federal actions occurring within its territorial waters, the U.S. EEZ, the high seas, and the EEZs of foreign nations.

1.5. Document Scope

This draft EA was prepared in accordance with NEPA (42 USC 4321, et seq.) and CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508). The analysis in this draft EA addresses potential impacts to the human environment and natural resources, specifically marine mammals and their habitat, resulting from NMFS' proposed action to authorize incidental take associated with the proposed seismic surveys by L-DEO. We analyze direct, indirect, and cumulative impacts related to authorizing incidental take of marine mammals under the MMPA. The scope of our analysis is limited to the decision for which we are responsible (i.e. whether or not to issue the IHA). This draft EA is intended to provide focused information on the primary issues and impacts of environmental concern, which is our issuance of the IHA authorizing the take of marine mammals incidental to L-DEO's seismic survey activities, and the mitigation and monitoring measures to minimize the effects of that take. For these reasons, this EA does not provide a detailed evaluation of the effects to the elements of the human environment listed in Table 1 below. In summary, the analysis herein supports our preliminary determinations that the issuance of an IHA would not result in any significant direct, indirect or cumulative impacts. Based on our MMPA analysis, harassment from the seismic survey activities involving the use of airguns may have short-term, limited impacts on individual marine mammals, but impacts resulting from the activity are not expected to adversely affect marine mammal species or stocks through effects on annual rates of recruitment or survival.

1.5.1. Best Available Data and Information

In accordance with NEPA and the Administrative Procedure Act of 1946 (5 U.S.C. §§ 551–559), NMFS used the best available data and information accepted by the appropriate regulatory and scientific communities to compile and assess the environmental baseline and impacts evaluated in this document. Literature searches of journals, books, periodicals or technical reports and prior analyses were conducted to support the analysis of potential impacts to marine mammals associated with acoustic sources and for the identification and evaluation of mitigation measures.

In addition, NMFS previously prepared Environmental Assessments (EAs) analyzing the environmental impacts associated with the authorization of seismic surveys involving the use of airgun arrays which resulted in Findings of No Significant Impacts (FONSIs). Each of these EAs

demonstrate the issuance of an IHA does not affect other aspects of the human environment because the action only affects the marine mammals that are the subject of the IHA. These EAs also demonstrate the issuance of IHAs for these types of activities (i.e., seismic surveys involving use of airgun arrays) do not individually or cumulatively have a significant effect on the human environment and resulted in negligible impacts to marine mammals under the MMPA (NMFS, 2013a; NMFS, 2013b; NMFS, 2014a; NMFS, 2017a). NOTE: All sources identified in this EA,including those listed in Chapter 6, were evaluated for credibility of the source, quality of the information, and relevance of the content to ensure use of the best available information.

Table 1. Components of the human environment not affected by our issuance of an IHA

Biological	**Physical**	**Socioeconomic / Cultural**
Amphibians	Air Quality	Commercial Fishing
Humans	Geography	Military Activities
Non-Indigenous Species	Land Use	Oil and Gas Activities
Seabirds	Oceanography	Recreational Fishing
	State Marine Protected Areas	Shipping and Boating
	Federal Marine Protected Areas	National Historic Preservation Sites
	National Estuarine Research Reserves	National Trails and Nationwide Inventory of Rivers
	National Marine Sanctuaries	Low Income Populations
	Park Land	Minority Populations
	Prime Farmlands	Indigenous Cultural Resources
	Wetlands	Public Health and Safety
	Wild and Scenic Rivers	Historic and Cultural Resources
	Ecologically Critical Areas	

Chapter 2 Alternatives

2.1. Introduction

As described in Chapter 1, NMFS's Proposed Action is to issue an IHA to authorize the take of small numbers of marine mammals incidental to L-DEO's proposed seismic survey activity. NMFS' Proposed Action is triggered by L-DEO's request for an IHA per the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq.*). In accordance with the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) Regulations, NMFS is required to consider alternatives to a Proposed Action. This includes the no action and other reasonable course of action associated with authorizing incidental take of protected species. This evaluation of alternatives under NEPA assists NMFS with ensuring that any unnecessary impacts are avoided through an assessment of alternative ways to achieve the purpose and need for our Proposed Action that may result in less environmental harm. To warrant detailed evaluation under NEPA, an alternative must be reasonable along with meeting the stated purpose and need for the proposed action. For the purposes of this draft EA, an alternative will only meet the purpose and need if it satisfies the requirements under section 101(a)(5)(D) of the MMPA. Therefore, NMFS applied the screening criteria described below to the alternatives to identify which alternatives to carry forward for analysis. Accordingly, an alternative must meet the criteria described below to be considered "reasonable".

The MMPA requires NMFS to prescribe the means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat. In order to do so, NMFS must consider L-DEO's proposed mitigation measures, as well as other potential measures, and assess how such measures could minimize impacts on the affected species or stocks and their habitat. Our evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, we expect the successful implementation of the measure to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation. Any additional mitigation measure proposed by us beyond what the applicant proposes should be able to or have a reasonable likelihood of accomplishing or contributing to the accomplishment of one or more of the following goals:

- Avoidance or minimization of marine mammal injury, serious injury, or death, wherever possible;
- A reduction in the numbers of marine mammals taken (total number or number at biologically important time or location);
- A reduction in the number of times the activity takes individual marine mammals (total number or number at biologically important time or location);
- A reduction in the intensity of the anticipated takes (either total number or number at biologically important time or location);
- Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base; activities that block or limit passage to or from biologically important areas; permanent destruction of habitat; or temporary destruction/disturbance of habitat during a biologically important time; and
- For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Alternative 1 includes a suite of mitigation measures intended to minimize potentially adverse interactions with marine mammals.

2.2. Description of Applicant's Proposed Activities

As discussed in Chapter 1, L-DEO, in conjunction with researchers from Cal Poly, Caltech, Penn State, USC, USM, and UH, UT, and UW propose to conduct three seismic surveys from the NSF-owned R/V *Langseth* in the waters of New Zealand in the southwest Pacific Ocean in 2017/2018. The following offers in-depth information regarding each of the three proposed surveys:

North Island 2-D survey

During the proposed North Island 2-D survey, approximately 5,398 km of track lines would be surveyed, spanning an area off eastern North Island from the south coast to the Bay of Plenty. Approximately 9 percent of the proposed North Island 2-D survey would occur within New Zealand's territorial sea. The main goal of the proposed North Island 2-D survey is to collect seismic data to create images of the plate boundary fault zone and to show other faults and folding of the upper New Zealand plate and the underlying Pacific plate. The data would improve scientific understanding of why the different parts of the same plate boundary are behaving so differently to produce slow slip events and large stick-slip earthquakes. A better understanding of what causes the differences may help New Zealand government agencies in their efforts to mitigate danger posed by earthquakes in this area.

To achieve the project goals of the North Island 2-D survey, the Principle Investigator and co-Principle Investigators propose to use multi-channel seismic (MCS) reflection surveys and seismic refraction data recorded by OBSs to characterize the incoming Hikurangi Plateau, the seaward portion of the accretionary prism, and document subducted sediment variations. The project also includes an onshore/offshore seismic component. A total of 90 short-period seismometers would be deployed on the Raukumara Peninsula. The land seismometers would record seismic energy from the R/V Langseth during the North Island 2-D and 3-D surveys and would remain in place for three to four months to also record earthquakes. This instrumentation allows for very deep seismic sampling of the Hikurangi Subduction system to determine the structure of the upper plate and properties of the deeper plate boundary zone. The North Island 2-D survey would use a 36-airgun towed array with a discharge volume of ~6600 in3 (See Table 2).

North Island 3-D survey

During the proposed North Island 3-D survey, approximately 5,025 km of track lines would be surveyed within a 15 × 60 km survey area that would begin at the Hikurangi trench and extend to within ~20 km of the shoreline. Approximately 1 percent of the proposed North Island 3-D survey would occur within New Zealand's territorial sea. The main goal of the proposed North Island 3-D survey is to determine what conditions are associated with slow slip behavior, how they differ from conditions associated with subduction zones that generate great earthquakes, and what controls the development of slow-slip faults instead of earthquake prone faults. The Principle Investigator and co- Principle Investigators propose to use MCS surveys to acquire 3-D seismic reflection data offshore New Zealand's Hikurangi trench and forearc. Although not funded through NSF, international collaborators would work with the PIs to achieve the research goals, providing assistance, such as through logistical support and data acquisition and exchange.

This international collaborative experiment would record Langseth shots during seismic acquisition and develop the first ever high-resolution 3-D velocity models across a subduction zone using 3-D full-waveform inversion, overlapping and extending beyond the 3-D volume. The proposed 3D survey would use two 18-airgun towed arrays that would fire alternately with a total discharge volume of ~3300 in3 per each array (See Table 2).

South Island 2-D survey

During the South Island 2-D survey, marine seismic refraction data would be collected along two east-west lines across the plate boundary. One 200-km line would cross the Puysegur Trench at 49° S, and would be occupied by 20 short-period OBSs. A second line 47.3° S would be 260 km long with 23 OBSs. MCS profiles would occur along these same two lines (thus each of the two lines would be surveyed twice) as well as in between and within ~100 km north and south of the two OBS lines. Approximately 4,876 km of track lines would be surveyed during the proposed South Island 2-D survey. Approximately 6 percent of those track lines would be within New Zealand's territorial sea. The South Island 2-D survey would use a 36-airgun towed array with a discharge volume of ~6600 in3 (See Table 2).

The main goal of the South Island 2-D survey is to test models for the formation of new subduction zones and to measure several fundamental aspects of this poorly understood process. The study would strive to (1) measure the angle of the new fault which forms the new plate boundary and test ideas of how the faults form; (2) measure the thickness of the oceanic crust at the Puysegur ridge and test models of how the force from the nascent slab is transmitted into the plate; and (3) measure the nature of the faults, especially the thrust faults, on the over-riding plate and test models for how the forces on the over-riding plate change with time. In addition, the airguns would be used as a source of seismic waves that would be recorded onshore of the South Island, to test models for the tectonic evolution and nature of the shallow mantle directly below the plates. To achieve the project goals of the South Island 2-D survey, the PI and co-PIs propose to use MCS surveys to acquire a combination of 2-D MCS and refraction profiles with OBSs along the Puysegur Ridge and Trench south of South Island. Although not funded through NSF, international collaborators would work with the PIs to achieve the research goals, providing assistance, such as through logistical support and data acquisition and exchange. In addition, the collaborators would use land seismometers to record offshore airgun shots to determine the structure of the upper plate.

Additional Acoustic Devices

In addition to the operations of the airgun arrays, the ocean floor would be mapped with a multibeam echosounder (MBES) and a sub-bottom profiler (SBP). An Acoustic Doppler Current Profiler (ADCP) would be used to measure water current velocities. These would operate continuously during the proposed surveys, but not during transit to and from the survey areas.

Table 2 Specifications of airgun arrays, trackline distances, and water depths associated with three proposed R/V Langseth surveys off New Zealand.

	North Island 2-D survey	North Island 3-D survey	South Island 2-D survey
Airgun array configuration and total volume	36 airguns, four strings, total volume of ~6,600 in^3	two separate 18-airgun arrays that would fire alternately; each array would have a total discharge volume of ~3,300 in^3	36 airguns, four strings, total volume of ~6,600 in^3
Tow depth of arrays	9 m	9 m	9 m
Shot point intervals	37.5 m	37.5 m	50 m
Source velocity (tow speed)	4.3 knots	4.5 knots	4.5 knots
Water depths	8%, 23%, and 69% of line km would take place in shallow (<100 m), intermediate (100–1000 m), and deep water (>1000 m), respectively	0%, 42%, and 58% of line km would take place in shallow, intermediate, and deep water, respectively	1%, 17%, and 82% of line km would take place in shallow, intermediate, and deep water, respectively
Approximate trackline distance	5,398 km	3,025 km	4,876 km
Percentage of survey tracklines proposed in New Zealand Territorial Waters	Approximately 9 percent	Approximately 1 percent	Approximately 6 percent

2.2.1. Specified Time and Specified Area

The North Island 2-D survey would consist of approximately 35 days of seismic operations plus approximately 2 days of transit and towed equipment deployment/retrieval. The Langseth would depart Auckland on approximately October 26, 2017 and arrive in Wellington on December 1, 2017. The North Island 3-D survey is proposed for approximately January 5, 2018 – February 8, 2018 and would consist of approximately 33 days of seismic operations plus approximately 2 days of transit and towed equipment deployment/retrieval. The Langseth would leave and return to port in Napier.The South Island 2-D survey is proposed for approximately February 15, 2018 – March 15, 2018 and would consist of approximately 22 days of seismic operations, approximately 3 days of transit, and approximately 7 days of ocean bottom seismometer (OBS) deployment/retrieval.

The proposed surveys would occur within the Exclusive Economic Zone (EEZ) and Territorial Waters of New Zealand. The proposed North Island 2-D survey would occur within ~37–43°S between 180°E and the east coast of North Island along the Hikurangi margin. The proposed North Island 3-D survey would occur over a 15 × 60 km area offshore at the Hikurangi trench and forearc off North Island within ~38–39.5°S, ~178–179.5°E. The proposed South Island 2-D survey would occur along the Puysegur margin off South Island within ~163–168°E between 50°S and the south coast of South Island. Please see Figure 1 and Figure 2 for maps depicting the specified geographic region of the proposed surveys.

2.3. Alternative 1 – Issuance of an Authorization with Mitigation Measures

The Proposed Action constitutes Alternative 1 and is the Preferred Alternative. Under this alternative, NMFS would issue an IHA to L-DEO allowing the incidental take, by Level A harassment and Level B harassment, of 38 species (NMFS does not authorize the take of Maui dolphin for this IHA) of marine mammals subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the proposed IHA, if issued. This Alternative includes mandatory requirements for L-DEO to achieve the MMPA standard of effecting the

least practicable impact on each species or stock of marine mammal and their habitat, paying particular attention to rookeries, mating grounds, and other areas of similar significance.

2.3.1. Proposed Mitigation and Monitoring Measures

As described in Section 1.2.2, NMFS must prescribe the means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat. In order to do so, we must consider L-DEO's proposed mitigation measures, as well as other potential measures, and assess how such measures could benefit the affected species or stocks and their habitat. Our evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, the successful implementation of the measure(s) is expected to reduce impacts to marine mammals, marine mammal species or stocks, and their habitat. This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned) and the likelihood of effective implementation (probability implemented as planned). And (2) the practicability of the measure(s) for applicant implementation, which may consider such things as cost, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

To reduce the potential for disturbance associated with the activities, L-DEO has proposed to implement several mitigation and monitoring measures. NMFS has also incorporated additional measures into the IHA. L-DEO would employ the following mitigation measures:

1. Establishment of an Exclusion Zone (EZ). An exclusion zone is a defined area within which occurrence of a marine mammal triggers mitigation action intended to reduce the potential for certain outcomes, *e.g.*, auditory injury, disruption of critical behaviors. PSOs would establish a default EZ with a 500 m radius. The 500 m EZ would be based on radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). With certain exceptions (described below), if a marine mammal appears within, enters, or appears on a course to enter this zone, the acoustic source would be powered down.

2. Use of power down procedures. A power down involves decreasing the number of airguns in use such that the radius of the mitigation zone is decreased to the extent that marine mammals are no longer in, or about to enter, the 500 m EZ. During a power down, one 40-in^3 airgun would be operated. The continued operation of one 40-in3 airgun is intended to alert marine mammals to the presence of the seismic vessel in the area, and to allow them to leave the area of the seismic vessel if they choose. If a marine mammal is detected outside the EZ but appears likely to enter the EZ, the airguns would be powered down before the animal is within the EZ. Likewise, if a mammal is already within the EZ when first detected, the airguns would be powered down immediately.

   Following a power down, airgun activity would not resume until all marine mammals have cleared the 500 m EZ. The animal would be considered to have cleared the EZ if (1) it is visually observed to have left the EZ, or (2) it has not been seen within the EZ for 15 min in the case of small odontocetes, or (3) it has not been seen within the EZ for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales.

   This power down requirement would be in place for all marine mammals, with the exception of small delphinoids under certain circumstances. The small delphinoid group is intended to encompass those members of the Family Delphinidae most likely to

voluntarily approach the source vessel for purposes of interacting with the vessel and/or airgun array (*e.g.*, bow riding). This exception to the power down requirement would apply solely to specific species of small dolphins — short-beaked common dolphins, dusky dolphins and southern right whale dolphins.

In the event of a power down, a 100 m EZ would be established around the single 40-in^3 airgun. If a marine mammal is detected within or near the 100 m EZ for the single 40-in^3 airgun, the single airgun would be shut down.

3. Use of shutdown procedures. The operating airgun(s) would be completely shut down if a marine mammal is seen within or approaching the 100 m EZ for the single 40-in^3 airgun. Shutdown would be implemented (1) if an animal enters the EZ of the single 40-in^3 airgun after a power down has been initiated, or (2) if an animal is initially seen within the 100 m EZ of the single airgun when more than one airgun (typically the full array) is operating. Airgun activity would not resume until all marine mammals have cleared the 500 m EZ. Criteria for judging that the animal has cleared the 500 m EZ would be as described for power down procedures, above. The shutdown requirement, like the power down requirement, would be waived for short-beaked common dolphins, dusky dolphins and southern right whale dolphins. A shutdown would also be implemented upon the following, at any distance: visual detection of a large whale (*i.e.*, sperm whale or any baleen whale) with calf; visual detection of an aggregation (*i.e.*, six or more animals) of large whales of any species (*i.e.*, sperm whale or any baleen whale); visual or acoustic detection a beaked whale or *Kogia* spp.; visual or acoustic detection a Hector's or Maui dolphin; or, acoustic detection of a sperm whale, if the spern whale cannot be definiticvely localized as being located beyond the 500 m EZ.
4. Use of ramp-up procedures. Ramp-up of an acoustic source is intended to provide a gradual increase in sound levels following a power down or shutdown, enabling animals to move away from the source if the signal is sufficiently aversive prior to its reaching full intensity. Ramp-up procedures would occur any time the array is started up, including after power down or shutdown for any reason. The ramp-up procedure involves a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved.
5. Visual and Acoustic Monitoring. Monitoring would be conducted by a minimum of five dedicated, trained, NMFS-approved PSOs. The PSOs would have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements. PSO observations would take place during daytime airgun operations and nighttime start ups (if applicable) of the airguns. Airgun operations would be suspended when marine mammals are observed within, or about to enter, the EZ. PSOs would also watch for marine mammals near the seismic vessel for at least 30 minutes prior to the planned start of airgun operations. Observations would also be made during daytime periods when the *Langseth* is underway without seismic operations, such as during transits.

   During the majority of seismic operations, at least two PSOs would visually monitor for marine mammals around the seismic vessel (with the exception of meal times, during which one PSO may be on duty). Use of two simultaneous observers would increase the effectiveness of detecting animals around the source vessel. PSOs would be on duty in shifts of duration no longer than four hours.

In addition to visual monitoring, passive acoustic monitoring (PAM) would complement the visual monitoring program. Acoustic monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. PAM would serve to alert visual observers when vocalizing cetaceans are detected. One acoustic PSO would be on board in addition to the four visual PSOs. When a vocalization is detected while visual observations are in progress, the acoustic PSO would contact the visual PSO(s) immediately, to alert the visual PSO(s) to the presence of cetaceans (if they have not already been seen), and to allow a power down or shutdown to be initiated, if required.

2.3.2 Proposed Reporting Measures

L-DEO is required to submit a draft monitoring report to the NMFS Office of Protected Resources within 90 days after the conclusion of the activities. A final report shall be prepared and submitted within 30 days following resolution of any comments on the draft report from NMFS. The final report will include:

The following information would be recorded for each sighting and would be documented in the monitoring report submitted to NMFS:

- Species, group size, age/size/sex categories (if determinable);
- Behavior when first sighted and after initial sighting;
- Heading (if consistent), bearing and distance from seismic vessel;
- Sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc.);
- Behavioral pace;
- Time, location, heading, speed, activity of the vessel;
- Sea state;
- Visibility; and
- Sun glare

All observations, speed or course alterations, and shut downs would be recorded in a standardized format. Data would be entered into an electronic database. The accuracy of the data entry would be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures would allow initial summaries of data to be prepared during and shortly after the field program, and would facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations would provide

1. The basis for real-time mitigation (airgun shut down).
2. Information needed to estimate the number of marine mammals potentially taken by harassment.
3. Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted.
4. Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

2.4. Alternative 2 – No Action

For NMFS, denial of MMPA authorizations constitutes the NMFS No Action Alternative, which is consistent with our statutory obligation under the MMPA to grant or deny permit applications and to prescribe mitigation, monitoring and reporting with any authorizations. Under the No Action Alternative, there are two potential outcome scenarios. One is that the planned marine seismic survey, including deployment of the airgun array, would occur in the absence of an MMPA authorization. In this case, (1) L-DEO would be in violation of the MMPA if takes occur, (2) mitigation, monitoring and reporting measures would not be prescribed by NMFS, and (3) mitigation measures might not be performed voluntarily by the applicant. Another potential outcome scenario is L-DEO could choose not to proceed with their seismic surveys.

By prescribing measures to protect and minimize impacts on marine mammal species or stocks from incidental take through the authorization program, we can potentially lessen the impacts of these activities on the marine environment. While NMFS does not authorize the survey activity itself, NMFS does authorize the unintentional, incidental unintentional take of marine mammals (under its jurisdiction) in connection with these activities and prescribes, where applicable, the methods of taking and other means of effecting the least practicable impact on the species and stocks and their habitats. Although the No Action Alternative would not meet the purpose and need to allow incidental takes of marine mammals under certain conditions, the CEQ's regulations require consideration and analysis of a No Action Alternative for the purposes of presenting a comparative analysis to the action alternative(s).

2.5. Alternatives Considered but Eliminated from Further Consideration

NMFS considered whether other alternatives could meet the purpose and need and support L-DEO's proposed project. An alternative that would allow for the issuance of an IHA with no required mitigation or monitoring measures was considered but eliminated from consideration, as it would not be in compliance with the MMPA and, therefore, would not meet the purpose and need. For that reason, this alternative is not analyzed further in this document.

Chapter 3 Affected Environment

NMFS reviewed all possible environmental, cultural, historical, social, and economic resources based on the geographic location associated with NMFS's proposed action, alternatives, and L-DEO's request for an IHA. Based on this review, this section describes the affected environment and existing (baseline) conditions for select resource categories. As explained in Chapter 1, certain resource categories not affected by NMFS's proposed action and alternatives were not carried forward for further consideration or evaluation in this EA (See Table 1 in Section 1.5.1). Chapter 4 provides an analysis and description of environmental impacts associated with the affected environment.

3.1. Physical Environment

The Pacific Ocean covers approximately 165.2 million square kilometers (63.8 million square mi) and extends approximately 15,500 km (9,600 mi) from the Bering Sea in the Arctic to the northern extent of the circumpolar Southern Ocean at 60 S. Most of the proposed survey area is located within the New Zealand Shelf Large Marine Ecosystem (LME). The shelf around New Zealand varies in width from a few to several hundred kilometers (Aquarone and Adams 2009). To the north, this LME is influenced by the warm Tasman and North Cape currents, and to the south, by the colder Southland Current (Aquarone and Adams 2009). Although this LME is a considered a Class III low productivity ecosystem (<150gCm-2yr-1), areas of higher productivity are found at Chatham Rise (off the northeast coast of South Island), eastern Cook Strait, and the northeast shelf, in particular Bay of Islands (Aquarone and Adams 2009), especially during the spring and summer (Longhurst 2009). Chlorophyll accumulation is greatest over the entire shelf during September–October.

3.1.1. Ambient Sound

The need to understand the marine acoustic environment is critical when assessing the effects of anthropogenic noise on marine wildlife. Sounds generated by seismic surveys within the marine environment can affect its inhabitants' behavior (e.g., deflection from loud sounds) or ability to effectively live in the marine environment (e.g., masking of sounds that could otherwise be heard).

Ambient sound levels are the result of numerous natural and anthropogenic sounds that can propagate over large distances and vary greatly on a seasonal and spatial scale. These ambient sounds occupy all frequencies and contributions in ocean soundscape from a few hundred Hz to 200 kHz (NRC, 2003). The main sources of underwater ambient sound are typically associated with:

- Wind and wave action
- Precipitation
- Vessel activities
- Biological sounds (e.g. fish, snapping shrimp)

The contribution of these sources to background sound levels differs with their spectral components and local propagation characteristics (e.g., water depth, temperature, salinity, and ocean bottom conditions). In deep water, low-frequency ambient sound from 1-10 Hz mainly comprises turbulent pressure fluctuations from surface waves and the motion of water at the air-water interfaces. At these infrasonic frequencies, sound levels depend only slightly on wind speed. Between 20-300 Hz, distant anthropogenic sound (ship transiting, etc.) dominates wind-

related sounds. Above 300 Hz, the ambient sound level depends on weather conditions, with wind- and wave-related effects mostly dominating sounds. Biological sounds arise from a variety of sources (e.g., marine mammals, fish, and shellfish) and range from approximately 12 Hz to over 100 kHz. The relative strength of biological sounds varies greatly; depending on the situation, biological sound can be nearly absent to dominant over narrow or even broad frequency ranges (Richardson et al. 1995).

3.2. Biological Environment

The primary component of the biological environment that would be impacted by the proposed issuance of an IHA would be marine mammals, which would be directly impacted by the authorization of incidental take.

3.2.1. Marine Mammal Habitat

We present information on marine mammal habitat and the potential impacts to marine mammal habitat in our Federal Register notice of the proposed IHA (82 FR 45116, September 27, 2017). Also, L-DEO presented more detailed information on the physical and oceanographic aspects of the southwest Pacific Ocean environment in the IHA application (LGL, 2017). In summary, there are no rookeries or major haulout sites nearby or ocean bottom structure of significant biological importance to marine mammals that may be present in the marine waters in the vicinity of the project area. No ESA-listed designated critical habitat exists in the area of the proposed activities. Marine mammals in the survey area use pelagic, open ocean waters, but may have differing habitat preferences based on their life history functions (LGL, 2017).

3.2.2. Marine Mammals

Of the 38 cetacean species that may occur within or near the survey area in the southwest Pacific Ocean, seven are listed under the ESA as endangered or threatened: southern right whale, fin whale, sei whale, blue whale, sperm whale, South Island Hector's dolphin and Maui dolphin. The rest of this section deals with species distribution in the proposed survey area offshore New Zealand. Information on the occurrence near the proposed survey area, habitat, population size, and conservation status for each of the cetacean species is presented in Table 3.

In addition to the marine mammal species known to occur in proposed survey areas, there are 19 species of marine mammals with ranges that are known to potentially occur in the waters of the proposed survey areas, but they are categorized as "vagrant" under the New Zealand Threat Classification System (Baker et al., 2016a). These species are: the ginkgo-toothed whale (Mesoplodon ginkgodens); pygmy beaked whale (M. peruvianus); dwarf sperm whale (Kogia sima); killer whale (Orcinus orca) Types B, C, D; pygmy killer whale (Feresa attenuata); melon-headed whale (Peponocephala electra); Risso's dolphin (Grampus griseus); Fraser's dolphin (Lagenodelphis hosei), pantropical spotted dolphin (Stenella attenuata); striped dolphin (S. coeruleoalba); rough-toothed dolphin (Steno bredanensis); Antarctic fur seal (Arctocephalus gazelle); Subantarctic fur seal (A. tropicalis); leopard seal (Hydrurga leptonyx); Weddell seal (Leptonychotes weddellii); crabeater seal (Lobodon carcinophagus); and Ross seal (Ommatophoca rossi). Except for Risso's dolphin and leopard seal, for which there have been several sightings and strandings in New Zealand (Clement 2010; Torres 2012; Berkenbusch et al. 2013; NZDOC 2017), the other "vagrant" species listed above are not expected to occur in the proposed survey areas and are therefore not considered further in this document.

Table 4. Marine mammals that could occur in or near the proposed survey area in the southwestern Pacific Ocean.

Common name	Scientific name	Stock	ESA/MMPA status; Strategic (Y/N)[1]	Population abundance[2]
Order Cetartiodactyla – Cetacea – Superfamily Mysticeti (baleen whales)				
Family Balaenidae				
Southern right whale	Eubalaena australis	N/A	E/D;N	12,000[3]
Family Balaenopteridae (rorquals)				
Humpback whale	Megaptera novaeangliae	N/A	-/-;N	42,000[3]
Bryde's whale	Balaenoptera edeni	N/A	-/-; N	48,109[4]
Common minke whale	Balaenoptera acutorostrata	N/A	-/-; N	750,000[5,6]
Antarctic minke whale	Balaenoptera bonaerensis	N/A	-/-; N	750,000[5,6]
Sei whale	Balaenoptera borealis	N/A	E/D;-	10,000[5]
Fin whale	Balaenoptera physalus	N/A	E/D;-	15,000[5]
Blue whale	Balaenoptera musculus	N/A	E/D;-	3,800[3,5]
Family Cetotheriidae				
Pygmy right whale	Caperea marginata	N/A	-/-; N	N/A
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)				
Family Physeteridae				
Sperm whale	Physeter macrocephalus	N/A	E/D;-	30,000[5]
Family Kogiidae				
Pygmy sperm whale	Kogia breviceps	N/A	-/-; N	N/A
Family Ziphiidae (beaked whales)				
Cuvier's beaked whale	Ziphius cavirostris	N/A	-/-; N	600,000[5,7]
Arnoux's beaked whale	Berardius arnuxii	N/A	-/-; N	600,000[5,7]
Shepherd's beaked whale	Tasmacetus shepherdi	N/A	-/-; N	600,000[5,7]
Hector's beaked whale	Mesoplodon hectori	N/A	-/-; N	600,000[5,7]
True's beaked whale	Mesoplodon mirus	N/A	-/-; N	N/A
Southern bottlenose whale	Hyperoodon planifrons	N/A	-/-; N	600,000[5,7]

Gray's beaked whale	Mesoplodon grayi	N/A	-/-; N	600,000[5,7]
Andrew's beaked whale	Mesoplodon bowdoini	N/A	-/-; N	600,000[5,7]
Strap-toothed beaked whale	Mesoplodon layardii	N/A	-/-; N	600,000[5,7]
Blainville's beaked whale	Mesoplodon densirostris	N/A	-/-; N	600,000[5,7]
Spade-toothed beaked whale	Mesoplodon traversii	N/A	-/-; N	600,000[5,7]
Family Delphinidae				
Bottlenose dolphin	Tursiops truncatus	N/A	-/-; N	N/A
Short-beaked common dolphin	Delphinus delphis	N/A	-/-; N	N/A
Dusky dolphin	Lagenorhynchus obscurus	N/A	-/-; N	12,000-20,000[8]
Hourglass dolphin	Lagenorhynchus cruciger	N/A	-/-; N	150,000[5]
Southern right whale dolphin	Lissodelphis peronii	N/A	-/-; N	N/A
Risso's dolphin	Grampus griseus	N/A	-/-; N	N/A
South Island Hector's dolphin	Cephalorhynchus hectori	N/A	-/-; N	14,849[9]
Maui dolphin	Cephalorhynchus hectori maui	N/A	-/-; N	55-63[10]
False killer whale	Pseudorca crassidens	N/A	-/-; N	N/A
Killer whale	Orcinus orca	N/A	-/-; N	80,000[5]
Long-finned pilot whale	Globicephala melas	N/A	-/-; N	200,000[5]
Short-finned pilot whale	Globicephala macrorhynchus	N/A	-/-; N	N/A
Family Phocoenidae (porpoises)				
Spectacled porpoise	Phocoena dioptrica	N/A	-/-; N	N/A
Order Carnivora – Superfamily Pinnipedia				
Family Otariidae (eared seals and sea lions)				
New Zealand fur seal	Arctocephalus forsteri	N/A	-/-; N	200,000[8]
New Zealand sea lion	Phocarctos hookeri	N/A	-/-; N	9,880[11]
Family Phocidae (earless seals)				
Leopard seal	Hydrurga leptonyx	N/A	-/-; N	222,000[8]
Southern elephant seal	Mirounga leonina	N/A	-/-; N	607,000[8]

N/A = Not available or not assessed
1 Endangered Species Act (ESA) status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.
2 Abundance for the Southern Hemisphere or Antarctic unless otherwise noted
3 IWC (2016)
4 IWC (1981)
5 Boyd (2002)
6 Dwarf and Antarctic minke whales combined
7 All Antarctic beaked whales combined
8 Estimate for New Zealand; NZDOC 2017
9 Estimate for New Zealand; MacKenzie and Clement 2016
10 Estimate for New Zealand; Hamner *et al*. (2014) and Baker *et al*. (2016b)
11 Geschke and Chilvers (2009)

All species that could potentially occur in the proposed survey area are included in table 2. However, of the species described in Table 2, the temporal and/or spatial occurrence of one subspecies, the Maui dolphin, is such that take is not expected to occur as a result of the proposed project. The Maui dolphin is one of two subspecies of Hectors's dolphin (the other being the South Island Hector's dolphin), both of which are endemic to New Zealand. The Maui dolphin has been demonstrated to be genetically distinct from the South Island subspecies of Hector's dolphin based on studies of mitochondrial and nuclear DNA (Pichler et al. 1998). It is currently considered one of the rarest dolphins in the world with a population size estimated at just 55–63 individuals (Hamner et al. 2014; Baker et al. 2016b). Historically, Hector's dolphins are thought to have ranged along almost the entire coastlines of both the North and South Islands of New Zealand, though their present range is substantially smaller (Pichler 2002). The range of the Maui dolphin in particular has undergone a marked reduction (Dawson et al. 2001; Slooten et al. 2005), with the subspecies now restricted to the northwest coast of the North Island, between Maunganui Bluff in the north and Whanganui in the south (Currey et al., 2012). Occasional sightings and strandings have also been reported from areas further south along the west coast as well as possible sightings in other areas such as Hawke's Bay on the east coast of North Island (Baker 1978, Russell 1999, Ferreira and Roberts 2003, Slooten et al. 2005, DuFresne 2010, Berkenbusch et al. 2013; Torres et al. 2013; Patiño-Pérez 2015; NZDOC 2017) though it is unclear whether those individuals may have originated from the South Island Hector's dolphin populations. A 2016 NMFS Draft Status Review Report concluded the Maui dolphin is facing a high risk of extinction as a result of small population size, reduced genetic diversity, low theoretical population growth rates, evidence of continued population decline, and the ongoing threats of fisheries bycatch, disease, mining and seismic disturbances (L. Manning and K. Grantz, 2016). Due to its extremely low population size and the fact that the subspecies is not expected to occur in the proposed survey areas off the North Island, take of Maui dolphins is not expected to occur as a result of the proposed activities and is not authorized by NMFS.

NMFS reviewed L-DEO's species descriptions, including life history information, distribution, regional distribution, diving behavior, and acoustics and hearing, for accuracy and completeness. Below, for the 38 species that are likely to be taken by the activities described, we offer a brief introduction to the species and relevant stock as well as available information regarding population trends and threats, and describe any information regarding local occurrence.

3.2.2.1 ESA-Listed Species

Southern right whale

The southern right whale occurs throughout the Southern Hemisphere between ~20°S and 60°S (Kenney 2009). Southern right whales calve in nearshore coastal waters during the winter and typically migrate to offshore feeding grounds during summer (Patenaude 2003). Wintering populations off the subantarctic Auckland Islands of New Zealand spend the majority of their time resting or engaging in social interactions regardless of their group type (e.g. single whale, group, and mother-calf pair). Over 35% of mother-calf pairs in the area were seen traveling (Patenaude and Baker 2001).

Southern right whale sounds and their role in communication have been fully described by Clark (1983) and are categorized into three general classes (blow, slaps, and calls). Calls are generally low frequency (peak frequencies < 500 Hertz (Hz)) and one common call—'Up'—has been described to function as a way for individuals to find and make contact with each other. The available information suggests that southern right whales could be migrating near or within the proposed survey areas during October–March, with the possibility of some individuals calving in nearshore waters off eastern North Island during November. Habitat use (Torres et al. 2013c) and suitability modeling (Patiño-Pérez 2015) for New Zealand showed that a large proportion of the proposed North and South Island survey areas (mainly in deeper water) has low habitat suitability for the southern right whale; sheltered coastal areas had the highest habitat suitability, especially in Foveaux Strait between South and Stewart Islands.

Sei whale

The sei whale occurs in all ocean basins (Horwood 2009) but appears to prefer mid-latitude temperate waters (Jefferson et al. 2008). It undertakes seasonal migrations to feed in subpolar latitudes during summer and returns to lower latitudes during winter to calve (Horwood 2009). The sei whale is pelagic and generally not found in coastal waters (Harwood and Wilson 2001). It occurs in deeper waters characteristic of the continental shelf edge region (Hain et al. 1985) and in other regions of steep bathymetric relief such as seamounts and canyons (Kenney and Winn 1987; Gregr and Trites 2001). In the South Pacific, sei whales typically concentrate between the sub-tropical and Antarctic convergences during the summer (Horwood 2009). The sei whale is likely to be uncommon in the proposed survey areas during October–March.

Fin whale

Fin whales are found throughout all oceans from tropical to polar latitudes, however, its overall range and distribution is not well known (Jefferson et al. 2015). The fin whale most commonly occurs offshore but can also be found in coastal areas (Aguilar 2009). Most populations migrate seasonally between temperate waters where mating and calving occur in winter, and polar waters where feeding occurs in summer (Aguilar 2009). However, recent evidence suggests that some animals may remain at high latitudes in winter or low latitudes in summer (Edwards et al. 2015). Northern and southern fin whale populations are distinct and are sometimes recognized as different subspecies (Aguilar 2009). In the Southern Hemisphere, fin whales are usually distributed south of 50ºS in the austral summer, and they migrate northward to breed in the winter (Gambell 1985).

Blue whale

The blue whale has a cosmopolitan distribution and tends to be pelagic, only coming nearshore to feed and possibly to breed (Jefferson et al. 2008). Blue whale migration is less well defined than for some other rorquals, and their movements tend to be more closely linked to areas of high primary productivity, and hence prey, to meet their high energetic demands (Branch et al. 2007). Generally, blue whales are seasonal migrants between high latitudes in the summer, where they

feed, and low latitudes in the winter, where they mate and give birth (Lockyer and Brown 1981). Some individuals may stay in low or high latitudes throughout the year (Reilly and Thayer 1990; Watkins et al. 2000).

Three subspecies of blue whale are recognized: B. m. musculus in the Northern Hemisphere; B. m. intermedia (the true blue whale) in the Antarctic, and B. m. brevicauda (the pygmy blue whale) in the sub-Antarctic zone of the southern Indian Ocean and the southwestern Pacific Ocean (Sears and Perrin 2009). The pygmy and Antarctic blue whale occur in New Zealand (Branch et al. 2007). The blue whale is considered rare in the Southern Ocean (Sears and Perrin 2009). Most pygmy blue whales do not migrate south during summer; however, Antarctic blue whales are typically found south of 55ºS during summer, although some are known not to migrate (Branch et al. 2007).

Blue whale calls have been detected in New Zealand waters year-round (Miller et al. 2014). Vocalizations have been recorded within 2 km from Great Barrier Island, northern New Zealand, from June to December 1997 (McDonald 2006), as well as off the tip of Northland (Miller et al. 2014). Blue whale vocalizations were also detected along the west and east coasts of South Island during January–March 2013; these included songs detected in four locations off the southwest tip of the South Island in early February and at multiple locations south of Stewart Island in mid-March (Miller et al 2014). Southern Ocean blue whale songs were detected further offshore during May–July (McDonald 2006).Based on the available information, it is possible that pygmy blue whales could be encountered in the proposed survey areas during October–March.

Sperm whale

Sperm whales are found throughout the world's oceans in deep waters from the tropics to the edge of the ice at both poles (Leatherwood and Reeves 1983; Rice 1989; Whitehead 2002). Sperm whales throughout the world exhibit a geographic social structure where females and juveniles of both sexes occur in mixed groups and inhabit tropical and subtropical waters. Males, as they mature, initially form bachelor groups but eventually become more socially isolated and more wide-ranging, inhabiting temperate and polar waters as well (Whitehead 2003). Females typically inhabit waters >1000 m deep and latitudes <40º (Rice 1989). Torres et al. (2013a) found that sperm whale distribution is associated with proximity to geomorphologic features, as well as surface temperature

Sperm whales are widely distributed throughout New Zealand waters, occurring in offshore and nearshore regions, with decreasing abundance away from New Zealand toward the central South Pacific Ocean (Gaskin 1973). Sperm whale sightings have been reported throughout the year in and near the proposed North Island survey area, including the Bay of Plenty and off East Cape (Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b; Blue Planet Marine 2016; NZDOC 2017b), as well as in and near the South Island survey area (Berkenbusch et al. 2013; NZDOC 2017b). Although sightings have been made during the summer in the proposed North Island survey area, no summer sightings were reported for the South Island survey area. However, sightings were made just to the south of the proposed survey area during summer (Kasamatsu and Joynce 1995). There have been at least 211 strandings reported for New Zealand (Berkenbusch et al. 2013), including along the coast of East Cape, in Hawke's Bay, Cook Strait, and along the south coast of South Island (Brabyn 1991; NZDOC 2017b).

South Island Hector's dolphin and Maui dolphin

Hector's dolphins are endemic to New Zealand and have one of the most restricted distributions of any cetacean (Dawson and Slooten 1988); they occur in New Zealand waters year-round (Berkenbusch et al. 2013) and are found mainly in coastal waters, preferring depths of <90 m (Bräger et al. 2003; Rayment et al. 2006; Slooten et al. 2006) within 10 km from shore (Hutching 2015). Two subspecies of Hector's dolphins, the South Island Hector's dolphin (C. hectori hectori) and Maui dolphin (C. hectori maui) (also known as the North Island Hector's dolphin) have been formally recognized on the basis of multiple morphological distinctions and genetic evidence of reproductive isolation (Baker et al., 2002; Pichler 2002, Hamner et al., 2014). Historically, Hector's dolphins are thought to have ranged along almost the entire coastlines of both the North and South Islands of New Zealand, though their present range is substantially smaller (Pichler 2002).

The South Island subpopulation of Hector's dolphin is found only off the coast of the South Island of New Zealand (Manning and Grantz, 2016). There are at least three genetically separate populations of Hector's dolphin off South Island: off the east coast (particularly around Banks Peninsula), off the west coast, and off the Southland coast of southern South Island (Baker et al. 2002). The majority of Hector's dolphins off the South Island are found along the West Coast (between Farewell Spit and Milford Sound) with the remainder (about 1200 to 2900) found along the East Coast (from Farewell Spit to Nugget Point) and South Coast (from Nugget Point to Long Point) (Dawson et al. 2004). The South Island Hector's dolphin is listed under the ESA as threatened.

The North Island subpopulation of Hector's dolphin, known as the Maui dolphin, is found only off the coast of the North Island of New Zealand and is currently considered one of the rarest dolphins in the world, with a population size estimated at just 55–63 individuals (Hamner *et al*. 2014; Baker *et al*. 2016). The range of the Maui dolphin has undergone a marked reduction (Dawson *et al.* 2001; Slooten *et al.* 2005), with the subspecies now restricted to the northwest coast of the North Island, between Maunganui Bluff in the north and Whanganui in the south (Currey *et al*., 2012). A 2016 NMFS Draft Status Review Report concluded the Maui dolphin is facing a high risk of extinction as a result of small population size, reduced genetic diversity, low theoretical population growth rates, evidence of continued population decline, and the ongoing threats of fisheries bycatch, disease, mining and seismic disturbances (Manning and Grantz, 2016). The Maui dolphin is listed under the ESA as endangered.

3.2.2.2 Non-ESA Listed Species

Bryde's whale

The Bryde's whale occurs in all tropical and warm temperate waters in the Pacific, Atlantic, and Indian oceans, between 40°N and 40°S (Kato and Perrin 2009). It is one of the least known large baleen whales, and it remains uncertain how many species are represented in this complex (Kato and Perrin 2009). Bryde's whales remain in warm (>16°C) water year-round, and seasonal movements towards the Equator in winter and offshore in summer have been recorded (Kato and Perrin 2009). The Bryde's whale is likely to occur in the Bay of Plenty in the proposed North Island survey area; it is unlikely to occur anywhere else in the North Island or South Island survey areas.

Humpback whale

Humpback whales are found worldwide in all ocean basins. In winter, most humpback whales occur in the subtropical and tropical waters of the Northern and Southern Hemispheres (Muto et

al., 2016). These wintering grounds are used for mating, giving birth, and nursing new calves. In the South Pacific Ocean, there are several distinct winter breeding grounds, including eastern Australia and Oceania (Anderson et al. 2010; Garrigue et al. 2011; Bettridge et al. 2015). Whales from Oceania migrate past New Zealand to Antarctic summer feeding areas (Constantine et al. 2007; Garrigue et al. 2000, 2010); migration from eastern Australia past New Zealand has also been reported (Franklin et al. 2014). The northern migration along the New Zealand coast occurs from May to August, with a peak in late June to mid-July; the southern migration occurs from September to December, with a peak in late October to late November (Dawbin 1956). It is likely that some humpback whales would be encountered in the survey area during November and December, as they migrate from winter breeding areas in the tropics to summer feeding grounds in the Antarctic. Fewer humpbacks are expected to occur in the proposed survey areas during January through March, as most individuals occur further south during the summer. Humpback whales were listed as endangered under the Endangered Species Conservation Act (ESCA) in June 1970. In 1973, the ESA replaced the ESCA, and humpbacks continued to be listed as endangered. NMFS recently evaluated the status of the species, and on September 8, 2016, NMFS divided the species into 14 distinct population segments (DPS), removed the current species-level listing, and in its place listed four DPSs as endangered and one DPS as threatened (81 FR 62259; September 8, 2016). The remaining nine DPSs were not listed. The only DPSs with the potential to occur in the proposed survey areas would be the Oceania DPS and the Eastern Australia DPS; neither of these DPSs is listed under the ESA (81 FR 62259; September 8, 2016).

Minke whale

The minke whale has a cosmopolitan distribution ranging from the tropics and sub-tropics to the ice edge in both hemispheres (Jefferson et al. 2015). Its distribution in the Southern Hemisphere is not well known (Jefferson et al. 2015). Populations of minke whales around New Zealand are migratory (Baker 1983). Clement (2010) noted that minke whales likely use East Cape to navigate along the east coast of New Zealand during the northern and southern migrations. Small groups of minke whales have been sighted off New Zealand (Baker 1999; Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b; Patiño-Pérez 2015). Minke whales, particularly common minke whales, could be encountered during the proposed surveys.

Antarctic minke whale

The Antarctic minke whale has a circumpolar distribution in coastal and offshore areas of the Southern Hemisphere from ~7°S to the ice edge (Jefferson et al. 2015). Antarctic minke whales are found between 60°S and the ice edge during the austral summer(December to February); in the austral winter(June to August), they are mainly found at breeding grounds at mid latitudes, including 10°S–30°S and 170°E–100°W in the Pacific, off eastern Australia (Perrin and Brownell 2009). Antarctic minke whales would be less likely to be encountered during the time of the proposed surveys, because they would be expected to be in their summer feeding areas further south.

Pygmy right whale

The pygmy right whale is the smallest, most cryptic and least known of the living baleen whales. Pygmy right whales are found individually or in pairs, although groups of up to 80 whales have been observed. Although little is known about them, it is thought that pygmy right whales do not exhibit common behaviors of other whales such as breaching or displaying their flukes. In one case, a pygmy right whale was observed swimming by undulating the body from head to tail

rather than swimming using movement of the tail area and flukes like other cetaceans. Pygmy right whales are strong, fast swimmers (Fordyce 2013).

The pygmy right whale's distribution is circumpolar in the Southern Hemisphere between 30°S and 55°S in oceanic and coastal environments (Kemper 2009; Jefferson et al. 2015). Pygmy right whales appear to be non-migratory, although there may be some movement inshore during spring and summer (Kemper 2002). Strandings appear to be associated with favorable feeding areas in New Zealand, including upwelling regions, along the Subtropical Convergence, and the Southland Current (Kemper 2002; Kemper et al. 2013). Despite the scarcity of sightings, Kemper (2009) noted that the number of strandings indicate that the pygmy right whale may be relatively common in Australia and New Zealand. In spite of the lack of sightings, it is possible that this species could be encountered during the proposed surveys off the North or South Islands.

Pygmy sperm whale

Pygmy sperm whales are found in tropical and warm-temperate waters throughout the world (Ross and Leatherwood 1994) and prefer deeper waters with observations of this species in greater than 4,000 m depth (Baird et al., 2013). Sightings are rare of this species. They are difficult to sight at sea, because of their dive behavior and perhaps because of their avoidance reactions to ships and behavior changes in relation to survey aircraft (Würsig et al. 1998). Both pygmy and dwarf sperm whales are sighted primarily along the continental shelf edge and slope and over deeper waters off the shelf (Jefferson et al. 2008).

There have been very few sightings of pygmy sperm whales in New Zealand. The lack of sightings is likely because of their subtle surface behavior and long dive times (Clement 2010). However, the pygmy sperm whale is one of the most regularly stranded cetacean species in New Zealand, suggesting that this species is relatively common in those waters (Clement 2010). Pygmy sperm whales are likely to occur near the North Island survey area but are less likely to occur in the South Island survey area.

Cuvier's beaked whale

Cuvier's beaked whale is the most widespread of the beaked whales occurring in almost all temperate, subtropical, and tropical waters and even some sub-polar and polar waters (MacLeod et al. 2006). It is found in deep water over and near the continental slope (Jefferson et al. 2008). Cuvier's beaked whale is probably the most widespread of the beaked whales, although it is not found in polar waters (Heyning 1989). New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of Cuvier's beaked whales in the proposed survey area (MacLeod et al. 2006; Thompson et al. 2013).

Cuvier's beaked whales strand relatively frequently in New Zealand; at least 82 strandings have been reported (Berkenbusch et al. 2013). For the North Island, strandings have been reported for the Bay of Plenty, East Cape, Mahia Peninsula, Hawke's Bay, as well as Cook Strait; strandings have occurred along all coasts of South Island (Brabyn 1991; Clement 2010; Thompson et al. 2013). Strandings have been reported throughout the year, with a peak during fall (Thompson et al. 2013). Cuvier's beaked whale could be encountered in the deeper offshore areas during the proposed surveys.

Arnoux's beaked whale

Arnoux's beaked whale is distributed in deep, temperate and subpolar waters of the Southern Hemisphere, with most records for southeast South America, the Antarctic Peninsula, South Africa, New Zealand, and southern Australia (Jefferson et al. 2015). It typically occurs south of 40ºS, but it could reach latitudes of 34ºS or even farther north (Jefferson et al. 2015). Arnoux's beaked whale strands frequently in New Zealand (Ross 2006), with strandings reported for the northwest coast of North Island, Bay of Plenty, Hawke's Bay, and Cook Strait (Clement 2010; Thompson et al. 2013). MacLeod et al. (2006) reported numerous strandings of Berardius spp. for New Zealand. One sighting has been made in the Bay of Plenty (Clement 2010).

Shepherd's beaked whale

Based on known records, it is likely that Shepherd's beaked whale has a circumpolar distribution in the cold temperate waters of the Southern Hemisphere (Mead 1989a). This species is primarily known from strandings, most of which have been recorded in New Zealand (Mead 2009). Thus, MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for Shepherd's beaked whale. However, only a few sightings of live animals have been reported for New Zealand (MacLeod and Mitchell 2006). One possible sighting was made near Christchurch (Watkins 1976). In 2016, there were two sightings of Shepherd's beaked whale on a winter survey offshore from the Otago Peninsula on the South Island (NZDOC 2017b). At least 20 specimens have stranded on the coast of New Zealand (Baker 1999), including in southern Taranaki Bight and Banks Peninsula (Brabyn 1991). Stranding records also exist for Mahia Peninsula and northeastern North Island (Thompson et al. 2013).

Hector's beaked whale

Hector's beaked whale is thought to have a circumpolar distribution in deep oceanic temperate waters of the Southern Hemisphere (Pitman 2002). Based on the number of stranding records for the species, it appears to be relatively rare. One individual was observed swimming close to shore off southwestern Australia for periods of weeks before disappearing (Gales et al. 2002). This was the first live sighting in which species identity was confirmed.

MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for this species. There are sighting and stranding records of Hector's beaked whales for New Zealand (MacLeod et al. 2006; Clement 2010). One sighting has been reported for the Bay of Plenty on the North Island (Clement 2010). At least 12 strandings have been reported for New Zealand (Berkenbusch et al. 2013), including records for the Bay of Plenty, East Cape, Mahia Peninsula, Hawke's Bay, Cook Strait, and the east coast of South Island (Brabyn 1991; Clement 2010; Thompson et al. 2013; NZDOC 2017b).

True's beaked whale

True's beaked whale has a disjunct, antitropical distribution in the Northern and Southern hemispheres (Jefferson et al. 2015). In the Southern Hemisphere, it is known to occur in the Atlantic and Indian oceans, including Brazil, South Africa, Madagascar, and southern Australia (Jefferson et al. 2015). There is a single record of True's beaked whale in New Zealand, which stranded on the west coast of South Island in November 2011 (Constantine et al. 2014).

Southern bottlenose whale

The southern bottlenose whale can be found throughout the Southern Hemisphere from 30°S to the ice edge, with most sightings occurring from ~57° S to 70° S (Jefferson et al. 2015). It is apparently migratory, occurring in Antarctic waters during summer (Jefferson et al. 2015). New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of southern bottlenose whales in the area (MacLeod et al. 2006). At

least six sightings have been reported for waters around New Zealand, including one in Hauraki Gulf, one on the southwest coast of South Island, one off the east coast of North Island within the proposed survey area, one off the Otago Peninsula, and two sightings south of New Zealand within the EEZ (Berkenbusch et al. 2013; NZDOC 2017b). In addition, 24 strandings were reported for New Zealand between 1970 and 2013 (Berkenbusch et al. 2013). Strandings have been reported for Bay of Plenty, East Cape, Hawke's Bay, southern North Island, northeastern South Island, and Cook Strait (Brabyn 1991; Clement 2010; Thompson et al. 2013). The southern bottlenose whale could be encountered during the proposed surveys.

Gray's beaked whale

Gray's beaked whale is thought to have a circumpolar distribution in temperate waters of the Southern Hemisphere (Pitman 2002). Gray's beaked whale primarily occurs in deep waters beyond the edge of the continental shelf (Jefferson et al. 2015). Some sightings have been made in very shallow water, usually of sick animals coming in to strand (Gales et al. 2002; Dalebout et al. 2004). One Gray's beaked whale was observed within 200 m of the shore off southwestern Australia off and on for periods of weeks before disappearing (Gales et al. 2002). There are many sighting records from Antarctic and sub-Antarctic waters, and in summer months they appear near the Antarctic Peninsula and along the shores of the continent (sometimes in the sea ice).

New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of Gray's beaked whales in the proposed survey area (MacLeod et al. 2006; Thompson et al. 2013). In particular, the area between the South Island of New Zealand and the Chatham Islands has been suggested to be a hotspot for sightings of this species (Dalebout et al. 2004). As a result, Gray's beaked whale could be encountered during the proposed surveys.

Andrew's beaked whale

Andrew's beaked whale has a circumpolar distribution in temperate waters of the Southern Hemisphere (Baker 2001). This species is known only from stranding records between 32°S and 55°S, with more than half of the strandings occurring in New Zealand (Jefferson et al. 2015). Thus, New Zealand may be a globally important area for Andrew's beaked whale (MacLeod and Mitchell 2006). In particular, Clement (2010) suggested that the East Cape/Hawke's Bay waters may be an important habitat for Andrew's beaked whale.

There have been at least 19 strandings in New Zealand (Berkenbusch et al. 2013), at least 10 of which have been reported in the spring and summer (Baker 1999). Strandings have occurred from the North Island to the sub-Antarctic Islands (Baker 1999), including East Cape, Hawke's Bay, Cook Strait, and southeast of Stewart Island (Brabyn 1991; Clement 2010; Thompson et al. 2013). Andrew's beaked whale could be encountered during the proposed surveys.

Strap-toothed beaked whale

The strap-toothed beaked whale is thought to have a circumpolar distribution in temperate and sub-Antarctic waters of the Southern Hemisphere, mostly between 35° and 60°S (Jefferson et al. 2015). Based on the number of stranding records, it appears to be fairly common. Strap-toothed whales are thought to migrate northward from Antarctic and sub-Antarctic latitudes during April–September (Sekiguchi et al. 1996).

New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of strap-toothed beaked whales adjacent to the proposed survey area (MacLeod et al. 2006; Clement 2010; Thompson et al. 2013). Strap-toothed whales commonly strand in New Zealand, with at least 78 strandings reported (Berkenbusch et al. 2013). Most strandings occur between January and April, suggesting some seasonal austral summer inshore migration (Baker 1999; Thompson et al. 2013). Strap-toothed whale strandings have been reported for the east coast of North Island and South Island, including the Bay of Plenty, East Cape, Hawke's Bay, Cook Strait, the Otago Peninsula and along Foveaux Strait (Brabyn 1991; Clement 2010; Thompson et al. 2013). The strap-toothed beaked whale could be encountered during the proposed surveys.

Blainville's beaked whale

Blainville's beaked whale is found in tropical and warm temperate waters of all oceans; it has the widest distribution throughout the world of all mesoplodont species and appears to be common (Pitman 2009). In the western Pacific, strandings have been reported from Japan to Australia and New Zealand (MacLeod et al. 2006). There have been at least four strandings of Blainville's beaked whale in New Zealand, including three strandings for the northwest coast of North Island and another for Hawke's Bay, but none for the South Island (Thompson et al. 2013a). Blainville's beaked whale could be encountered during the proposed surveys.

Spade-toothed beaked whale

The spade-toothed beaked whale is the name proposed for the species formerly known as Bahamonde's beaked whale (M. bahamondi). Recent genetic evidence has shown that they belong to the species first identified by Gray in 1874 (van Helden et al. 2002). The species is considered relatively rare and is known from only four records, three of which are from New Zealand (Thompson et al. 2012). One mandible was found at the Chatham Islands in 1872; two skulls were found at White Island, Bay of Plenty, in the 1950s; a skull was collected at Robinson Crusoe Island, Chile, in 1986; and most recently, two live whales, a female and a male, stranded at Opape, in the Bay of Plenty, and subsequently died (Thompson et al. 2012). MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for the spade-toothed beaked whale. The spade-toothed beaked whale is unlikely to be encountered during the proposed surveys.

Bottlenose dolphin

Bottlenose dolphins are widely distributed throughout the world in tropical and warm-temperate waters (Perrin et al. 2009). Generally, there are two distinct bottlenose dolphin ecotypes: one mainly found in coastal waters and one mainly found in oceanic waters (Duffield et al. 1983; Hoelzel et al. 1998; Walker et al. 1999). As well as inhabiting different areas, these ecotypes differ in their diving abilities (Klatsky 2004) and prey types (Mead and Potter 1995).

Short-beaked common dolphin

The short-beaked common dolphin is found in tropical to cool temperate oceans around the world, and ranges as far south as ~40°S (Perrin 2009). It is generally considered an oceanic species (Jefferson et al. 2015), but Neumann (2001) noted that this species can be found in coastal and offshore habitats. Short-beaked common dolphins are found in shelf waters of New Zealand, generally north of Stewart Island; they are more commonly seen in waters along the northeastern coast of North Island (Stockin and Orams 2009; NABIS 2017) and may occur closer to shore during the summer (Neumann 2001; Stockin et al. 2008). They can be found all around New Zealand (Baker 1999) with abundance hotspots on the coasts of Northland, Hauraki Gulf,

Mahia Peninsula, Cape Palliser, Cook Strait, Marlborough Sounds, and the northwest coast of South Island (NABIS 2017).

The short-beaked common dolphin is likely the most common cetacean species in New Zealand waters, occurring there year-round (Clement 2010; Hutching 2015). Numerous sightings have been made in shelf waters of the east coast of North and South Islands, as well as farther offshore, throughout the year, including within the proposed survey areas (Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b; Patiño-Pérez 2015; Blue Planet Marine 2016; NZDOC 2017b). As sightings have been made within the North Island and South Island survey areas during austral spring and summer, this species is likely to be encountered during the proposed surveys.

Dusky dolphin

The dusky dolphin is found throughout the Southern Hemisphere, occurring in disjunct subpopulations in the waters off southern Australia, New Zealand (including some sub-Antarctic Islands), central and southern South America, and southwestern Africa (Jefferson et al. 2015). The species occurs in coastal and continental slope waters and is uncommon in waters >2000 m deep (Würsig et al 2007). The dusky dolphin is common in New Zealand (Hutching 2015) and occurs there year-round. Dusky dolphins migrate northward to warmer waters in winter and south during the summer (Gaskin 1968).

Sightings of dusky dolphins exist for shelf as well as deep, offshore waters (Berkenbusch et al. 2013). Würsig et al. (2007) noted that dusky dolphins typically move into deeper waters during the winter. Sightings have been made in and near the proposed North and South Island survey areas during summer (see Clement 2010; Berkenbusch et al. 2013; Patiño-Pérez 2015; Blue Planet Marine 2016; NZDOC 2017b). Some sightings in the austral spring and summer have been made along Northland, Bay of Plenty, off East Cape, southeast coast of North Island, Cape Palliser, and Cook Strait (Berkenbusch et al. 2013; NZDOC 2017b). However, sightings off the entire coastline of South Island appear to be more common and are made throughout the year. As a result, the dusky dolphin is likely to be encountered during the proposed surveys, especially off the South Island.

Hourglass dolphin

The hourglass dolphin occurs in all parts of the Southern Ocean south of ~45°S, with most sightings between 45°S and 60°S (Goodall 2009). Although it is pelagic, it is also sighted near banks and Islands (Goodall 2009). Baker (1999) noted that the hourglass dolphin is considered a rare coastal visitor to New Zealand. Berkenbusch et al. (2013) reported five sightings of hourglass dolphins in New Zealand waters, including one off Banks Peninsula, one off the southeast coast of South Island, two within the proposed South Island survey, and one southwest of the Auckland Islands. All sightings were made during November–February. In addition, there have been at least five strandings in New Zealand (Berkenbusch et al. 2013), including records for the South Island (Baker 1999). Due to these observations, the hourglass dolphin would likely be rare in the proposed North survey area and uncommon in the South Island survey area.

Southern right whale dolphin

The southern right whale dolphin is distributed between the Subtropical and Antarctic Convergences in the Southern Hemisphere, generally between ~30ºS and 65ºS (Jefferson et al. 2015). It is sighted most often in cool, offshore waters, although it is sometimes seen near shore where coastal waters are deep (Jefferson et al. 2015). The species has rarely been seen at sea in

New Zealand (Baker 1999). Berkenbusch et al. (2013) reported five sightings for the EEZ of New Zealand, including one each off the southeast coast and southwest coast of South Island, and three to the southeast of Stewart Island; sightings were made during February and September. During August 1999, a group 500+ southern right whale dolphins including a calf were sighted southeast of Kaikoura in water >1500 m deep (Visser et al. 2004). There were five additional sightings in the OBIS database, including one sighting in the South Taranaki Bight, two sightings southeast of Kaikoura during 1985–1986, and two sightings off the southwest coast of South Island (OBIS 2017). Several more sightings have also been reported off the southeast coast of South Island (NZDOC 2017b).

At least 16 strandings have been reported for New Zealand (Berkenbusch et al. 2013). Most strandings have occurred along the north coast of South Island (Brabyn 1991), but strandings were also reported for Hawke's Bay, southeast North Island, Banks Peninsula, and Foveaux Strait (Clement 2010; NZDOC 2017b). Due to this, the southern right whale dolphin could be encountered during the proposed North or South Island surveys.

Risso's dolphin

Risso's dolphins are found in tropical to warm-temperate waters (Carretta et al., 2016). The species occurs from coastal to deep water but is most often found in depths greater than 3,000 m with the highest sighting rate in depths greater than 4,500 m (Baird 2016) and is known to frequent seamounts and escarpments (Kruse et al. 1999). It occurs between 60ºN and 60ºS where surface water temperatures are at least 10ºC (Kruse et al. 1999).

According to Jefferson et al. (2014, 2015), the range of the Risso's dolphin includes the waters of New Zealand, although the number of records for that region is small. Nonetheless, a few records exist for the North Island, including the east coast (Clement 2010; Berkenbusch et al. 2013; Jefferson et al. 2014). Although some sightings have been reported in New Zealand, such as in South Taranaki Bight on the west coast of North Island (Torres 2012), only strandings are known for the east coast of North Island (Clement 2010). One stranding has been reported for the northwest coast of South Island (NZDOC 2017b).Risso's dolphin could be encountered during the proposed surveys.

False killer whale

The false killer whale is found in all tropical and warm temperate oceans of the world, with only occasional sightings in cold temperate waters (Baird 2009b). It is known to occur in deep, offshore waters (Odell and McClune 1999), but can also occur over the continental shelf and in nearshore shallow waters (Jefferson et al. 2015; Zaeschmar et al. 2014). In the western Pacific, the false killer whale is distributed from Japan south to Australia and New Zealand.

Berkenbusch et al. (2013) reported at least 27 sightings of false killer whales in New Zealand during summer and fall, primarily along the coast of North Island, but also off South Island and in South Taranaki Bight. In addition, there have been at least 28 strandings in New Zealand (Zaeschmar 2014), including along East Cape, Hawke's Bay, Cape Palliser, Cook Strait, Otago Peninsula, and Catlin's coast (Brabyn 1991; Clement 2010; NZDOC 2017b). The strandings include a mass stranding on North Island (~37°S) of 231 whales in March 1978 (Baker 1999). Due to this, false killer whales could be encountered during the proposed surveys.

Killer whale

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters (Heyning and Dahlheim

1988), killer whales prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). High densities of the species occur in high latitudes, especially in areas where prey is abundant.

The killer whale has been reported to be common in New Zealand waters (Baker 1999), with a population of ~200 individuals (Suisted and Neale 2004). Killer whales have been sighted in all months around North and South Islands (Berkenbusch et al. 2013; Torres 2012; NABIS 2017). Calves and juveniles occur there throughout the year (Visser 2000). Only the Type A killer whale is considered resident in New Zealand, while Types B, C, and D are vagrant and most common in the Southern Ocean (Visser 2000, 2007; Baker et al. 2010, 2016a). As sighting of killer whales have been made near and within the survey areas during austral spring and summer, killer whales could occur in small numbers near the project areas.

Long-finned pilot whale

Long-finned pilot whales roam throughout the cold temperate waters of the Southern. They live in stable family groups, and offspring of both sexes stay in their mother's pod throughout their lives. Each pod numbers 20-100 whales, though they can congregate in much larger numbers. Pilot whales are prolific stranders, and this behaviour is not well understood. There are recordings of individual strandings all over New Zealand, and there are a few mass stranding "hotspots" at Golden Bay, Stewart Island, and the Chatham Islands. Due to this, it is possible for the proposed survey to encounter species.

Short-finned pilot whale

Short finned pilot whales tend to inhabit more sub-tropical and tropical zones. Although long-finned and short-finned pilot whales are readily distinguishable by differences in tooth count, flipper length, and skull morphology, it is almost impossible to distinguish between the two species at sea. The species prefers deeper waters, ranging from 324 m to 4,400 m, with most sightings between 500 m and 3,000 m (Baird 2016).

Short-finned pilot whale stranding records exist for the Bay of Plenty, East Cape, Hawke's Bay, off Banks Peninsula, and the southeast coast of South Island. While most pilot whales sighted south of ~40°S would likely be the long-finned variety, short-finned pilot whales could also be encountered during the survey, particularly off the northeast coast of North Island.

Spectacled porpoise

The spectacled porpoise is circumpolar in cool temperate, sub-Antarctic, and low Antarctic waters (Goodall 2009). It is thought to be oceanic in temperate to sub-Antarctic waters and is often sighted in deep waters far from land (Goodall 2009). Little is known regarding the distribution and abundance of the species, but it is believed to be rare throughout most of its range (Goodall and Schiavini 1995). Only five sightings were made during 10 years (1978/79–1987/88) of extensive Antarctic surveys for minke whales (Kasamatsu et al. 1990). An additional 23 at-sea sightings described in Sekiguchi et al. (2006) have expanded the knowledge of the species. The sightings were circumpolar, mostly in offshore waters with sea surface temperatures of 0.9–10.3°C, with a concentration south of the Auckland Islands (Sekiguchi et al. 2006). Sightings have been reported for the west coast of Northland and off the southeast coast of South Island (NZDOC 2017b). Strandings have occurred along the Bay of Plenty, South Taranaki Bight, Banks Peninsula, Otago Peninsula, Catlins Coast, and the Auckland Islands (NZDOC 2017b). The spectacled porpoise is rare; it is not expected to occur in the proposed North Island survey area but could occur off South Island.

New Zealand fur seal
New Zealand fur seals are found on rocky shores around the mainland, Chatham Islands and the Subantarctic islands (including Macquarie Island) of New Zealand. They are also found much further afield in South Australia, Western Australia and Tasmania. Off Otago, New Zealand fur seal's prey stay very deep underwater during the day, and then come closer to the surface at night. Here, fur seals feed almost exclusively at night, when prey is closer to the surface, as deep as 163 m during summer. Their summer foraging is concentrated over the continental shelf, or near the slope. They will dive continuously from sundown to sunrise. In autumn and winter, they dive much deeper with many dives greater than 100 m. At least some females dive deeper than 240 m, and from satellite tracking they may forage up to 200 km beyond the continental slope in water deeper than 1000 m (NZDOC 2017a).

On the east coast of North Island, there are at least 15 haul-out sites and three breeding areas between Cape Palliser and Bay of Plenty, including haul out sites along Hawke's Bay, on East Cape, and in the Bay of Plenty (Clement 2010). In addition, there are also at least two haul-out sites along the northeast coast of South Island (Taylor et al. 1995). Numerous nearshore and offshore sightings have been made within the proposed survey area east of North Island from seismic vessels off the southeast coast of North Island (Blue Planet Marine 2016; SIO n.d.). New Zealand fur seals would likely be encountered during the proposed surveys off the North and South Islands.

New Zealand sea lion
The New Zealand sea lion is New Zealand's only endemic pinniped. it is one of the world's rarest pinnipeds, with a highly restricted breeding range between 50°s and 53°s, primarily on the Auckland (50°S, 166°E) and Campbell islands (52°33 S, 169°09 E) (Gales & Fletcher 1999; McNally 2001; Childerhouse et al. 2005).

Sea lions that were satellite-tracked in the Auckland Islands during January and February foraged over the entire shelf out to a water depth of 500 m (Chilvers 2009; Meynier et al. 2014) and beyond (Geschke and Chilvers 2009), including near the southeastern-most edge of the proposed survey area. New Zealand sea lions are also known to forage on arrow squid near Snares Islands (Lalas and Webster 2013). Numerous nearshore and offshore sightings have been made off South Island from seismic vessels, including off the southeast coast, east of Stewart Island, and east of Snares Island (Blue Planet Marine 2016). It is possible that New Zealand sea lions would be encountered during the proposed survey off South Island, but unlikely that they would be encountered in the proposed survey areas off North Island.

Leopard seal
Adult leopard seals are normally found along the edge of the Antarctic pack ice but in winter, young animals move throughout the southern ocean visiting New Zealand. Auckland and Campbell islands are known to have leopard seals annually and the mainland regularly receives visitors (NZDOC 2017a). Although adult seals are typically found near the edge of the pack ice, young animals can travel far throughout the Southern Ocean and occasionally occur in New Zealand, including the Auckland and Campbell Islands, and the mainland (NZDOC 2017a). Numerous sightings have been made along the North and South Islands, not only in the winter but also during January–March (NZDOC 2017b). Sightings for the North Island include Cook Strait, Cape Palliser, the Bay of Plenty, and Hauruki Gulf; there is also one record for offshore waters of the study area off the southeast coast of North Island. For the South Island, sightings

have been reported on all coasts, including Forveaux Strait and Stewart Island off the south coast, and in offshore waters off the southeast coast of Stewart Island during January–March. Leopard seals are unlikely to be encountered during the proposed surveys.

Southern elephant seal

The southern elephant seal has a near circumpolar distribution in the Southern Hemisphere (Jefferson et al. 2015). However, the distribution of southern elephant seals does not typically extend to the proposed survey areas (NABIS 2017). Breeding colonies occur on some New Zealand sub-Antarctic Islands, including Antipodes and Campbell Islands (Suisted and Neale 2004); these are part of the Macquarie Island stock of southern elephant seals (Taylor and Taylor 1989). Pups are occasionally born during September–October on east coast beaches of the mainland, including the southern coast of South Island (between Oamaru and Nugget Point), Kaikoura Peninsula, and on the southeast coast of North Island (Taylor and Taylor 1989; Harcourt 2001).

Even though mainland New Zealand is not part of their regular distribution, juvenile southern elephant seals are sometimes seen over the shelf of South Island (van den Hoff et al. 2002; Field et al. 2004); there are numerous sightings along the southeastern and southwestern coasts of South Island in the marine mammal sightings and strandings database (NZDOC 2017b). Most sightings occur during the haul-out period in July and August and between November and January during the molt (van den Hoff 2001). Sightings have been made on the northeastern coast of South Island, including Kaikoura Peninsula (Harcourt 2001; van den Hoff 2001; NZDOC 2017b). Individuals have also occurred in the Bay of Plenty and Gisborne (Harcourt 2001); others have been seen in Wellington and other North Island beaches (Daniel 1971), and off Cape Palliser during the austral summer (NZDOC 2017b). It is possible that elephant seals could be encountered in the proposed survey areas.

3.3. Socioeconomic Environment

3.3.1. Subsistence

There are no subsistence harvests for marine mammals in this area of the southwestern Pacific Ocean. Therefore, we anticipate no impacts to the subsistence harvest of marine mammals in the region.

Chapter 4 Environmental Consequences

The National Marine Fisheries Service (NMFS) reviewed all possible direct, indirect, cumulative, short-term, and long-term impacts to protected species and their environment associated with NMFS' proposed action and alternatives. Based on this review, this section describes the potential environmental consequences for the affected resources described in Chapter 3.

4.1. Effects of Alternative 1 – Issuance of an IHA with Mitigation Measures

Under the Preferred Alternative, we would propose to issue an IHA to L-DEO allowing the take, by Level A and Level B harassment, of 38 species of marine mammals incidental to the proposed seismic surveys, subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the Authorization, if issued. We would incorporate the mitigation and monitoring measures and reporting described earlier in this EA into a final Authorization.

4.1.1. Impacts to Marine Mammal Habitat

The proposed action (i.e., the issuance of an IHA for the take of marine mammals) would not result in any permanent impacts to marine mammals' habitat and would have only minimal, short-term effects on prey species. The proposed survey would not result in substantial damage to ocean and coastal habitats that constitute marine mammal habitats as airgun sounds do not result in physical impacts to habitat features, including substrates and/or water quality, and no anchoring of the vessel will occur during the survey as the survey is planned in water depths where anchoring is not practicable. The primary potential impacts to marine mammal habitat associated with elevated sound levels produced by the seismic airguns would have a limited effect on prey species.

The overall response of fishes and squids from seismic surveys is to exhibit responses including no reaction or habituation (Peña, Handegard, & Ona, 2013) to startle responses and/or avoidance (Fewtrell & McCauley, 2012) and vertical and horizontal movements away from the sound source. McCauley et al. (2017) reported that experimental exposure to a 150 in^3 airgun pulse decreased zooplankton abundance when compared with controls, and caused a two- to threefold increase in dead adult and larval zooplankton. Impacts to marine mammal prey are expected to be limited due to the transient nature of the survey. Exploratory surveys such as these cover a large area but would be temporally ephemeral rather than focused in a given location over time. Therefore, impacts from the proposed surveys would not be considered chronic in any given location.

In summary, activities associated with the proposed action are not likely to have a permanent, adverse effect on any fish habitat or populations of fish species or on the quality of acoustic habitat. Thus, any impacts to marine mammal habitat are not expected to cause significant or long-term consequences for individual marine mammals or their populations.We expect that the seismic survey would have no more than a temporary and minimal adverse effect on any fish or invertebrate species. Although there is a small potential for injury to fish or marine life in close proximity to the vessel, we expect that the impacts of the seismic survey on fish and other marine life specifically related to acoustic activities would be temporary in nature, negligible, and would not result in substantial impact to these species' role in the ecosystem.

4.1.2. Impacts to Marine Mammals

We expect that L-DEO's seismic survey has the potential to take marine mammals by harassment, as defined by the MMPA. Acoustic stimuli generated by the airgun array may affect marine mammals in one or more of the following ways: behavioral disturbance, tolerance,

masking of natural sounds, and temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al., 1995).

Our *Federal Register* notice of proposed Authorization (82 FR 45116, September 27, 2017) and L-DEO's application (LGL, 2017) provide detailed descriptions of these potential effects of seismic surveys on marine mammals. Potentinal effects are outlined below.

The effects of noise on marine mammals are highly variable, ranging from minor and negligible to potentially significant, depending on the intensity of the source, the distances between the animal and the source, and the overlap of the source frequency with the animals' audible frequency. Nevertheless, monitoring and mitigation measures required by NMFS for L-DEO's proposed activities would effectively reduce any significant adverse effects of these sound sources on marine mammals. The following descriptions summarize acoustic effects resulting from the use of airguns:

Behavioral Disturbance: The studies discussed in the *Federal Register* notice for the proposed Authorization (82 FR 45116, September 27, 2017) note that there is variability in the behavioral responses of marine mammals to noise exposure. It is important to consider context in predicting and observing the level and type of behavioral response to anthropogenic signals (Ellison et al., 2012).

Marine mammals may react to sound when exposed to anthropogenic noise. These behavioral reactions are often shown as: changing durations of surfacing and dives; number of blows per surfacing; changing direction and/or speed; reduced/increased vocal activities; changing or cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (e.g., pinnipeds flushing into water from haulouts or rookeries). The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Richardson et al., 1995; Southall et al., 2007).

Studies have shown that underwater sounds from seismic activities are often readily detectable by marine mammals in the water at distances of many kilometers (Castellote, Clark, & Lammers, 2012; Castellote & Llorens 2016). Many studies have also shown that marine mammals at distances more than a few kilometers away often show no apparent response when exposed to seismic activities (e.g., Akamatsu et al, 1993; Harris, et al, 2001; Madsen & Møhl, 2000; Malme, Miles, Clark, Tyack, & Bird, 1983, 1984; Richardson, Würsig, & Greene Jr., 1986; Weir, 2008). Other studies have shown that marine mammals continue important behaviors in the presence of seismic pulses (e.g., Dunn & Hernandez, 2009; Greene Jr., Altman, & Richardson, 1999; Holst & Beland, 2010; Holst & Smultea, 2008; Holst, Smultea, Koski, & Haley, 2005; Nieukirk, Stafford, Mellinger, Dziak, & Fox, 2004; Richardson et al., 1986; Smultea, Holst, Koski, & Stoltz, 2004).

In a passive acoustic research program that mapped the soundscape in the North Atlantic Ocean, Clark and Gagnon (2006) reported that some fin whales in the southwest Pacific Ocean stopped singing for an extended period starting soon after the onset of a seismic survey in the area. The authors could not determine whether or not the whales left the area ensonified by the survey, but the evidence suggests that most, if not all, of the singers remained in the area. When the survey stopped temporarily, the whales resumed singing within a few hours and the number of singers increased with time. Also, one whale continued to sing while the seismic survey was actively operating (Figure 4, Clark & Gagnon, 2006). The authors concluded that there is not enough

scientific knowledge to adequately evaluate whether or not these effects on singing or mating behaviors are significant or would alter survivorship or reproductive success.

MacLeod et al. (2006) discussed the possible displacement of fin and sei whales related to distribution patterns of the species during a large-scale, offshore seismic survey along the west coast of Scotland in 1998. The authors hypothesized about the relationship between the whale's absence and the concurrent seismic activity, but could not rule out other contributing factors (Macleod et al., 2006; Parsons et al., 2009). We would expect that marine mammals may briefly respond to underwater sound produced by L-DEO's seismic survey by slightly changing their behavior or relocating a short distance. Based on the best available information, we expect short-term disturbance reactions that are confined to relatively small distances and durations (D. R. Thompson, Sjoberg, Bryant, Lovell, & Bjorge, 1998; P. M. Thompson et al., 2013), with no long-term effects on recruitment or survival of marine mammals.

McDonald et al. (1995) tracked blue whales relative to a seismic survey with a 1,600 in3 airgun array. One whale started its call sequence within 15 km (9.3 mi) from the source, then followed a pursuit track that decreased its distance to the vessel where it stopped calling at a range of 10 km (6.2 mi) (estimated received level at 143 dB re: 1 μPa (peak-to-peak)). After that point, the ship increased its distance from the whale which continued a new call sequence after approximately one hour and 10 km (6.2 mi) from the ship. The authors reported that the whale had taken a track paralleling the ship during the cessation phase but observed the whale moving diagonally away from the ship after approximately 30 minutes continuing to vocalize. Because the whale may have approached the ship intentionally or perhaps was unaffected by the airguns, the authors concluded that there was insufficient data to infer conclusions from their study related to blue whale responses (McDonald et al., 1995).

McCauley et al. (2000; 1998) studied the responses of migrating humpback whales off western Australia to a full-scale seismic survey with a 16-airgun array (2,678 in3) and to a single, 20-in3 airgun. Both studies point to a contextual variability in the behavioral responses of marine mammals to sound exposure. The mean received level for initial avoidance of an approaching airgun was 140 dB re: 1 μPa for humpback whale pods containing females. In contrast, some individual humpback whales, mainly males, approached within distances of 100 to 400 m (328 to 1,312 ft), where sound levels were 179 dB re: 1 μPa (McCauley et al., 2000). The authors hypothesized that the males gravitated towards the single operating air gun possibly due to its similarity to the sound produced by humpback whales breaching. Despite the evidence that some humpback whales exhibited localized avoidance reactions at received levels below 160 dB re: 1 μPa, the authors found no evidence of any gross changes in migration routes, such as inshore/offshore displacement during seismic operations (McCauley et al., 2000; McCauley et al., 1998).

DeRuiter et al. (2013) recently observed that beaked whales (considered a particularly sensitive species) exposed to playbacks (i.e., simulated) of U.S. Navy tactical mid-frequency active sonar from 89 to 127 dB re: 1 μPa at close distances responded notably by altering their dive patterns. In contrast, individuals showed no behavioral responses when exposed to similar received levels from actual U.S. Navy tactical mid-frequency active sonar operated at much further distances (DeRuiter et al., 2013). As noted earlier, one must consider the importance of context (e.g., the distance of a sound source from the animal) in predicting behavioral responses.

Tolerance: With repeated exposure to sound, many marine mammals may habituate to the sound at least partially (Richardson & Wursig, 1997). Bain and Williams (2006) examined the effects of a large airgun array (maximum total discharge volume of 1,100 in3) on six species in shallow waters off British Columbia and Washington: harbor seal, California sea lion (Zalophus

californianus), Steller sea lion (Eumetopias jubatus), gray whale (Eschrichtius robustus), Dall's porpoise (Phocoenoides dalli), and the harbor porpoise. Harbor porpoises showed reactions at received levels less than 145 dB re: 1 μPa at a distance of greater than 70 km (43 miles) from the seismic source (Bain & Williams, 2006). However, the tendency for greater responsiveness by harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson et al., 1995; Southall et al., 2007). In contrast, the authors reported that gray whales seemed to tolerate exposures to sound up to approximately 170 dB re: 1 μPa (Bain & Williams, 2006) and Dall's porpoises occupied and tolerated areas receiving exposures of 170–180 dB re: 1 μPa (Bain & Williams, 2006; Parsons et al., 2009). The authors observed several gray whales that moved away from the airguns toward deeper water where sound levels were higher due to propagation effects resulting in higher noise exposures (Bain & Williams, 2006). However, it is unclear whether their movements reflected a response to the sounds (Bain & Williams, 2006). Thus, the authors surmised that the lack of gray whale responses to higher received sound levels were ambiguous at best because one expects the species to be the most sensitive to the low-frequency sound emanating from the airguns (Bain & Williams, 2006).

Pirotta et al. (2014) observed short-term responses of harbor porpoises to a 2-D seismic survey in an enclosed bay in northeast Scotland which did not result in broad-scale displacement. The harbor porpoises that remained in the enclosed bay area reduced their buzzing activity by 15% during the seismic survey (Pirotta et al., 2014). Thus, animals exposed to anthropogenic disturbance may make trade-offs between perceived risks and the cost of leaving disturbed areas (Pirotta et al., 2014). However, unlike the semi-enclosed environment described in the Scottish study area, L-DEO's seismic study occurs in the open ocean. Because L-DEO would conduct the survey in an open ocean area, we do not anticipate that the seismic survey would entrap marine mammals between the sound source and the shore as marine mammals can temporarily leave the survey area during the operation of the airgun(s) to avoid acoustic harassment.

Masking: Studies have shown that marine mammals are able to compensate for masking by adjusting their acoustic behavior such as shifting call frequencies and increasing call volume and vocalization rates. For example, blue whales increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio & Clark, 2010). North Atlantic right whales exposed to high shipping noise increased call frequency (Parks, Clark, & Tyack, 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller, Biassoni, Samuels, & Tyack, 2000).

Risch et al. (2012) documented reductions in humpback whale vocalizations in the Stellwagen Bank National Marine Sanctuary concurrent with transmissions of the Ocean Acoustic Waveguide Remote Sensing (OAWRS) low-frequency fish sensor system at distances of 200 km from the source. The recorded OAWRS produced series of frequency modulated pulses and the signal received levels ranged from 88 to 110 dB re: 1 μPa (Risch et al., 2012). The authors hypothesized that individuals did not leave the area but instead ceased singing and noted that the duration and frequency range of the OAWRS signals (a novel sound to the whales) were similar to those of natural humpback whale song components used during mating (Risch et al., 2012). Thus, the novelty of the sound to humpback whales in the study area provided a compelling contextual probability for the observed effects (Risch et al., 2012). However, the authors did not state or imply that these changes had long-term effects on individual animals or populations (Risch et al., 2012).

We expect that masking effects of seismic pulses would be limited in the case of smaller odontocetes given the intermittent nature of seismic pulses in addition to the fact that sounds

important to them are predominantly at much higher frequencies than are the dominant components of airgun sounds.

Hearing Impairment: Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (Akamatsu et al. 1993), which is the loss of hearing sensitivity at certain frequency ranges (Finneran, Carder, Schlundt, & Ridgway, 2005; Finneran & Schlundt, 2013; Finneran et al., 2000; Kastak & Schusterman, 1998; Kastak, Schusterman, Southall, & Reichmuth, 1999; C. E. Schlundt, J. J. Finneran, B. K. Branstetter, J. S. Trickey, & Jenkins, 2013; C. R. Schlundt, Finneran, Carder, & Ridgway, 2000).

Lucke et al. (2009) found a threshold shift (Akamatsu et al. 1993) of a harbor porpoise after exposing it to airgun noise with a received sound pressure level (SPL) at 200.2 dB (peak –to-peak) re: 1 μPa, which corresponds to a sound exposure level of 164.5 dB re: 1 μPa2 s after integrating exposure. NMFS currently uses the root-mean-square (rms) of received SPL at 180 dB and 190 dB re: 1 μPa as the threshold above which permanent threshold shift (PTS) could occur for cetaceans and pinnipeds, respectively. Because the airgun noise is a broadband impulse, one cannot directly determine the equivalent of rms SPL from the reported peak-to-peak SPLs. However, applying a conservative conversion factor of 16 dB for broadband signals from seismic surveys (McCauley et al., 2000) to correct for the difference between peak-to-peak levels reported in Lucke et al. (2009) and rms SPLs, the rms SPL for TTS would be approximately 184 dB re: 1 μPa, and the received levels associated with PTS (Level A harassment) would be higher. This is still above our current 180 dB rms re: 1 μPa threshold for injury. However, we recognize that TTS of harbor porpoises is lower than other cetacean species empirically tested (Finneran & Schlundt, 2010; Finneran, Schlundt, Carder, & Ridgway, 2002; Kastelein & Jennings, 2012).

Studies by Kujawa and Liberman (2009) and Lin et al. (2011) found that despite completely reversible threshold shifts that leave cochlear sensory cells intact, large threshold shifts could cause synaptic level changes and delayed cochlear nerve degeneration in mice and guinea pigs, respectively. We note that the high level of TTS that led to the synaptic changes shown in these studies is in the range of the high degree of TTS that Southall et al. (2007) used to calculate PTS levels. It is unknown whether smaller levels of TTS would lead to similar changes. We, however, acknowledge the complexity of noise exposure on the nervous system, and will re-examine this issue as more data become available.

A study on bottlenose dolphins (C. E. Schlundt et al., 2013) measured hearing thresholds at multiple frequencies to determine the amount of TTS induced before and after exposure to a sequence of impulses produced by a seismic air gun. The air gun volume and operating pressure varied from 40-150 in3 and 1000-2000 psi, respectively. After three years and 180 sessions, the authors observed no significant TTS at any test frequency, for any combinations of airgun volume, pressure, or proximity to the dolphin during behavioral tests (C. E. Schlundt et al., 2013). Schlundt et al. (2013) suggest that the potential for airguns to cause hearing loss in dolphins is lower than previously predicted, perhaps as a result of the low-frequency content of air gun impulses compared to the high-frequency hearing ability of dolphins.

The avoidance behaviors observed in Thompson et al.'s (1998) study supports our expectation that individual marine mammals would largely avoid exposure at higher levels. Also, it is unlikely that animals would encounter repeated exposures at very close distances to the sound source because L-DEO would implement the required shutdown mitigation measures to ensure that observed marine mammals do not approach the applicable exclusion zone for Level A harassment. We also expect that the required vessel-based visual monitoring of the exclusion zone and implementation of mitigation measures would minimize instances of Level A harassment. However, sounds from airguns could result in PTS in a limited number of marine

mammals. As such, NMFS proposes to authorize take, in the form of Level A harassment, of marine mammals, specifically as a result of PTS. However, based on the results of our analyses, though PTS may occur in a small number of animals, there is no evidence that L-DEO's activities could result in serious injury or mortality of marine mammals within the action area. Even in the absence of the required mitigation and monitoring measures, the possibility of serious injury or lethal takes as a result of exposure to sound sources associated with L-DEO's seismic survey is considered extremely unlikely.

Strandings: In 2013, an International Scientific Review Panel (ISRP) investigated a 2008 mass stranding of approximately 100 melon-headed whales in a Madagascar lagoon system (Southall, Rowles, Gulland, Baird, & Jepson, 2013) associated with the use of a high-frequency mapping system. The report indicated that the use of a 12-kHz MBES was the most plausible and likely initial behavioral trigger of the mass stranding event. This was the first time that a relatively high-frequency mapping sonar system had been associated with a stranding event.

The report notes that there were several site- and situation-specific secondary factors that may have contributed to the avoidance responses that lead to the eventual entrapment and mortality of the whales within the Loza Lagoon system (e.g., the survey vessel transiting in a north-south direction on the shelf break parallel to the shore may have trapped the animals between the sound source and the shore driving them towards the Loza Lagoon). They concluded that for odontocete cetaceans that hear well in the 10-50 kHz range, where ambient noise is typically quite low, high-power active sonars operating in this range may be more easily audible and have potential effects over larger areas than low frequency systems that have more typically been considered in terms of anthropogenic noise impacts (Southall et al., 2013). However, the risk may be very low given the extensive use of these systems worldwide on a daily basis and the lack of direct evidence of such responses previously (Southall et al., 2013).

We have considered the potential for L-DEO's use of a MBES to result in stranding of marine mammals. Given that L-DEO proposes to conduct the seismic survey offshore and to transit in a manner that would not entrap marine mammals in shallow water, we believe it is extremely unlikely that the use of the MBES during the seismic survey would entrap marine mammals between the vessel's sound sources and the coastline. Stranding of marine mammals is not anticipated as a result of the planned seismic survey.

We interpret the anticipated effects on all marine mammals of L-DEO's planned seismic survey as falling within the MMPA definitions of Level A harassment and Level B harassment. We expect these impacts to be minor because we do not anticipate measurable changes to the population or measurable impacts to rookeries, mating grounds, and other areas of similar significance. Furthermore, L-DEO's proposed activities are not likely to obstruct movements or migration of marine mammals because the survery will occur over a limited time in a relatively small geographic area. Animals would be able to move away from sound soureces without significantly altering migration patterns. We expect that the proposed activities involving use of airguns would result, at worst, in PTS (Level A harassment) to a limited number of marine mammals, as well as temporary modification in behavior and/or temporary changes in animal distribution (Level B harassment) of certain species or stocks of marine mammals. It is likely that sounds from seismic airguns may result in temporary, short term changes in an animal's typical behavior and/or avoidance of the affected area, as described above. We base these conclusions on the results of the studies described above and on previous monitoring reports for similar activities and anecdotal observations for the same activities conducted in other open ocean environments.

Serious Injury or Mortality: L-DEO did not request authorization to take marine mammals by serious injury or mortality. Based on the results of our analyses, L-DEO's IHA application, and previous monitoring reports for similar seismic survey activities, we do not expect L-DEO's planned activities to result in serious injury or mortality of marine mammals within the action area, even in the absence of mitigation and monitoring measures. The required mitigation and monitoring measures would further minimize potential risks to marine mammals. Due in part to required monitoring measures for detecting marine mammals approaching the exclusion zone, and the required mitigation measures for speed or Course Alteration of the vessel and shut downs of the airgun array if a marine mammal is likely to enter the exclusion zone, any Level A harassment potentially incurred by marine mammals as a result of the planned seismic survey is expected to be in the form of some small degree of permanent hearing loss. Neither mortality nor complete deafness of marine mammals is expected to result from L-DEO's seismic survey.

Vessel Strikes: Vessel traffic has the potential to result in collisions with marine mammals. Studies have associated ship speed with the probability of a ship strike resulting in an injury or mortality of an animal. However, it is highly unlikely that L-DEO would strike a marine mammal given the *Langseth*'s slow survey speed (8.3 km/hr; 4.5 kt). Additionally, PSOs would be monitoring exclusion zones around the vessel and would be able to warn of any marine mammals that may be in the path of the *Langseth*. Moreover, mitigation measures would be required of L-DEO to reduce speed or alter course if a collision with a marine mammal appears likely. Therefore, it is extremely unlikely that the proposed activities would result in a vessel strike of a marine mammal.

4.1.3. Estimated Takes of Marine Mammals by Level A and Level B Harassment

L-DEO has requested take by Level A harassment and Level B harassment as a result of the acoustic stimuli generated by their proposed seismic survey. We estimate that the activities could potentially result in the incidental take of 38 species of marine mammals under NMFS jurisdiction by Level B harassment and of 24 species of marine mammals under NMFS jurisdiction by Level A harassment. For each species, estimates of take are small numbers relative to the population sizes. Tables 4, 5, 6, and 7 describe the number of Level A harassment takes and Level B harassment takes that NMFS proposes to authorize, and the percentage of each population or stock proposed for take authorization in the IHA as a result of L-DEO's activities.

Table 4. Numbers of Potential Incidental Take of Marine Mammals Proposed for Authorization during L-DEO's Proposed North Island 2-D Seismic Survey off New Zealand.

Species	Density (# / 1,000 km^2)	Proposed Level A Takes	Proposed Level B Takes	Total Proposed Level A and Level B takes
Southern right whale	0.24	2	23	25
Pygmy right whale	0.10	1	9	10
Humpback whale	0.24	2	23	25
Bryde's whale	0.14	1	14	15

Common minke whale	0.14	1	14	15
Antarctic minke whale	0.14	1	14	15
Sei whale	0.14	1	14	15
Fin whale	0.25	2	24	26
Blue whale	0.04	0	4	4
Sperm whale	2.89	1	305	306
Cuvier's beaked whale	2.62	1	276	277
Arnoux's beaked whale	2.62	1	276	277
Southern bottlenose whale	1.74	0	184	184
Shepard's beaked whale	1.74	0	184	184
Hector's beaked whale	1.74	0	184	184
True's beaked whale	0.87	0	92	92
Gray's beaked whale	3.49	1	368	369
Andrew's beaked whale	1.74	0	184	184
Strap-toothed whale	2.62	1	276	277
Blainville's beaked whale	0.87	0	92	92
Spade-toothed whale	0.87	0	92	92
Bottlenose dolphin	5.12	1	540	541
Short-beaked common dolphin	10.25	2	1080	1082
Dusky dolphin	5.12	1	540	541
Southern right-whale dolphin	3.07	1	324	325

Risso's dolphin	2.05	0	216	216
False killer whale	3.07	1	324	325
Killer whale	1.91	0	202	202
Long-finned pilot whale	8.28	2	872	874
Short-finned pilot whale	4.10	1	432	433
Pygmy sperm whale	1.74	6	177	183
Hourglass dolphin	4.16	15	424	439
Hector's dolphin	0	0	0	0
Spectacled porpoise	0	0	0	0
New Zealand fur seal	22.50	4	2373	2377
New Zealand sea lion	0	0	0	0
Southern elephant seal	4.50	3	472	475
Leopard seal	2.25	1	236	237

Table 5. Numbers of Potential Incidental Take of Marine Mammals Proposed for Authorization during L-DEO's Proposed North Island 3-D Seismic Survey off New Zealand.

Species	Density (# / 1,000 km^2)	Proposed Level A Takes	Proposed Level B Takes	Total Proposed Level A and Level B takes
Southern right whale	0.24	0	13	13
Pygmy right whale	0.10	0	5	5
Humpback whale	0.24	0	13	13
Bryde's whale	0.14	0	8	8

Common minke whale	0.14	0	8	8
Antarctic minke whale	0.14	0	8	8
Sei whale	0.14	0	8	8
Fin whale	0.25	0	13	13
Blue whale	0.04	0	2	2
Sperm whale	2.89	1	159	160
Cuvier's beaked whale	2.62	1	143	144
Arnoux's beaked whale	2.62	1	143	144
Southern bottlenose whale	1.74	0	96	96
Shepard's beaked whale	1.74	0	96	96
Hector's beaked whale	1.74	0	96	96
True's beaked whale	0.87	0	48	48
Gray's beaked whale	3.49	1	191	192
Andrew's beaked whale	1.74	0	96	96
Strap-toothed whale	2.62	1	143	144
Blainville's beaked whale	0.87	0	48	48
Spade-toothed whale	0.87	0	48	48
Bottlenose dolphin	5.12	1	281	282
Short-beaked common dolphin	10.25	2	562	564
Dusky dolphin	5.12	1	281	282
Southern right-whale dolphin	3.07	1	168	169

Risso's dolphin	2.05	0	112	112
False killer whale	3.07	1	168	169
Killer whale	1.91	0	105	105
Long-finned pilot whale	8.28	2	454	456
Short-finned pilot whale	4.10	1	225	226
Pygmy sperm whale	1.74	4	91	95
Hourglass dolphin	4.16	10	219	229
Hector's dolphin	0	0	0	0
Spectacled porpoise	0	0	0	0
New Zealand fur seal	22.50	5	1234	1239
New Zealand sea lion	0	0	0	0
Southern elephant seal	4.50	2	245	247
Leopard seal	2.25	1	123	124

Table 6. Numbers of Potential Incidental Take of Marine Mammals Proposed for Authorization during L-DEO's Proposed South Island 2-D Seismic Survey off New Zealand.

Species	Density (# / 1,000 km^2)	Proposed Level A Takes	Proposed Level B Takes	Total Proposed Level A and Level B takes
Southern right whale	0.24	1	15	16
Pygmy right whale	0.10	0	6	6
Humpback whale	0.24	1	12	13
Bryde's whale	0.14	0	0	0

Common minke whale	0.14	1	9	10
Antarctic minke whale	0.14	1	9	10
Sei whale	0.14	1	9	10
Fin whale	0.25	1	15	16
Blue whale	0.04	0	2	2
Sperm whale	2.89	0	190	190
Cuvier's beaked whale	2.62	0	172	172
Arnoux's beaked whale	2.62	0	172	172
Southern bottlenose whale	1.74	0	114	114
Shepard's beaked whale	1.74	0	114	114
Hector's beaked whale	1.74	0	114	114
True's beaked whale	0.87	0	57	57
Gray's beaked whale	3.49	0	229	229
Andrew's beaked whale	1.74	0	114	114
Strap-toothed whale	2.62	0	172	172
Blainville's beaked whale	0.87	0	57	57
Spade-toothed whale	0.87	0	57	57
Bottlenose dolphin	5.12	1	314	315
Short-beaked common dolphin	10.25	1	314	315
Dusky dolphin	5.12	1	502	503
Southern right-whale dolphin	3.07	0	188	188

Risso's dolphin	2.05	0	126	126
False killer whale	3.07	1	188	189
Killer whale	1.91	0	126	126
Long-finned pilot whale	8.28	1	543	544
Short-finned pilot whale	4.10	0	126	126
Pygmy sperm whale	1.74	5	109	114
Hourglass dolphin	4.16	12	261	273
Hector's dolphin	0	0	2	2
Spectacled porpoise	0	6	120	126
New Zealand fur seal	22.50	2	1477	1479
New Zealand sea lion	0	1	591	592
Southern elephant seal	4.50	2	294	296
Leopard seal	2.25	1	147	148

Table 7. Total Numbers of Potential Incidental Take of Marine Mammals Proposed for Authorization during L-DEO's Proposed North Island 3-D Survey, North Island 2-D Survey, and South Island 3-D Surveys of the R/V Langseth off New Zealand.

Species	Density (# / 1,000 km^2)	Proposed Level A Takes	Proposed Level B Takes	Total Proposed Level A and Level B takes	Total Proposed Level A and Level B takes as a Percentage of Population
Southern right whale	0.24	3	51	54	0.45
Pygmy right whale	0.10	1	20	21	N.A.
Humpback whale	0.19	3	48	51	0.12
Bryde's whale	0.00	1	22	23	0.05

Common minke whale	0.14	2	31	33	< 0.01
Antarctic minke whale	0.14	2	31	33	< 0.01
Sei whale	0.14	2	31	33	0.33
Fin whale	0.25	3	52	55	0.37
Blue whale	0.04	0	8	8	0.21
Sperm whale	2.89	2	654	656	2.19
Cuvier's beaked whale	2.62	2	591	593	0.10
Arnoux's beaked whale	2.62	2	591	593	0.10
Southern bottlenose whale	1.74	0	394	394	0.07
Shepard's beaked whale	1.74	0	394	394	0.07
Hector's beaked whale	1.74	0	394	394	0.07
True's beaked whale	0.87	0	197	197	N.A.
Gray's beaked whale	3.49	2	788	790	0.13
Andrew's beaked whale	1.74	0	394	394	0.07
Strap-toothed whale	2.62	2	591	593	0.10
Blainville's beaked whale	0.87	0	197	197	0.03
Spade-toothed whale	0.87	0	197	197	0.03
Bottlenose dolphin	4.78	3	1135	1138	N.A.
Short-beaked common dolphin	4.78	5	1956	1961	N.A.
Dusky dolphin	7.65	3	1323	1326	11.05
Southern right-whale dolphin	2.87	2	680	682	N.A.

Risso's dolphin	1.91	0	454	454	N.A.
False killer whale	2.87	3	680	683	N.A.
Killer whale	1.91	0	433	433	0.54
Long-finned pilot whale	8.28	5	1869	1874	0.94
Short-finned pilot whale	1.91	2	783	785	N.A.
Pygmy sperm whale	1.74	15	377	392	N.A.
Hourglass dolphin	4.16	37	904	941	0.63
Hector's dolphin	0.04	0	2	2	0.01
Spectacled porpoise	1.91	6	120	126	N.A.
New Zealand fur seal	22.50	11	5084	5095	2.55
New Zealand sea lion	9.00	1	591	592	5.99
Southern elephant seal	4.50	7	1011	1018	0.17
Leopard seal	2.25	3	506	509	0.23

It should be noted that the proposed take numbers shown in Tables 4, 5, 6 and 7 are expected to be conservative for several reasons. First, in the calculations of estimated take, 50 percent has been added: 25 percent has been added to account for an additional contingency for potential additional seismic operations (associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard, as proposed by L-DEO) and an additional 25 percent contingency has been added to account for uncertainties in available density estimates. Additionally, marine mammals would be expected to move away from a sound source that represents an aversive stimulus, such as an airgun array. However, the extent to which marine mammals would move away from the sound source is difficult to quantify and is therefore not accounted for in the take estimates shown above.

Take estimates are based on a consideration of the number of marine mammals that could be within the area around the operating airgun array (array source levels for marine mammal hearing groups are shown in Table 8) where received levels of sound exceeding thresholds for Level B harassment and Level A harassment are predicted to occur (Tables 9-12). Take estimates are based on the densities (shown above in Tables 4-7) of marine mammals expected to occur in the area in the absence of a seismic survey. To the extent that marine mammals would be expected to move away from a sound source that represents an aversive stimulus before the

sound level reaches the criterion level, these estimates likely overestimate the numbers actually exposed to the specified level of sound.

Table 8: Modeled source levels based on modified farfield signature for the R/V Langseth 6,600 in^3 airgun array, 3,300 in^3 airgun array, and single 40 in^3 airgun.

	Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)
6,600 in^3 airgun array (Peak SPL$_{flat}$)	250.77	252.76	249.44	250.50	252.72
6,600 in^3 airgun array (SEL$_{cum}$)	232.75	232.67	232.83	232.67	231.07
3,300 in^3 airgun array (Peak SPL$_{flat}$)	246.34	250.98	243.64	246.03	251.92
3,300 in^3 airgun array (SEL$_{cum}$)	226.22	226.13	226.75	226.13	226.89
40 in^3 airgun (Peak SPL$_{flat}$)	224.02	225.16	224.00	224.09	226.64
40 in^3 airgun (SEL$_{cum}$)	202.33	202.35	203.12	202.35	202.61

Table 9. Predicted Radial Distances from R/V Langseth Seismic Source to Isopleths Corresponding to Level B Harassment Threshold

Source and Volume	Water Depth	Predicted Distance to Threshold (160 dB re 1 µPa) [1]
1 airgun, 40 in^3	>1000 m	388 m
	100–1000 m	582 m
	<100 m	938 m
18 airguns, 3,300 in^3	>1000 m	3,562 m
	100–1000 m	5,343 m
	<100 m	10,607 m
36 airguns, 6,600 in^3	>1000 m	5,629 m
	100–1000 m	8,444 m
	<100 m	22,102 m

Table 10. Modeled radial distances (m) to isopleths corresponding to Level A harassment thresholds during proposed North Island 2-D survey.

	Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)
6,600 in^3 airgun array (Peak SPL$_{flat}$)	38.8	13.8	229.2	42.2	10.9
6,600 in^3 airgun array (SEL$_{cum}$)	501.3	0	1.2	13.2	0
40 in^3 airgun (Peak SPL$_{flat}$)	1.8	0.6	12.6	2.0	0.5
40 in^3 airgun (SEL$_{cum}$)	0.4	0	0	0	0

Table 11. Modeled radial distances (m) to isopleths corresponding to Level A harassment thresholds during proposed North Island 3-D survey.

	Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)
3,300 in^3 airgun array (Peak SPL_{flat})	23.3	11.2	119.0	25.2	9.9
3,300 in^3 airgun array (SEL_{cum})	73.1	0	0.3	2.8	0
40 in^3 airgun (Peak SPL_{flat})	1.8	0.6	12.6	2.0	0.5
40 in^3 airgun (SEL_{cum})	0.4	0	0	0	0

Table 12. Modeled radial distances (m) to isopleths corresponding to Level A harassment thresholds during proposed South Island 2-D survey.

	Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)
6,600 in^3 airgun array (Peak SPL_{flat})	38.8	13.8	229.2	42.2	10.9
6,600 in^3 airgun array (SEL_{cum})	376.0	0	0.9	9.9	0
40 in^3 airgun (Peak SPL_{flat})	1.8	0.6	12.6	2.0	0.5
40 in^3 airgun (SEL_{cum})	0.3	0	0	0	0

As briefly mentioned in Chapter 2, a Kongsberg EM 122 MBES, a Knudsen Chirp 3260 SBP, and a Teledyne RDI 75 kHz Ocean Surveyor ADCP would be operated continuously during the proposed surveys, but not during transit to and from the survey areas. Due to the lower source level of the Kongsberg EM 122 MBES relative to the Langseth's airgun array (242 dB re 1 µPa · m for the MBES versus a minimum of 249.4 dB re 1 µPa · m (rms) for the 36 airgun array and a minimum of 243.6 dB re 1 µPa · m (rms) for the 18 airgun array) (NSF-USGS, 2011; See Table 8 above), sounds from the MBES are expected to be effectively subsumed by the sounds from the airgun array. Thus, any marine mammal potentially exposed to sounds from the MBES would already have been exposed to sounds from the airgun array, which are expected to propagate further in the water. Each ping emitted by the MBES consists of eight (in water >1,000 m deep) or four (<1,000 m) successive fan-shaped transmissions, each ensonifying a sector that extends 1° fore–aft. Given the movement and speed of the vessel, the intermittent and narrow downward-directed nature of the sounds emitted by the MBES would result in no more than one or two brief ping exposures of any individual marine mammal, if any exposure were to occur. Due to the lower source levels of both the Knudsen Chirp 3260 SBP and the Teledyne RDI 75 kHz Ocean Surveyor ADCP relative to the Langseth's airgun array (maximum SL of 222 dB re 1 µPa · m for the SBP and maximum SL of 224 dB re 1 µPa · m for the ADCP, versus a minimum of 249.4 dB re 1 µPa · m for the 36 airgun array and a minimum of 243.6 dB re 1 µPa · m for the 18 airgun array) (NSF-USGS, 2011; See Table 8 above), sounds from the SBP and ADCP are expected to be effectively subsumed by sounds from the airgun array. Thus, any marine mammal potentially exposed to sounds from the SBP and/or the ADCP would already have been exposed

to sounds from the airgun array, which are expected to propagate further in the water. As such, we conclude that the likelihood of marine mammal take resulting from exposure to sound from the MBES, SBP or ADCP is discountable and therefore we do not consider noise from the MBES, SBP or ADCP further in this analysis.

4.2. Effects of Alternative 2- No Action Alternative

Under the No Action Alternative, we would not issue an IHA to L-DEO. As a result, L-DEO would not receive an exemption from the MMPA prohibitions against the take of marine mammals and would be in violation of the MMPA if take of marine mammals were to occur.

The impacts to elements of the human environment resulting from the No Action alternative – conducting the marine geophysical survey in the absence of required protective measures for marine mammals under the MMPA – would be greater than those impacts resulting from Alternative 1, the Preferred Alternative.

4.2.1. Impacts to Marine Mammal Habitat

Under the No Action Alternative, the effects on the physical environment or on components of the biological environment that function as marine mammal habitat would result from L-DEO's planned geophysical survey, are similar to those described in Section 4.1.1.

4.2.2. Impacts to Marine Mammals

Under the No Action Alternative, L-DEO's planned geophysical survey activities could result in increased amounts of Level A harassment and Level B harassment to marine mammals, although no takes by serious injury or mortality would be expected even in the absence of mitigation and monitoring measures. While it is difficult to provide an exact number of takes that might occur under the No Action Alternative, the numbers would be expected to be larger than those presented in Tables 4-7 above because L-DEO would not be required to implement mitigation measures designed to warn marine mammals of the impending increased underwater sound levels, and additional numbers of marine mammals may be incidentally taken because L-DEO would not be required to shut down seismic survey activities if marine mammals occurred in the project vicinity.

If the activities proceeded without the mitigation and monitoring measures required by Alternative 1, the direct, indirect, and cumulative effects on the human or natural environment of not issuing the IHA would include an increase in the number of animals incurring PTS and behavioral responses because of the lack of mitigation measures that would be required in the IHA. Thus, the incidental take of marine mammals would likely occur at higher levels than we identified and evaluated in the proposed IHA; and NMFS would not be able to obtain the monitoring and reporting data needed to assess the anticipated impact of the activity upon the species or stock nor the increased knowledge of the marine mammal species, as required under the MMPA.

4.3. Unavoidable Adverse Impacts

L-DEO's application and our notice of proposed IHA, summarize unavoidable adverse impacts to marine mammals or the populations to which they belong or on their habitats occurring in the proposed project area.

We acknowledge that the incidental take authorized could potentially result in adverse impacts to marine mammals including behavioral responses, alterations in the distribution of local populations, and injury. However, we do not expect L-DEO's activities to have adverse consequences on annual rates of recruitment or survival of marine mammal species or stocks in

the southwestern Pacific Ocean, and we do not expect the marine mammal populations in that area to experience reductions in reproduction, numbers, or distribution that might appreciably reduce their likelihood of surviving and recovering in the wild. We expect that the numbers of individuals of all species taken by harassment would be small (relative to species or stock abundance), and that the proposed project and the take resulting from the proposed project activities would have a negligible impact on the affected species or stocks of marine mammals.

4.4. Cumulative Effects

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR §1508.7). Cumulative impacts can result from individually minor but collectively significant actions that take place over a period of time.

Past, present, and reasonably foreseeable impacts to marine mammal populations in the southwest Pacific Ocean include the following: seismic surveys; climate change; marine pollution; disease; and increased vessel traffic. These activities account for cumulative impacts to regional and worldwide populations of marine mammals, many of which are a small fraction of their former abundance. However, quantifying the biological costs for marine mammals within an ecological framework is a critical missing link to our assessment of cumulative impacts in the marine environment and assessing cumulative effects on marine mammals (Clark *et al*., 2009).

The proposed seismic surveys would add another, albeit temporary, activity to the marine environment in the southwestern Pacific Ocean. This activity would be limited to waters off the coast of New Zeland in the southwestern Pacific Ocean and with the three surveys occuring for approximately 90 days. L-DEO's application (LGL, 2017) summarized the potential cumulative effects to marine mammals or the populations to which they belong and their habitats within the survey area. This section incorporates L-DEO's application (LGL, 2017) by reference and provides a brief summary of the human-related activities affecting the marine mammal species in the action area.

4.4.1. Future Seismic Survey Activities in the Southwestern Pacific Ocean

There are no other seismic surveys with an IHA issued from us scheduled to occur in the southwestern Pacific Ocean from October 2017 to March 2018. Therefore, we are unaware of any synergistic impacts to marine resources associated with reasonably foreseeable future actions that may be planned or occur within the same region of influence. The impacts of conducting the seismic survey on marine mammals are specifically related to acoustic activities, and these are expected to be temporary in nature, negligible, and would not result in substantial impacts to marine mammals or to their role in the ecosystem. We do not expect that the issuance of an IHA would have a significant cumulative effect on the human environment, due to the required mitigation and monitoring measures described in Section 2.3.1

Based on the analyses above and in our *Federal Register* notice of proposed Authorization (82 FR 45116, September 27, 2017) and L-DEO's application (LGL, 2017), NMFS does not expect that L-DEO's proposed seismic surveys would have effects that could cause significant or long-term consequences for individual marine mammals or their populations alone or in combination with past or present activities discussed above.

4.4.2. Climate Change

Global climate change could significantly affect the marine resources of the southwest Pacific Ocean. Possible impacts include temperature and rainfall changes and potentially rising sea levels and changes to ocean conditions. These changes may affect marine ecosystems in the proposed action area by increasing the vertical stratification of the water column and changing the intensity and rhythms of coastal winds and upwelling. Such modifications could cause ecosystem regime shifts as the productivity of the regional ecosystem undergoes various changes related to nutrients input and coastal ocean process (USFWS 2011).

The precise effects of global climate change on the action area, however, cannot be predicted at this time because the marine ecosystem is highly variable in its spatial and temporal scales.

4.4.3. Coastal Development

L-DEO's planned activities would occur in the open ocean environment for a relatively short period. Therefore, the proposed activities would have no cumulative impact on coastal development offshore New Zealand.

4.4.4. Marine Pollution

Marine mammals are exposed to contaminants via the food they consume, the water in which they swim, and the air they breathe. Point and non-point source pollutants from coastal runoff, offshore mineral and gravel mining, at-sea disposal of dredged materials and sewage effluent, marine debris, and organic compounds from aquaculture are all lasting threats to marine mammals in the project area. The long-term impacts of these pollutants, however, are difficult to measure.

The persistent organic pollutants tend to bioaccumulate through the food chain; therefore, the chronic exposure of persistent organic pollutants in the environment is perhaps of the most concern to high trophic level predators.

L-DEO's activities associated with the marine seismic survey are not expected to cause increased exposure of persistent organic pollutants to marine mammals in the project vicinity due to the relatively small scale and localized nature of the activities.

4.4.5. Disease

Disease is common in many marine mammal populations and has been responsible for major die-offs worldwide, but such events are usually relatively short-lived. L-DEO's survey activities are not expected to affect the disease rate among marine mammals in the project vicinity.

4.4.6. Increased Vessel Traffic

L-DEO's proposed activities would not result in a cumulative increase in vessel traffic beyond any direct impacts associated with the proposed short-term surveys by the *Langseth*. As such, ship traffic should remain constant, underwater sound levels should remain stable and ship strikes of marine animals may occur at the levels they have in the recent past.

Chapter 5 List of Preparers and Agencies Consulted

Prepared By:

Jonathan Molineaux
Senior Analyst
Permits and Conservation Division
Office of Protected Resources
NOAA National Marine Fisheries Service

Jordan Carduner
Fishery Biologist
Permits and Conservation Division
Office of Protected Resources
NOAA National Marine Fisheries Service

Agencies Consulted internal to NOAA
NMFS Office of Protected Resources Interagency Cooperation Division

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