DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XF456

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey in the Southwest Pacific Ocean, 2017/2018

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; proposed incidental harassment authorization; request for comments.

SUMMARY: NMFS has received a request from Lamont-Doherty Earth Observatory (L–DEO) for authorization to take marine mammals incidental to a WHEN OU marine geophysical survey in the southwest Pacific Ocean. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an incidental harassment authorization (IHA) to incidentally take marine mammals during the specified activities. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorization and agency responses will be summarized in the notice of our final decision.

DATES: Comments and information must be received no later than October 26, 2017.

ADDRESSES: Comments should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service. Physical comments should be sent to 1315 East-West Highway, Silver Spring, MD 20910 and electronic comments should be sent to *ITP.Carduner@noaa.gov.*

Instructions: NMFS is not responsible for comments sent by any other method, to any other address or individual, or received after the end of the comment period. Comments received electronically, including all attachments, must not exceed a 25-megabyte file size. Attachments to electronic comments will be accepted in Microsoft Word or Excel or Adobe PDF file formats only. All comments received are a part of the public record and will generally be posted online at *www.nmfs.noaa.gov/pr/permits/incidental/research.htm* without change. All personal identifying information (*e.g.,* name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Jordan Carduner, Office of Protected Resources, NMFS, (301) 427–8401. Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *www.nmfs.noaa.gov/pr/permits/incidental/research.htm.* In case of problems accessing these documents, please call the contact listed above.

SUPPLEMENTARY INFORMATION:

Background

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

An authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

NMFS has defined ‘‘negligible impact’’ in 50 CFR 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

The MMPA states that the term ‘‘take’’ means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.

Except with respect to certain activities not pertinent here, the MMPA defines ‘‘harassment’’ as: Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216–6A, NMFS must review our proposed action (*i.e.,* the issuance of an incidental harassment authorization) with respect to potential impacts on the human environment. Accordingly, NMFS is preparing an Environmental Assessment (EA) to consider the environmental impacts associated with the issuance of the proposed IHA. NMFS' EA is available at *www.nmfs.noaa.gov/pr/permits/incidental/research.htm.* We will review all comments submitted in response to this notice prior to concluding our NEPA process or making a final decision on the IHA request.

Summary of Request

On May 17, 2017, NMFS received a request from the L–DEO for an IHA to take marine mammals incidental to conducting a marine geophysical survey in the southwest Pacific Ocean. On September 13, 2017, we deemed L–DEO's application for authorization to be adequate and complete. L–DEO's request is for take of a small number of 38 species of marine mammals by Level B harassment and Level A harassment. Neither L–DEO nor NMFS expects mortality to result from this activity, and, therefore, an IHA is appropriate. The planned activity is not expected to exceed one year, hence, we do not expect subsequent MMPA incidental harassment authorizations would be issued for this particular activity.

Description of Proposed Activity

Overview

Researchers from California State Polytechnic University, California Institute of Technology, Pennsylvania State University, University Southern California, University of Southern Mississippi (USM), University of Hawaii at Manoa, University of Texas, and University of Wisconsin Madison, with funding from the U.S. National Science Foundation, propose to conduct three high-energy seismic surveys from the research vessel (R/V) *Marcus G. Langseth* (*Langseth*) in the waters of New Zealand in the southwest Pacific Ocean in 2017/2018. The NSF-owned *Langseth* is operated by L–DEO. One proposed survey would occur east of North Island and would use an 18-airgun towed array with a total discharge volume of ~3300 cubic inches (in^3). Two other proposed seismic surveys (one off the east coast of North Island and one south of South Island) would use a 36-airgun towed array with a discharge volume of ~6600 in^3. The surveys would take place in water depths from ~50 to >5,000 m.

Dates and Duration

The North Island two-dimensional (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 three-dimensional (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.

Specific Geographic Region

The proposed surveys would occur within the Exclusive Economic Zone (EEZ) and territorial sea 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 x 60 kilometer (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 in L–DEO's IHA application for maps depicting the specified geographic region of the proposed surveys.

Detailed Description of Specific Activity

The proposed study consists of three seismic surveys off the coast of New Zealand in the southwest Pacific Ocean. The proposed surveys include: (1) A 2–D survey along the Hikurangi margin off the east coast of North Island; (2) a deep penetrating 3–D seismic reflection acquisition over a 15 x 60 km area offshore at the Hikurangi trench and forearc off the east coast of North Island; and (3) a 2–D survey along the Puysegur margin off the south coast of South Island. Water depths in the proposed survey areas range from ~50 to >5000 m. The proposed surveys would be conducted within both the territorial sea of New Zealand (from 0–12 nautical miles (nm) from shore) and the EEZ of New Zealand (from 12 to 200 nm from shore). All planned geophysical data acquisition activities would be conducted by L–DEO with onboard assistance by the scientists who have proposed the studies. The vessel would be self-contained, and the crew would live aboard the vessel.

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 turns and acquires data on a different track. Representative survey tracklines are shown in Figures 1 and 2 in L–DEO's IHA; 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 proposed surveys would entail a total of approximately 13,299 km of track lines.

During the two 2–D surveys, the *Langseth* would tow a full array, consisting of four strings with 36 airguns (plus 4 spares) and a total volume of approximately 6,600 in^3. During the North Island 3–D survey, the *Langseth* would tow two separate 18-airgun arrays that would fire alternately; each array would have a total discharge volume of approximately 3,300 in^3. Specifications of the airgun arrays, trackline distances, and water depths of each of the three proposed surveys are shown in Table 1. Descriptions of the three proposed surveys are provided below. More detailed descriptions of the three proposed surveys are provided in the IHA application (LGL, 2017).

TABLE 1—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.

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 principal investigators (PIs) and co-PIs propose to use multi-channel seismic (MCS) reflection surveys and seismic refraction data recorded by OBSs to characterize the incoming Hikurangi Plateau and 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.

North Island 3–D Survey

During the proposed North Island 3–D survey, approximately 3,025 km of track lines would be surveyed within a 15 x 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 PI and co-PIs 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.

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 at 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 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.

In addition to the operations of the airgun array, 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.

Proposed mitigation, monitoring, and reporting measures are described in detail later in this document (please see ''Proposed Mitigation'' and ''Proposed Monitoring and Reporting'').

Description of Marine Mammals in the Area of Specified Activities

Section 4 of the IHA application summarizes available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species. More general information about these species (*e.g.,* physical and behavioral descriptions) may be found on NMFS' Web site (*www.nmfs.noaa.gov/pr/species/mammals/*). Table 2 lists all species with expected potential for occurrence in the Southwest Pacific Ocean off New Zealand and summarizes information related to the population, including regulatory status under the MMPA and ESA. The populations of marine mammals considered in this document do not occur within the U.S. EEZ and are therefore not assigned to stocks and are not assessed in NMFS' Stock Assessment Reports (*www.nmfs.noaa.gov/pr/sars/*). As such, information on potential biological removal (PBR; defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population) and on annual levels of serious injury and mortality from anthropogenic sources are not available for these marine mammal populations.

In addition to the marine mammal species known to occur in proposed survey areas, there are 16 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.,* 2016). These species are: The ginkgo-toothed whale (*Mesoplodon ginkgodens*); pygmy beaked whale (*M. peruvianus*); dwarf sperm whale (*Kogia sima*); 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 reported 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.

Marine mammal abundance estimates presented in this document represent the total number of individuals estimated within a particular study or survey area. All values presented in Table 2 are the most recent available at the time of publication.

TABLE 2—MARINE MAMMALS THAT COULD OCCUR IN THE PROPOSED SURVEY AREAS

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	[3]12,000
Family Balaenopteridae (rorquals)				
Humpback whale	Megaptera novaeangliae	N/A	-/-; N	[3]42,000
Bryde's whale	Balaenoptera edeni	N/A	-/-; N	[4]48,109
Common minke whale	Balaenoptera acutorostrata	N/A	-/-; N	[5,6]750,000
Antarctic minke whale	Balaenoptera bonaerensis	N/A	-/-; N	[5,6]750,000
Sei whale	Balaenoptera borealis	N/A	E/D;-	[5]10,000
Fin whale	Balaenoptera physalus	N/A	E/D;-	[5]15,000
Blue whale	Balaenoptera musculus	N/A	E/D;-	[3,5]3,800
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;-	[5]30,000
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	[5,7]600,000
Arnoux's beaked whale	Berardius arnuxii	N/A	-/-; N	[5,7]600,000
Shepherd's beaked whale	Tasmacetus shepherdi	N/A	-/-; N	[5,7]600,000
Hector's beaked whale	Mesoplodon hectori	N/A	-/-; N	[5,7]600,000
True's beaked whale	Mesoplodon mirus	N/A	-/-; N	N/A
Southern bottlenose whale	Hyperoodon planifrons	N/A	-/-; N	[5,7]600,000
Gray's beaked whale	Mesoplodon grayi	N/A	-/-; N	[5,7]600,000
Andrew's beaked whale	Mesoplodon bowdoini	N/A	-/-; N	[5,7]600,000
Strap-toothed beaked whale	Mesoplodon layardii	N/A	-/-; N	[5,7]600,000
Blainville's beaked whale	Mesoplodon densirostris	N/A	-/-; N	[5,7]600,000
Spade-toothed beaked whale	Mesoplodon traversii	N/A	-/-; N	[5,7]600,000
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	[8]12,000–20,000
Hourglass dolphin	Lagenorhynchus cruciger	N/A	-/-; N	[5]150,000
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 hectori	N/A	T/D;-	[9]14,849
Maui dolphin	Cephalorhynchus hectori maui	N/A	E/D;-	[10]55–63
False killer whale	Pseudorca crassidens	N/A	-/-; N	N/A
Killer whale	Orcinus orca	N/A	-/-; N	[5]80,000
Long-finned pilot whale	Globicephala melas	N/A	-/-; N	[5]200,000
Short-finned pilot whale	Globicephala macrorhynchus	N/A	-/-; N	N/A

TABLE 2—MARINE MAMMALS THAT COULD OCCUR IN THE PROPOSED SURVEY AREAS—Continued

Common name	Scientific name	Stock	ESA/MMPA status; strategic (Y/N)[1]	Population abundance[2]
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	[8] 200,000
New Zealand sea lion	Phocarctos hookeri	N/A	-/-; N	[11] 9,880
Family Phocidae (earless seals)				
Leopard seal	Hydrurga leptonyx	N/A	-/-; N	[8] 222,000
Southern elephant seal	Mirounga leonina	N/A	-/-; N	[8] 607,000

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.* (2016).

[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 Hector'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.* 2016). 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 (Manning and 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. Therefore the Maui dolphin is not discussed further beyond the explanation provided here.

We have reviewed L–DEO's species descriptions, including life history information, distribution, regional distribution, diving behavior, and acoustics and hearing, for accuracy and completeness. We refer the reader to Section 4 of L–DEO's IHA application, rather than reprinting the information here. 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.

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.

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.,* 2015). 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.* 2013). 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).

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.

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).

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.

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, their 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 50 °S. 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 55° S. 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).

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.

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 <40° (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).

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 (Hansen *et al.* 1994; Davis *et al.* 1998; 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). 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.* 2013a).

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.* 2013a). Strandings have been reported throughout the year, with a peak during fall (Thompson *et al.* 2013a).

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 40° S., but it could reach latitudes of 34° S. 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.* 2013a). 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.* 2013a).

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.* 2013a; 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.* 2013a).

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.* 2013a). 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).

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.* 2013a).

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.* 2013a). 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.* 2013a). 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.* 2013a).

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 2009b). 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).

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.

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).

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.

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 ~30° S. and 65° S. (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).

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 60° N. and 60° S. where surface water temperatures are at least 10 °C (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).

South Island Hector's 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). As described above, the South Island Hector's dolphin (*C. hectori hectori*) is one of two subspecies of Hector's dolphins that 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.,* 2012).

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 Hector's dolphin is found only off the coast of the South Island of New Zealand (L. Manning and K. 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).

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).

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 Hemisphere. 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 behavior 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 and occasionally occur in New Zealand, including the Auckland and Campbell Islands, and the mainland (NZDOC 2017a). Auckland and Campbell islands are known to have leopard seals annually and the mainland regularly receives visitors (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.

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).

Marine Mammal Hearing—Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2016) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. The functional groups and the associated frequencies are indicated below (note that these frequency ranges correspond to the range for the composite group, with the entire range not necessarily reflecting the capabilities of every species within that group):

- Low-frequency cetaceans (mysticetes): Generalized hearing is estimated to occur between approximately 7 Hz and 35 kHz, with best hearing estimated to be from 100 Hz to 8 kHz;
- Mid-frequency cetaceans (larger toothed whales, beaked whales, and most delphinids): Generalized hearing is estimated to occur between approximately 150 Hz and 160 kHz, with best hearing from 10 to less than 100 kHz;
- High-frequency cetaceans (porpoises, river dolphins, and members of the genera *Kogia* and *Cephalorhynchus;* including two members of the genus *Lagenorhynchus,* on the basis of recent echolocation data and genetic data): Generalized hearing is estimated to occur between approximately 275 Hz and 160 kHz.
- Pinnipeds in water; Phocidae (true seals): Generalized hearing is estimated to occur between approximately 50 Hz to 86 kHz, with best hearing between 1–50 kHz;
- Pinnipeds in water; Otariidae (eared seals): Generalized hearing is estimated to occur between 60 Hz and 39 kHz, with best hearing between 2–48 kHz.

The pinniped functional hearing group was modified from Southall *et al.* (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al.,* 2006; Kastelein *et al.,* 2009; Reichmuth and Holt, 2013).

TABLE 3—MARINE FUNCTIONAL MAMMAL HEARING GROUPS AND THEIR GENERALIZED HEARING RANGES

Hearing group	Generalized hearing range *
Low frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz.
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz.
High-frequency (HF) cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, Lagenorhynchus cruciger and L. australis).	275 Hz to 160 kHz.
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz.
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz.

* Represents the generalized hearing range for the entire group as a composite (*i.e.,* all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall *et al.,* 2007) and PW pinniped (approximation).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2016) for a review of available information. Thirty-eight marine mammal species have the reasonable potential to co-occur with the proposed survey activities (Table 2). Of the cetacean species that may be present, 9 are classified as low-frequency cetaceans (*i.e.,* all mysticete species), 21 are classified as mid-frequency cetaceans (*i.e.,* all delphinid and ziphiid species and the sperm whale), and 4 are classified as high-frequency cetaceans (*i.e.,* Kogia spp.). For the four pinniped species that may be present, 2 are otariids and 2 are classified as phocids.

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The ''Estimated Take by Incidental Harassment'' section later in this document includes a quantitative analysis of the number of individuals that are expected to be taken by this activity. The ''Negligible Impact Analysis and Determination'' section considers the content of this section, the ''Estimated Take by Incidental Harassment'' section, and the ''Proposed Mitigation'' section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and how those impacts on individuals are likely to impact marine mammal species or stocks.

Description of Active Acoustic Sound Sources

This section contains a brief technical background on sound, the characteristics of certain sound types, and on metrics used in this proposal inasmuch as the information is relevant to the specified activity and to a discussion of the potential effects of the specified activity on marine mammals found later in this document.

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in Hz or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the ''loudness'' of a sound and is typically described using the relative unit of the decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 microPascal (μPa)) and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source (referenced to 1 μPa) while the received level is the SPL at the listener's position (referenced to 1 μPa).

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Root mean square is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1983). Root mean square accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Sound exposure level (SEL; represented as dB re 1 μPa^2-s) represents the total energy contained within a pulse and considers both intensity and duration of exposure. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-p) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source and is represented in the same units as the rms sound pressure. Another common metric is peak-to-peak sound pressure (pk-pk), which is the algebraic difference between the peak positive and peak negative sound pressures. Peak-to-peak pressure is typically approximately 6 dB higher than peak pressure (Southall *et al.,* 2007).

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for pulses produced by the airgun arrays considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound. Ambient sound is defined as environmental background sound levels lacking a single source or point (Richardson *et al.,* 1995), and the sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (*e.g.,* wind and waves, earthquakes, ice, atmospheric sound), biological (*e.g.,* sounds produced by marine mammals, fish, and invertebrates), and anthropogenic (*e.g.,* vessels, dredging, construction) sound. A number of sources contribute to ambient sound, including the following (Richardson *et al.,* 1995):

- Wind and waves: The complex interactions between wind and water surface, including processes such as breaking waves and wave-induced bubble oscillations and cavitation, are a main source of naturally occurring ambient sound for frequencies between 200 Hz and 50 kHz (Mitson, 1995). In general, ambient sound levels tend to increase with increasing wind speed and wave height. Surf sound becomes important near shore, with measurements collected at a distance of 8.5 km from shore showing an increase of 10 dB in the 100 to 700 Hz band during heavy surf conditions.
- Precipitation: Sound from rain and hail impacting the water surface can become an important component of total sound at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times.
- Biological: Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz.
- Anthropogenic: Sources of ambient sound related to human activity include transportation (surface vessels), dredging and construction, oil and gas drilling and production, seismic surveys, sonar, explosions, and ocean acoustic studies. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly. Sound from identifiable anthropogenic sources other than the activity of interest (*e.g.,* a passing vessel) is sometimes termed background sound, as opposed to ambient sound.

The sum of the various natural and anthropogenic sound sources at any given location and time—which comprise ‘‘ambient’’ or ‘‘background’’ sound—depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of the dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10–20 dB from day to day (Richardson *et al.,* 1995). The result is that, depending on the source type and its intensity, sound from a given activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals. Details of source types are described in the following text.

Sounds are often considered to fall into one of two general types: Pulsed and non-pulsed (defined in the following). The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.,* Ward, 1997 in Southall *et al.,* 2007). Please see Southall *et al.* (2007) for an in-depth discussion of these concepts.

Pulsed sound sources (*e.g.,* airguns, explosions, gunshots, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (ANSI, 1986, 2005; Harris, 1998; NIOSH, 1998; ISO, 2003) and occur either as isolated events or repeated in some succession. Pulsed sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features.

Non-pulsed sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous (ANSI, 1995; NIOSH, 1998). Some of these non-pulsed sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.,* rapid rise time). Examples of non-pulsed sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems (such as those used by the U.S. Navy). The duration of such sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

Airgun arrays produce pulsed signals with energy in a frequency range from about 10–2,000 Hz, with most energy radiated at frequencies below 200 Hz. The amplitude of the acoustic wave emitted from the source is equal in all directions (*i.e.,* omnidirectional), but airgun arrays do possess some directionality due to different phase delays between guns in different directions. Airgun arrays are typically tuned to maximize functionality for data acquisition purposes, meaning that sound transmitted in horizontal directions and at higher frequencies is minimized to the extent possible.

As described above, 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; Table 6), 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; Table 6 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.

Acoustic Effects

Here, we discuss the effects of active acoustic sources on marine mammals.

Potential Effects of Underwater Sound—Please refer to the information given previously (''Description of Active Acoustic Sources'') regarding sound, characteristics of sound types, and metrics used in this document. Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can potentially result in one or more of the following: Temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, stress, and masking (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007; Götz *et al.,* 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range. We first describe specific manifestations of acoustic effects before providing discussion specific to the use of airgun arrays.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal, but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.,* when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

We describe the more severe non-auditory physical or physiological effects only briefly as we do not expect that use of the airgun arrays is reasonably likely to result in such effects (see below for further discussion). Potential effects from impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.,* 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.,* change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007; Zimmer and Tyack, 2007; Tal *et al.,* 2015). The survey activities considered here do not involve the use of devices such as explosives or mid-frequency tactical sonar that are associated with these types of effects.

1. *Threshold Shift*—Marine mammals exposed to high-intensity sound, or to lower-intensity sound for prolonged periods, can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Finneran, 2015). TS can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall *et al.,* 2007). Repeated sound exposure that leads to TTS could cause PTS. In severe cases of PTS, there can be total or partial deafness, while in most cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985).

When PTS occurs, there is physical damage to the sound receptors in the ear (*i.e.,* tissue damage), whereas TTS represents primarily tissue fatigue and is reversible (Southall *et al.,* 2007). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.,* Ward, 1997). Therefore, NMFS does not consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, and there is no PTS data for cetaceans but such relationships are assumed to be similar to those in humans and other terrestrial mammals. PTS typically occurs at exposure levels at least several decibels above (a 40-dB threshold shift approximates PTS onset; *e.g.,* Kryter *et al.,* 1966; Miller, 1974) that inducing mild TTS (a 6-dB threshold shift approximates TTS onset; *e.g.,* Southall *et al.* 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds for impulse sounds (such as airgun pulses as received close to the source) are at least 6 dB higher than the TTS threshold on a peak-pressure basis and PTS cumulative sound exposure level thresholds are 15 to 20 dB higher than TTS cumulative sound exposure level thresholds (Southall *et al.,* 2007). Given the higher level of sound or longer exposure duration necessary to cause PTS as compared with TTS, it is considerably less likely that PTS could occur.

For mid-frequency cetaceans in particular, potential protective mechanisms may help limit onset of TTS or prevent onset of PTS. Such mechanisms include dampening of hearing, auditory adaptation, or behavioral amelioration (*e.g.,* Nachtigall and Supin, 2013; Miller *et al.,* 2012; Finneran *et al.,* 2015; Popov *et al.,* 2016).

TTS is the mildest form of hearing impairment that can occur during exposure to sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard. In terrestrial and marine mammals, TTS can last from minutes or hours to days (in cases of strong TTS). In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals.

Marine mammal hearing plays a critical role in communication with conspecifics, and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.,* recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts.

Finneran *et al.* (2015) measured hearing thresholds in three captive bottlenose dolphins before and after exposure to ten pulses produced by a seismic airgun in order to study TTS induced after exposure to multiple pulses. Exposures began at relatively low levels and gradually increased over a period of several months, with the highest exposures at peak SPLs from 196 to 210 dB and cumulative (unweighted) SELs from 193–195 dB. No substantial TTS was observed. In addition, behavioral reactions were observed that indicated that animals can learn behaviors that effectively mitigate noise exposures (although exposure patterns must be learned, which is less likely in wild animals than for the captive animals considered in this study). The authors note that the failure to induce more significant auditory effects was likely due to the intermittent nature of exposure, the relatively low peak pressure produced by the acoustic source, and the low-frequency energy in airgun pulses as compared with the frequency range of best sensitivity for dolphins and other mid-frequency cetaceans.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale, harbor porpoise, and Yangtze finless porpoise) exposed to a limited number of sound sources (*i.e.,* mostly tones and octave-band noise) in laboratory settings (Finneran, 2015). In general, harbor porpoises have a lower TTS onset than other measured cetacean species (Finneran, 2015). Additionally, the existing marine mammal TTS data come from a limited number of individuals within these species. There are no data available on noise-induced hearing loss for mysticetes.

Critical questions remain regarding the rate of TTS growth and recovery after exposure to intermittent noise and the effects of single and multiple pulses. Data at present are also insufficient to construct generalized models for recovery and determine the time necessary to treat subsequent exposures as independent events. More information is needed on the relationship between auditory evoked potential and behavioral measures of TTS for various stimuli. For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see Southall *et al.* (2007), Finneran and Jenkins (2012), Finneran (2015), and NMFS (2016).

2. *Behavioral Effects*—Behavioral disturbance may include a variety of effects, including subtle changes in behavior (*e.g.,* minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Behavioral responses to sound are highly variable and context-specific and any reactions depend on numerous intrinsic and extrinsic factors (*e.g.,* species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day), as well as the interplay between factors (*e.g.,* Richardson *et al.,* 1995; Wartzok *et al.,* 2003; Southall *et al.,* 2007; Weilgart, 2007; Archer *et al.,* 2010). Behavioral reactions can vary not only among individuals but also within an individual, depending on previous experience with a sound source, context, and numerous other factors (Ellison *et al.,* 2012), and can vary depending on characteristics associated with the sound source (*e.g.,* whether it is moving or stationary, number of sources, distance from the source). Please see Appendices B–C of Southall *et al.* (2007) for a review of studies involving marine mammal behavioral responses to sound.

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.,* 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a ''progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial,'' rather than as, more generally, moderation in response to human disturbance (Bejder *et al.,* 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. As noted, behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al.,* 1995; NRC, 2003; Wartzok *et al.,* 2003). Controlled experiments with captive marine mammals have showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway *et al.,* 1997). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; see also Richardson *et al.,* 1995; Nowacek *et al.,* 2007). However, many delphinids approach acoustic source vessels with no apparent discomfort or obvious behavioral change (*e.g.,* Barkaszi *et al.,* 2012).

Available studies show wide variation in response to underwater sound; therefore, it is difficult to predict specifically how any given sound in a particular instance might affect marine mammals perceiving the signal. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (*e.g.,* Lusseau and Bejder, 2007; Weilgart, 2007; NRC, 2005). However, there are broad categories of potential response, which we describe in greater detail here, that include alteration of dive behavior, alteration of foraging behavior, effects to breathing, interference with or alteration of vocalization, avoidance, and flight.

Changes in dive behavior can vary widely, and may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.,* Frankel and Clark, 2000; Ng and Leung, 2003; Nowacek *et al.;* 2004; Goldbogen *et al.,* 2013a, b). Variations in dive behavior may reflect interruptions in biologically significant activities (*e.g.,* foraging) or they may be of little biological significance. The impact of an alteration to dive behavior resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.,* bubble nets or sediment plumes), or changes in dive behavior. As for other types of behavioral response, the frequency, duration, and temporal pattern of signal presentation, as well as differences in species sensitivity, are likely contributing factors to differences in response in any given circumstance (*e.g.,* Croll *et al.,* 2001; Nowacek *et al.;* 2004; Madsen *et al.,* 2006; Yazvenko *et al.,* 2007). A determination of whether foraging disruptions incur fitness consequences would require information on or estimates of the energetic requirements of the affected individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Visual tracking, passive acoustic monitoring, and movement recording tags were used to quantify sperm whale behavior prior to, during, and following exposure to airgun arrays at received levels in the range 140–160 dB at distances of 7–13 km, following a phase-in of sound intensity and full array exposures at 1–13 km (Madsen *et al.,* 2006; Miller *et al.,* 2009). Sperm whales did not exhibit horizontal avoidance behavior at the surface. However, foraging behavior may have been affected. The sperm whales exhibited 19 percent less vocal (buzz) rate during full exposure relative to post exposure, and the whale that was approached most closely had an extended resting period and did not resume foraging until the airguns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were 6 percent lower during exposure than control periods (Miller *et al.,* 2009). These data raise concerns that seismic surveys may impact foraging behavior in sperm whales, although more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior (Miller *et al.,* 2009).

Variations in respiration naturally vary with different behaviors and alterations to breathing rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Various studies have shown that respiration rates may either be unaffected or could increase, depending on the species and signal characteristics, again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure (*e.g.,* Kastelein *et al.,* 2001, 2005, 2006; Gailey *et al.,* 2007; Gailey *et al.,* 2016).

Marine mammals vocalize for different purposes and across multiple modes, such as whistling, echolocation click production, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result from a need to compete with an increase in background noise or may reflect increased vigilance or a startle response. For example, in the presence of potentially masking signals, humpback whales and killer whales have been observed to increase the length of their songs (Miller *et al.,* 2000; Fristrup *et al.,* 2003; Foote *et al.,* 2004), while right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al.,* 2007). In some cases, animals may cease sound production during production of aversive signals (Bowles *et al.,* 1994).

Cerchio *et al.* (2014) used passive acoustic monitoring to document the presence of singing humpback whales off the coast of northern Angola and to opportunistically test for the effect of seismic survey activity on the number of singing whales. Two recording units were deployed between March and December 2008 in the offshore environment; numbers of singers were counted every hour. Generalized Additive Mixed Models were used to assess the effect of survey day (seasonality), hour (diel variation), moon phase, and received levels of noise (measured from a single pulse during each ten minute sampled period) on singer number. The number of singers significantly decreased with increasing received level of noise, suggesting that humpback whale breeding activity was disrupted to some extent by the survey activity.

Castellote *et al.* (2012) reported acoustic and behavioral changes by fin whales in response to shipping and airgun noise. Acoustic features of fin whale song notes recorded in the Mediterranean Sea and northeast Atlantic Ocean were compared for areas with different shipping noise levels and traffic intensities and during a seismic airgun survey. During the first 72 h of the survey, a steady decrease in song received levels and bearings to singers indicated that whales moved away from the acoustic source and out of the study area. This displacement persisted for a time period well beyond the 10-day duration of seismic airgun activity, providing evidence that fin whales may avoid an area for an extended period in the presence of increased noise. The authors hypothesize that fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement.

Seismic pulses at average received levels of 131 dB re 1 μPa^2-s caused blue whales to increase call production (Di Iorio and Clark, 2010). In contrast, McDonald *et al.* (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 10 km from the acoustic source vessel (estimated received level 143 dB pk-pk). Blackwell *et al.* (2013) found that bowhead whale call rates dropped significantly at onset of airgun use at sites with a median distance of 41–45 km from the survey. Blackwell *et al.* (2015) expanded this analysis to show that whales actually increased calling rates as soon as airgun signals were detectable before ultimately decreasing calling rates at higher received levels (*i.e.,* 10-minute SEL_{cum} of ~127 dB). Overall, these results suggest that bowhead whales may adjust their vocal output in an effort to compensate for noise before ceasing vocalization effort and ultimately deflecting from the acoustic source (Blackwell *et al.,* 2013, 2015). These studies demonstrate that even low levels of noise received far from the source can induce changes in vocalization and/or behavior for mysticetes.

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of a sound or other stressors, and is one of the most obvious manifestations of disturbance in marine mammals (Richardson *et al.,* 1995). For example, gray whales are known to change direction—deflecting from customary migratory paths—in order to avoid noise from seismic surveys (Malme *et al.,* 1984). Humpback whales showed avoidance behavior in the presence of an active seismic array during observational studies and controlled exposure experiments in western Australia (McCauley *et al.,* 2000). Avoidance may be short-term, with animals returning to the area once the noise has ceased (*e.g.,* Bowles *et al.,* 1994; Goold, 1996; Stone *et al.,* 2000; Morton and Symonds, 2002; Gailey *et al.,* 2007). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.,* Bejder *et al.,* 2006; Teilmann *et al.,* 2006).

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. The flight response differs from other avoidance responses in the intensity of the response (*e.g.,* directed movement, rate of travel). Relatively little information on flight responses of marine mammals to anthropogenic signals exist, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996). The result of a flight response could range from brief, temporary exertion and displacement from the area where the signal provokes flight to, in extreme cases, marine mammal strandings (Evans and England, 2001). However, it should be noted that response to a perceived predator does not necessarily invoke flight (Ford and Reeves, 2008), and whether individuals are solitary or in groups may influence the response.

Behavioral disturbance can also impact marine mammals in more subtle ways. Increased vigilance may result in costs related to diversion of focus and attention (*i.e.,* when a response consists of increased vigilance, it may come at the cost of decreased attention to other critical behaviors such as foraging or resting). These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (*e.g.,* Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002; Purser and Radford, 2011). In addition, chronic disturbance can cause population declines through reduction of fitness (*e.g.,* decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g.,* Harrington and Veitch, 1992; Daan *et al.,* 1996; Bradshaw *et al.,* 1998). However, Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five-day period did not cause any sleep deprivation or stress effects.

Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Disruption of such functions resulting from reactions to stressors such as sound exposure are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). Note that there is a difference between multi-day substantive behavioral reactions and multi-day anthropogenic activities. For example, just because an activity lasts for multiple days does not necessarily mean that individual animals are either exposed to activity-related stressors for multiple days or, further, exposed in a manner resulting in sustained multi-day substantive behavioral responses.

Stone (2015) reported data from at-sea observations during 1,196 seismic surveys from 1994 to 2010. When large arrays of airguns (considered to be 500 in^3 or more) were firing, lateral displacement, more localized avoidance, or other changes in behavior were evident for most odontocetes. However, significant responses to large arrays were found only for the minke whale and fin whale. Behavioral responses observed included changes in swimming or surfacing behavior, with indications that cetaceans remained near the water surface at these times. Cetaceans were recorded as feeding less often when large arrays were active. Behavioral observations of gray whales during a seismic survey monitored whale movements and respirations pre-, during and post-seismic survey (Gailey *et al.,* 2016). Behavioral state and water depth were the best 'natural' predictors of whale movements and respiration and, after considering natural variation, none of the response variables were significantly associated with seismic survey or vessel sounds.

3. *Stress Responses*—An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (*e.g.,* Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Neuroendocrine stress responses often involve the hypothalamus-pituitary-adrenal system. Virtually all neuroendocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction, altered metabolism, reduced immune competence, and behavioral disturbance (*e.g.,* Moberg, 1987; Blecha, 2000). Increases in the circulation of glucocorticoids are also equated with stress (Romano *et al.,* 2004).

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and ''distress'' is the cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose serious fitness consequences. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other functions. This state of distress will last until the animal replenishes its energetic reserves sufficiently to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well-studied through controlled experiments and for both laboratory and free-ranging animals (*e.g.,* Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker, 2000; Romano *et al.,* 2002b) and, more rarely, studied in wild populations (*e.g.,* Romano *et al.,* 2002a). For example, Rolland *et al.* (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as ''distress.'' In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003).

4. *Auditory Masking*—Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.,* those used for intraspecific communication and social interactions, prey detection, predator avoidance, navigation) (Richardson *et al.,* 1995; Erbe *et al.,* 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.,* snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.,* shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.,* signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.,* sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age or TTS hearing loss), and existing ambient noise and propagation conditions.

Under certain circumstances, marine mammals experiencing significant masking could also be impaired from maximizing their performance fitness in survival and reproduction. Therefore, when the coincident (masking) sound is man-made, it may be considered harassment when disrupting or altering critical behaviors. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without resulting in TS) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in determining any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect detection of mysticete communication calls and other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (*e.g.,* Clark *et al.,* 2009) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.,* Miller *et al.,* 2000; Foote *et al.,* 2004; Parks *et al.,* 2007; Di Iorio and Clark, 2009; Holt *et al.,* 2009). Masking can be reduced in situations where the signal and noise come from different directions (Richardson *et al.,* 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.,* Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.,* Branstetter *et al.,* 2013).

Masking affects both senders and receivers of acoustic signals and can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.,* from vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

Other Potential Impacts

Here, we discuss potential effects of the proposed activity on marine mammals other than sound.

Ship Strike—Vessel collisions with marine mammals, or ship strikes, can result in death or serious injury of the animal. Wounds resulting from ship strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). An animal at the surface may be struck directly by a vessel, a surfacing animal may hit the bottom of a vessel, or an animal just below the surface may be cut by a vessel's propeller. Superficial strikes may not kill or result in the death of the animal. These interactions are typically associated with large whales (*e.g.,* fin whales), which are occasionally found draped across the bulbous bow of large commercial ships upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, they may also be susceptible to strike. The severity of injuries typically depends on the size and speed of the vessel, with the probability of death or serious injury increasing as vessel speed increases (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al.,* 2010; Gende *et al.,* 2011).

Pace and Silber (2005) also found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 kn, and exceeded 90 percent at 17 kn. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death through increased likelihood of collision by pulling whales toward the vessel (Clyne, 1999; Knowlton *et al.,* 1995). In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 kn. The chances of a lethal injury decline from approximately 80 percent at 15 kn to approximately 20 percent at 8.6 kn. At speeds below 11.8 kn, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward one hundred percent above 15 kn.

The *Langseth* travels at a speed of ~8.3 km/hour while towing seismic survey gear (LGL 2017). At this speed, both the possibility of striking a marine mammal and the possibility of a strike resulting in serious injury or mortality are discountable. At average transit speed, the probability of serious injury or mortality resulting from a strike is less than 50 percent. However, the likelihood of a strike actually happening is again discountable. Ship strikes, as analyzed in the studies cited above, generally involve commercial shipping, which is much more common in both space and time than is geophysical survey activity. Jensen and Silber (2004) summarized ship strikes of large whales worldwide from 1975–2003 and found that most collisions occurred in the open ocean and involved large vessels (*e.g.,* commercial shipping). Commercial fishing vessels were responsible for three percent of recorded collisions, while no such incidents were reported for geophysical survey vessels during that time period.

It is possible for ship strikes to occur while traveling at slow speeds. For example, a hydrographic survey vessel traveling at low speed (5.5 kn) while conducting mapping surveys off the central California coast struck and killed a blue whale in 2009. The State of California determined that the whale had suddenly and unexpectedly surfaced beneath the hull, with the result that the propeller severed the whale's vertebrae, and that this was an unavoidable event. This strike represents the only such incident in approximately 540,000 hours of similar coastal mapping activity ($p = 1.9 \times 10^{-6}$; 95% CI = $0–5.5 \times 10^{-6}$; NMFS, 2013b). In addition, a research vessel reported a fatal strike in 2011 of a dolphin in the Atlantic, demonstrating that it is possible for strikes involving smaller cetaceans to occur. In that case, the incident report indicated that an animal apparently was struck by the vessel's propeller as it was intentionally swimming near the vessel. While indicative of the type of unusual events that cannot be ruled out, neither of these instances represents a circumstance that would be considered reasonably foreseeable or that would be considered preventable.

Although the likelihood of the vessel striking a marine mammal is low, we require a robust ship strike avoidance protocol (see ''Proposed Mitigation''), which we believe eliminates any foreseeable risk of ship strike. We anticipate that vessel collisions involving a seismic data acquisition vessel towing gear, while not impossible, represent unlikely, unpredictable events for which there are no preventive measures. Given the required mitigation measures, the relatively slow speed of the vessel towing gear, the presence of bridge crew watching for obstacles at all times (including marine mammals), and the presence of marine mammal observers, we believe that the possibility of ship strike is discountable and, further, that were a strike of a large whale to occur, it would be unlikely to result in serious injury or mortality. No incidental take resulting from ship strike is anticipated, and this potential effect of the specified activity will not be discussed further in the following analysis.

Stranding— When a living or dead marine mammal swims or floats onto shore and becomes ''beached'' or incapable of returning to sea, the event is a ''stranding'' (Geraci *et al.,* 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding within the United States under the MMPA is that ''(A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance'' (16 U.S.C. 1421h(3)).

Marine mammals strand for a variety of reasons, such as infectious agents, biotoxicosis, starvation, fishery interaction, ship strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series. However, the cause or causes of most strandings are unknown (Geraci *et al.,* 1976; Eaton, 1979; Odell *et al.,* 1980; Best, 1982). Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Chroussos, 2000; Creel, 2005; DeVries *et al.,* 2003; Fair and Becker, 2000; Foley *et al.,* 2001; Moberg, 2000; Relyea, 2005a; 2005b, Romero, 2004; Sih *et al.,* 2004).

Use of military tactical sonar has been implicated in a majority of investigated stranding events, although one stranding event was associated with the use of seismic airguns. This event occurred in the Gulf of California, coincident with seismic reflection profiling by the R/V *Maurice Ewing* operated by Columbia University's Lamont-Doherty Earth Observatory and involved two Cuvier's beaked whales (Hildebrand, 2004). The vessel had been firing an array of 20 airguns with a total volume of 8,500 in^3 (Hildebrand, 2004; Taylor *et al.,* 2004). Most known stranding events have involved beaked whales, though a small number have involved deep-diving delphinids or sperm whales (*e.g.,* Mazzariol *et al.,* 2010; Southall *et al.,* 2013). In general, long duration (~1 second) and high-intensity sounds (>235 dB SPL) have been implicated in stranding events (Hildebrand, 2004). With regard to beaked whales, mid-frequency sound is typically implicated (when causation can be determined) (Hildebrand, 2004). Although seismic airguns create predominantly low-frequency energy, the signal does include a mid-frequency component. We have considered the potential for the proposed survey to result in marine mammal stranding and have concluded that, based on the best available information, stranding is not expected to occur.

Entanglement and discharges—We are not aware of any records of marine mammal entanglement in towed arrays such as those considered here. The discharge of trash and debris is prohibited (33 CFR 151.51–77) unless it is passed through a machine that breaks up solids such that they can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. Some personal items may be accidentally lost overboard. However, U.S. Coast Guard and Environmental Protection Act regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. There are no meaningful entanglement risks posed by the described activity, and entanglement risks are not discussed further in this document.

Marine mammals could be affected by accidentally spilled diesel fuel from a vessel associated with proposed survey activities. Quantities of diesel fuel on the sea surface may affect marine mammals through various pathways: Surface contact of the fuel with skin and other mucous membranes, inhalation of concentrated petroleum vapors, or ingestion of the fuel (direct ingestion or by the ingestion of oiled prey) (*e.g.,* Geraci and St. Aubin, 1980, 1985, 1990). However, the likelihood of a fuel spill during any particular geophysical survey is considered to be remote, and the potential for impacts to marine mammals would depend greatly on the size and location of a spill and meteorological conditions at the time of the spill. Spilled fuel would rapidly spread to a layer of varying thickness and break up into narrow bands or windrows parallel to the wind direction. The rate at which the fuel spreads would be determined by the prevailing conditions such as temperature, water currents, tidal streams, and wind speeds. Lighter, volatile components of the fuel would evaporate to the atmosphere almost completely in a few days. Evaporation rate may increase as the fuel spreads because of the increased surface area of the slick. Rougher seas, high wind speeds, and high temperatures also tend to increase the rate of evaporation and the proportion of fuel lost by this process (Scholz *et al.,* 1999). We do not anticipate potentially meaningful effects to marine mammals as a result of any contaminant spill resulting from the proposed survey activities, and contaminant spills are not discussed further in this document.

Anticipated Effects on Marine Mammal Habitat

Effects to Prey—Marine mammal prey varies by species, season, and location and, for some, is not well documented. Fish react to sounds which are especially strong and/or intermittent low-frequency sounds. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Hastings and Popper (2005) identified several studies that suggest fish may relocate to avoid certain areas of sound energy. Additional studies have documented effects of pulsed sound on fish, although several are based on studies in support of construction projects (*e.g.,* Scholik and Yan, 2001, 2002; Popper and Hastings, 2009). Sound pulses at received levels of 160 dB may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Pearson *et al.,* 1992; Skalski *et al.,* 1992). SPLs of sufficient strength have been known to cause injury to fish and fish mortality. The most likely impact to fish from survey activities at the project area would be temporary avoidance of the area. The duration of fish avoidance of a given area after survey effort stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated.

Information on seismic airgun impacts to zooplankton, which represent an important prey type for mysticetes, is limited. However, McCauley *et al.* (2017) reported that experimental exposure to a pulse from a 150 inch^3 airgun decreased zooplankton abundance when compared with controls, as measured by sonar and net tows, and caused a two- to threefold increase in dead adult and larval zooplankton. Although no adult krill were present, the study found that all larval krill were killed after air gun passage. Impacts were observed out to the maximum 1.2 km range sampled.

In general, impacts to marine mammal prey are expected to be limited due to the relatively small temporal and spatial overlap between the proposed survey and any areas used by marine mammal prey species. The proposed survey would occur over a relatively short time period (90 days) and would occur over a very small area relative to the area available as marine mammal habitat in the Pacific Ocean off New Zealand. We do not have any information to suggest the proposed survey area represents a significant feeding area for any marine mammal, and we believe any impacts to marine mammals due to adverse affects to their prey would be insignificant due to the limited spatial and temporal impact of the proposed survey. However, adverse impacts may occur to a few species of fish and to zooplankton.

Acoustic Habitat—Acoustic habitat is the soundscape—which encompasses all of the sound present in a particular location and time, as a whole—when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.,* produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are also defined by, and acoustic habitat influenced by, the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic, or may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of airgun arrays). Anthropogenic noise varies widely in its frequency content, duration, and loudness and these characteristics greatly influence the potential habitat-mediated effects to marine mammals (please see also the previous discussion on masking under ''Acoustic Effects''), which may range from local effects for brief periods of time to chronic effects over large areas and for long durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). For more detail on these concepts see, *e.g.,* Barber *et al.,* 2010; Pijanowski *et al.,* 2011; Francis and Barber, 2013; Lillis *et al.,* 2014.

Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). Although the signals emitted by seismic airgun arrays are generally low frequency, they would also likely be of short duration and transient in any given area due to the nature of these surveys. As described previously, exploratory surveys such as these cover a large area but would be transient rather than focused in a given location over time and therefore 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.

Estimated Take

This section provides an estimate of the number of incidental takes proposed for authorization through this IHA, which will inform both NMFS' consideration of whether the number of takes is ''small'' and the negligible impact determination.

Harassment is the only type of take expected to result from these activities. Except with respect to certain activities not pertinent here, section 3(18) of the MMPA defines ''harassment'' as: Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

Authorized takes would primarily be by Level B harassment, as use of the seismic airguns have the potential to result in disruption of behavioral patterns for individual marine mammals. There is also some potential for auditory injury (Level A harassment) to result, primarily for mysticetes and high frequency cetaceans (*i.e.,* kogiidae spp.), due to larger predicted auditory injury zones for those functional hearing groups. Auditory injury is unlikely to occur for mid-frequency species given very small modeled zones of injury for those species. The proposed mitigation and monitoring measures are expected to minimize the severity of such taking to the extent practicable.

As described previously, no serious injury or mortality is anticipated or proposed to be authorized for this activity. Below we describe how the take is estimated.

Described in the most basic way, we estimate take by considering: (1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and (4) and the number of days of activities. Below, we describe these components in more detail and present the exposure estimate and associated numbers of take proposed for authorization.

Acoustic Thresholds

Using the best available science, NMFS has developed acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur PTS of some degree (equated to Level A harassment).

Level B Harassment for non-explosive sources— Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.,* frequency, predictability, duty cycle), the environment (*e.g.,* bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.,* 2007, Ellison *et al.* 2011). Based on the best available science and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed in a manner we consider to fall under Level B harassment when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 µPa (rms) for continuous sources (*e.g.* vibratory pile-driving, drilling) and above 160 dB re 1 µPa (rms) for non-explosive impulsive (*e.g.,* seismic airguns) or intermittent (*e.g.,* scientific sonar) sources. L–DEO's proposed activity includes the use of impulsive seismic sources. Therefore, the 160 dB re 1 µPa (rms) criteria is applicable for analysis of level B harassment.

Level A harassment for non-explosive sources—NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS, 2016) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). The Technical Guidance identifies the received levels, or thresholds, above which individual marine mammals are predicted to experience changes in their hearing sensitivity for all underwater anthropogenic sound sources, reflects the best available science, and better predicts the potential for auditory injury than does NMFS' historical criteria.

These thresholds were developed by compiling and synthesizing the best available science and soliciting input multiple times from both the public and peer reviewers to inform the final product, and are provided in Table 4 below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS 2016 Technical Guidance, which may be accessed at: *http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm.* As described above, L–DEO's proposed activity includes the use of intermittent and impulsive seismic sources.

TABLE 4—THRESHOLDS IDENTIFYING THE ONSET OF PERMANENT THRESHOLD SHIFT IN MARINE MAMMALS

Hearing group	PTS onset thresholds	
	Impulsive *	Non-impulsive
Low-Frequency (LF) Cetaceans	*Lpk,flat*: 219 dB, $L_{E,LF,24h}$: 183 dB	$L_{E,LF,24h}$: 199 dB.
Mid-Frequency (MF) Cetaceans	*Lpk,flat*: 230 dB, $L_{E,MF,24h}$: 185 dB	$L_{E,MF,24h}$: 198 dB.
High-Frequency (HF) Cetaceans	*Lpk,flat*: 202 dB, $L_{E,HF,24h}$: 155 dB	$L_{E,HF,24h}$: 173 dB.
Phocid Pinnipeds (PW) (Underwater)	*Lpk,flat*: 218 dB, $L_{E,PW,24h}$: 185 dB	$L_{E,PW,24h}$: 201 dB.
Otariid Pinnipeds (OW) (Underwater)	*Lpk,flat*: 232 dB, $L_{E,OW,24h}$: 203 dB	$L_{E,OW,24h}$: 219 dB.

Note: *Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (Lpk) has a reference value of 1 µPa, and cumulative sound exposure level (LE) has a reference value of 1µPa2s. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (*i.e.,* varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

Ensonified Area

Here, we describe operational and environmental parameters of the activity that will feed into estimating the area ensonified above the relevant acoustic thresholds.

The proposed survey would entail use of a 36-airgun array with a total discharge of 6,600 in^3 at a tow depth of 9 m and an 18-airgun array with a total discharge of 3,300 in^3 at a tow depth of 7–9 m. Received sound levels were predicted by L–DEO's model (Diebold *et al.,* 2010) as a function of distance from the 36-airgun array and 18-airgun array and for a single 40-in^3 airgun which would be used during power downs; all models used a 9 m tow depth. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (approximately 1600 m), intermediate water depth on the slope (approximately 600–1100 m), and shallow water (approximately 50 m) in the Gulf of Mexico in 2007–2008 (Tolstoy *et al.* 2009; Diebold *et al.* 2010).

For deep and intermediate-water cases, L–DEO determined that the field measurements cannot be used readily to derive mitigation radii, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 m, which may not intersect all the SPL isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of approximately 2,000 m (See Appendix H in NSF–USGS 2011). At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep and slope sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the mitigation model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant. Please see the IHA application for further discussion of summarized results.

For deep water (>1000 m), L–DEO used the deep-water radii obtained from model results down to a maximum water depth of 2000 m. The radii for intermediate water depths (100–1000 m) were derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (See Fig. 16 in Appendix H of NSF–USGS, 2011). The shallow-water radii were obtained by scaling the empirically derived measurements from the Gulf of Mexico calibration survey to account for the differences in tow depth between the calibration survey (6 m) and the proposed surveys (9 m). A simple scaling factor is calculated from the ratios of the isopleths determined by the deep-water L–DEO model, which are essentially a measure of the energy radiated by the source array.

Measurements have not been reported for the single 40-in^3 airgun. L–DEO model results are used to determine the 160-dB (rms) radius for the 40-in^3 airgun at a 9 m tow depth in deep water (See LGL 2017, Figure 6). For intermediate-water depths, a correction factor of 1.5 was applied to the deep-water model results. For shallow water, a scaling of the field measurements obtained for the 36-airgun array was used.

L–DEO's modeling methodology is described in greater detail in the IHA application (LGL 2017) and we refer the reader to that document rather than repeating it here. The estimated distances to the Level B harassment isopleth for the *Langseth's* 36-airgun array, 18-airgun array, and the single 40-in^3 airgun are shown in Table 5.

TABLE 5—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.

[1] Distances for depths >1000 m are based on L–DEO model results. Distance for depths 100–1000 m are based on L–DEO model results with a 1.5 × correction factor between deep and intermediate water depths. Distances for depths <100 m are based on empirically derived measurements in the Gulf of Mexico with scaling applied to account for differences in tow depth.

Predicted distances to Level A harassment isopleths, which vary based on marine mammal hearing groups (Table 3), were calculated based on modeling performed by L–DEO using the NUCLEUS software program and the NMFS User Spreadsheet, described below. The updated acoustic thresholds for impulsive sounds (*e.g.,* airguns) contained in the Technical Guidance were presented as dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure metrics (NMFS 2016). As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (*i.e.,* metric resulting in the largest isopleth). The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group. In recognition of the fact that the requirement to calculate Level A harassment ensonified areas could be more technically challenging to predict due to the duration component and the use of weighting functions in the new SEL_{cum} thresholds, NMFS developed an optional User Spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to facilitate the estimation of take numbers.

The values for SEL_{cum} and peak SPL for the *Langseth* airgun array were derived from calculating the modified farfield signature (Table 6). The farfield signature is often used as a theoretical representation of the source level. To compute the farfield signature, the source level is estimated at a large distance below the array (*e.g.,* 9 km), and this level is back projected mathematically to a notional distance of 1 m from the array's geometrical center. However, when the source is an array of multiple airguns separated in space, the source level from the theoretical farfield signature is not necessarily the best measurement of the source level that is physically achieved at the source (Tolstoy *et al.* 2009). Near the source (at short ranges, distances <1 km), the pulses of sound pressure from each individual airgun in the source array do not stack constructively, as they do for the theoretical farfield signature. The pulses from the different airguns spread out in time such that the source levels observed or modeled are the result of the summation of pulses from a few airguns, not the full array (Tolstoy *et al.* 2009). At larger distances, away from the source array center, sound pressure of all the airguns in the array stack coherently, but not within one time sample, resulting in smaller source levels (a few dB) than the source level derived from the farfield signature. Because the farfield signature does not take into account the large array effect near the source and is calculated as a point source, the modified farfield signature is a more appropriate measure of the sound source level for distributed sound sources, such as airgun arrays. L–DEO used the acoustic modeling methodology as used for Level B takes with a small grid step of 1 m in both the inline and depth directions. The propagation modeling takes into account all airgun interactions at short distances from the source, including interactions between subarrays which are modeled using the NUCLEUS software to estimate the notional signature and MATLAB software to calculate the pressure signal at each mesh point of a grid.

TABLE 6—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

In order to more realistically incorporate the Technical Guidance's weighting functions over the seismic array's full acoustic band, unweighted spectrum data for the *Langseth's* airgun array (modeled in 1 Hz bands) was used to make adjustments (dB) to the unweighted spectrum levels, by frequency, according to the weighting functions for each relevant marine mammal hearing group. These adjusted/weighted spectrum levels were then converted to pressures (micropascals) in order to integrate them over the entire broadband spectrum, resulting in broadband weighted source levels by hearing group that could be directly incorporated within the User Spreadsheet (*i.e.,* to override the Spreadsheet's more simple weighting factor adjustment). Using the User Spreadsheet's ''safe distance'' methodology for mobile sources (described by Sivle *et al.,* 2014) with the hearing group-specific weighted source levels, and inputs assuming spherical spreading propagation and source velocities and shot intervals specific to each of the three proposed surveys (Table 1), potential radial distances to auditory injury zones were then calculated for SEL$_{cum}$ thresholds.

Inputs to the User Spreadsheets in the form of estimated SLs are shown in Table 6. User Spreadsheets used by L–DEO to estimate distances to Level A harassment isopleths (SEL$_{cum}$) for the 36-airgun array, 18-airgun array, and the single 40 in^3 airgun for the South Island 2–D survey, North Island 2–D survey, and North Island 3–D survey are shown in Tables 3, 4, 7, 10, 11, and 12, of the IHA application (LGL 2017). Outputs from the User Spreadsheets in the form of estimated distances to Level A harassment isopleths for the South Island 2–D survey, North Island 2–D survey, and North Island 3–D survey are shown in Tables 7, 8 and 9, respectively. As described above, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the dual metrics (SEL$_{cum}$ and Peak SPL$_{flat}$) is exceeded (*i.e.,* metric resulting in the largest isopleth).

TABLE 7—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 8—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 9—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

Note that because of some of the assumptions included in the methods used, isopleths produced may be overestimates to some degree, which will ultimately result in some degree of overestimate of Level A take. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 3D modeling methods are not available, and NMFS continues to develop ways to quantitatively refine these tools and will qualitatively address the output where appropriate. For mobile sources, such as the proposed seismic survey, the User Spreadsheet predicts the closest distance at which a stationary animal would not incur PTS if the sound source traveled by the animal in a straight line at a constant speed.

Marine Mammal Occurrence

In this section we provide the information about the presence, density, or group dynamics of marine mammals that will inform the take calculations. The best available scientific information was considered in conducting marine mammal exposure estimates (the basis for estimating take).

No systematic aircraft- or ship-based surveys have been conducted for marine mammals in offshore waters of the South Pacific Ocean off New Zealand that can be used to estimate species densities that we are aware of, with the exception of Hector's dolphin surveys that have occurred off the South Island. Densities for Hector's dolphins off the South Island were estimated using averaged estimated summer densities from the most southern stratum of an East Coast South Island survey (Otago) and a West Coast South Island survey (Milford Sound), both in three offshore strata categories (0–4 nm, 4–12 nm, and 12–20 nm; MacKenzie and Clement 2014, 2016). The estimated density for Hector's dolphins for the South Island 2–D survey was based on the proportion of that survey occurring in each offshore stratum.

For cetacean species other than Hector's dolphin, densities were derived from data available for the Southern Ocean (Butterworth *et al.* 1994; Kasamatsu and Joyce 1995) (See Table 17 in the IHA application). Butterworth *et al.* (1994) provided comparable data for sei, fin, blue, and sperm whales extrapolated to latitudes 30–40° S., 40–50° S., and 50–60° S. based on Japanese scouting vessel data from 1965/66–1977/78 and 1978/79–1987/88. Densities were calculated for these species based on abundances and surface areas provided in Butterworth *et al.* (1994) using the mean density for the more recent surveys (1978/79–1987/88) and the 30–40° S. and 40–50° S. strata, because the proposed survey areas are between ~37° S. and 50° S. Densities were corrected for mean trackline detection probability, *g*(0) availability bias, using mean *g*(0) values provided for these species during NMFS Southwest Fisheries Science Center ship-based surveys between 1991–2014 (Barlow 2016). Data for the humpback whale was also presented in Butterworth *et al.* (1994), but, based on the best available information, it was determined that the density values presented for humpback whales in Butterworth *et al.* (1994) were likely lower than would be expected in the proposed survey areas, thus the density for humpback whales was ultimately calculated in the same way as for the baleen whales for which density data was unavailable. Kasamatsu and Joyce (1995) provided data for beaked whales, killer whales, long-finned pilot whales, and Hourglass dolphins, based on surveys conducted as part of the International Whaling Commission/International Decade of Cetacean Research–Southern Hemisphere Minke Whale Assessment, started in 1978/79, and the Japanese sightings survey program started in 1976/77. Densities for these species were calculated based on abundances and surface areas provided in Kasamatsu and Joyce (1995) for Antarctic Areas V EMN and VI WM, which represent the two areas reported in Kasamatsu and Joyce (1995) that are nearest to the proposed South Island survey area. Densities were corrected for availability bias using mean *g*(0) values provided by Kasamatsu and Joyce (1995) for beaked whales, killer whales, and long-fined pilot whales, and provided by Barlow (2016) for the Hourglass dolphin using the mean *g*(0) calculated for unidentified dolphins during NMFS Southwest Fisheries Science Center ship-based surveys between 1991–2014.

For the remaining cetacean species, the relative abundances of individual species expected to occur in the survey areas were estimated within species groups. The relative abundances of these species were estimated based on several factors, including information on marine mammal observations from areas near the proposed survey areas (*e.g.,* monitoring reports from previous IHAs (NMFS, 2015); datasets of opportunistic sightings (Torres *et al.,* 2014); and analyses of observer data from other marine geophysical surveys conducted in New Zealand waters (Blue Planet, 2016)), information on latitudinal ranges and group sizes of marine mammals in New Zealand waters (*e.g.,* Jefferson *et al.,* 2015; NABIS, 2017; Perrin *et al.,* 2009), and other information on marine mammals in and near the proposed survey areas (*e.g.,* data on marine mammal bycatch in New Zealand fisheries (Berkenbush *et al.,* 2013), data on marine mammal strandings (New Zealand Marine Mammal Strandings and Sightings Database); and input from subject matter experts (pers. comm., E. Slooten, Univ. of Otago, to H. Goldstein, NMFS, April 11, 2015)).

For each species group (*i.e.,* mysticetes), densities of species for which data were available were averaged to get a mean density for the group (*e.g.,* densities of fin, sei, and blue whale were averaged to get a mean density for mysticetes). Relative abundances of those species were then averaged to get a mean relative abundances (*e.g.,* relative abundance of fin, sei, and blue whale were averaged to get a mean relative abundance for mysticetes). For the species for which density data was unavailable, their relative abundance score was multiplied by the mean density of their respective species group (*i.e.,* relative abundance of minke whale was multiplied by mean density for mysticetes). The product was then divided by the mean relative abundance of the species group to come up with a density estimate. The fin, sei, and blue whale densities calculated from Butterworth *et al.* (1994) were proportionally averaged and used to estimate the densities of the remaining mysticetes. The sperm whale density calculated from Butterworth *et al.* (1994) was used to estimate the density of the other *Physeteridae* species, the pygmy sperm whale. The Hourglass dolphin, killer whale, and long-finned pilot whale densities calculated from Kasamatsu and Joyce (1995) were proportionally averaged and used to estimate the densities of the other *Delphinidae* for which density data was not available. For beaked whales, the beaked whale density calculated from Kasamatsu and Joyce (1995) was proportionally allocated according to each beaked whale species' estimated relative abundance value.

We are not aware of any information regarding at-sea densities of pinnipeds off New Zealand. As such, a surrogate species (northern fur seal) was used to estimate offshore pinniped densities for the proposed surveys. The at-sea density of northern fur seals reported in Bonnell *et al.* (1992), based on systematic aerial surveys conducted in 1989–1990 in offshore areas off the west coast of the U.S., was used to estimate the numbers of pinnipeds that might be present off New Zealand. The northern fur seal density reported in Bonnell *et al.* (1992) was used as the New Zealand fur seal density. Densities for the other three pinniped species expected to occur in the proposed survey areas were proportionally allocated relative to the value of the density of the northern fur seal, in accordance to the estimated relative abundance value of each of the other pinniped species.

NMFS acknowledges there is some uncertainty related to the estimated density data and the assumptions used in their calculations. Given the lack of available data on marine mammal density in the proposed survey areas, the approach used is based on the best available data. In recognition of the uncertainties in the density data, we have proposed an additional 25 percent contingency in take estimates to account for the fact that density estimates used to estimate take may be underestimates of actual densities of marine mammals in the survey area.

Take Calculation and Estimation

Here we describe how the information provided above is brought together to produce a quantitative take estimate. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in Level A harassment or Level B harassment, radial distances from the airgun array to predicted isopleths corresponding to the Level A harassment and Level B harassment thresholds are calculated, as described above. Those radial distances are then used to calculate the area(s) around the airgun array predicted to be ensonified to sound levels that exceed the Level A harassment and Level B harassment thresholds. The area estimated to be ensonified in a single day of the survey is then calculated (Table 10), based on the areas predicted to be ensonified around the array and the estimated trackline distance traveled per day. This number is then multiplied by the number of survey days (*i.e.,* 35 days for the North Island 2–D survey, 33 days for the North Island 3–D survey, and 22 days for the South Island 2–D survey). The product is then multiplied by 1.5 to account for an additional 25 percent 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 in acknowledgement of uncertainties in available density estimates, as described above. This results in an estimate of the total areas (km^2) expected to be ensonified to the Level A harassment and Level B harassment thresholds. For purposes of Level B take calculations, areas estimated to be ensonified to Level A harassment thresholds are subtracted from total areas estimated to be ensonified to Level B harassment thresholds in order to avoid double counting the animals taken (*i.e.,* if an animal is taken by Level A harassment, it is not also counted as taken by Level B harassment). The marine mammals predicted to occur within these respective areas, based on estimated densities, are assumed to be incidentally taken.

Table 10—Areas (km^2) Estimated To Be Ensonified to Level A and Level B Harassment Thresholds Per Day for Three Proposed Seismic Surveys off New Zealand

Survey	Level B harassment threshold	Level A harassment threshold[1]				
	All marine mammals	Low frequency cetaceans	Mid frequency cetaceans	High frequency cetaceans	Otariid Pinnipeds	Phocid Pinnipeds
North Island 2–D Survey	1,931.3	144.5	3.9	65.8	3.1	12.0
North Island 3–D Survey	1,067.3	29.1	4.5	47.5	3.9	10.0
South Island 2–D Survey	1,913.4	111.1	4.1	86.3	3.2	12.4

[1] Level A ensonified areas are estimated based on the greater of the distances calculated to Level A isopleths using dual criteria (SEL_{cum} and $_{peak}SPL$).

Note: Estimated areas shown for single day do not include additional 50 percent contingency.

Factors including water depth, array configuration, and proportion of each survey occurring within territorial seas (versus within the EEZ) were also accounted for in estimates of ensonified areas. This was accomplished by selecting track lines for a single day (for each of the three proposed surveys) that were representative of the entire proposed survey(s) and using those representative track lines to calculate daily ensonified areas. Daily track line distance was selected depending on array configuration (*i.e.,* 160 km per day for the proposed 2–D surveys, 200 km per day for the proposed 3–D survey). Representative daily track lines were chosen to reflect the proportion of water depths (*i.e.,* less than 100 m, 100–1,000 m, and greater than 1,000 m) expected to occur for that entire survey (Table 5) as distances to isopleths corresponding to harassment vary depending on water depth (Table 5), and water depths vary considerably within the planned survey areas (Table 1). Representative track lines were also selected to reflect the amount of effort in the New Zealand territorial sea (versus within the New Zealand EEZ), for each of the three surveys, as NMFS does not authorize the incidental take of marine mammals within the New Zealand territorial sea. For example, for the proposed North Island 2–D survey approximately 9 percent of survey effort would occur in the New Zealand territorial sea (Table 1). Thus, representative track lines that were chosen also had approximately 9 percent of survey effort in territorial seas; the resultant ensonified areas within territorial seas were excluded from take calculations.

Estimated takes for all marine mammal species are shown in Tables 11, 12, 13 and 14. As described above, we propose to authorize the incidental takes that are expected to occur as a result of the proposed surveys within the New Zealand EEZ but outside of the New Zealand territorial sea.

TABLE 11—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	Total proposed Level A and Level B takes as a percentage of population
Southern right whale	0.24	2	23	25	0.18
Pygmy right whale	0.10	1	10	11	N.A.
Humpback whale	0.24	2	23	25	0.05
Bryde's whale	0.14	1	14	15	0.03
Common minke whale	0.14	1	14	15	<0.01
Antarctic minke whale	0.14	1	14	15	<0.01
Sei whale	0.14	1	14	15	0.13
Fin whale	0.25	2	24	26	0.14
Blue whale	0.04	0	4	4	0.11
Sperm whale	2.89	0	293	293	0.82
Cuvier's beaked whale	2.62	0	265	221	0.04
Arnoux's beaked whale	2.62	0	265	221	0.04
Southern bottlenose whale	1.74	0	177	148	0.02
Shepard's beaked whale	1.74	0	177	148	0.02
Hector's beaked whale	1.74	0	177	148	0.02
True's beaked whale	0.87	0	89	74	N.A.
Gray's beaked whale	3.49	1	353	354	0.05
Andrew's beaked whale	1.74	0	177	148	0.02
Strap-toothed whale	2.62	0	265	221	0.04
Blainville's beaked whale	0.87	0	89	74	0.01
Spade-toothed whale	0.87	0	89	74	0.01
Bottlenose dolphin	5.12	1	519	520	N.A.
Short-beaked common dolphin	10.25	2	1038	1040	N.A.
Dusky dolphin	5.12	1	519	520	3.61
Southern right-whale dolphin	3.07	1	312	313	N.A.
Risso's dolphin	2.05	0	208	208	N.A.
False killer whale	3.07	1	312	313	N.A.
Killer whale	1.91	0	194	194	0.20
Long-finned pilot whale	8.28	1	838	839	0.35
Short-finned pilot whale	4.10	1	415	416	N.A.
Pygmy sperm whale	1.74	3	172	175	N.A.
Hourglass dolphin	4.16	12	410	418	0.12
Hector's dolphin	0	0	0	0	0
Spectacled porpoise	0	0	0	0	0
New Zealand fur seal	22.50	3	2279	2283	0.50
New Zealand sea lion	0	0	0	0	0
Southern elephant seal	4.50	2	454	456	0.03
Leopard seal	2.25	1	227	228	0.04

TABLE 12—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	Total proposed Level A and Level B takes as a percentage of population
Southern right whale	0.24	0	13	13	0.09
Pygmy right whale	0.10	0	5	5	N.A.
Humpback whale	0.24	0	13	13	0.03

TABLE 12—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—Continued

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
Bryde's whale	0.14	0	8	8	0.01
Common minke whale	0.14	0	8	8	<0.01
Antarctic minke whale	0.14	0	8	8	<0.01
Sei whale	0.14	0	8	8	0.07
Fin whale	0.25	0	13	13	0.07
Blue whale	0.04	0	3	3	0.05
Sperm whale	2.89	1	153	154	0.43
Cuvier's beaked whale	2.62	0	138	138	0.02
Arnoux's beaked whale	2.62	0	138	138	0.02
Southern bottlenose whale	1.74	0	92	92	0.01
Shepard's beaked whale	1.74	0	92	92	0.01
Hector's beaked whale	1.74	0	92	92	0.01
True's beaked whale	0.87	0	46	46	N.A.
Gray's beaked whale	3.49	1	184	185	0.03
Andrew's beaked whale	1.74	0	92	92	0.01
Strap-toothed whale	2.62	0	138	138	0.02
Blainville's beaked whale	0.87	0	46	46	0.01
Spade-toothed whale	0.87	0	46	46	0.01
Bottlenose dolphin	5.12	1	270	271	N.A.
Short-beaked common dolphin	10.25	2	540	540	N.A.
Dusky dolphin	5.12	1	270	271	1.88
Southern right-whale dolphin	3.07	1	162	163	N.A.
Risso's dolphin	2.05	0	108	108	N.A.
False killer whale	3.07	1	162	163	N.A.
Killer whale	1.91	0	101	101	0.11
Long-finned pilot whale	8.28	2	436	438	0.18
Short-finned pilot whale	4.10	1	216	217	N.A.
Pygmy sperm whale	1.74	3	89	92	N.A.
Hourglass dolphin	4.16	8	212	220	0.12
Hector's dolphin	0	0	0	0	0
Spectacled porpoise	0	0	0	0	0
New Zealand fur seal	22.50	4	1186	1190	0.50
New Zealand sea lion	0	0	0	0	0
Southern elephant seal	4.50	2	236	238	0.03
Leopard seal	2.25	1	118	119	0.04

TABLE 13—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	Total proposed Level A and Level B takes as a percentage of population
Southern right whale	0.24	1	15	16	0.11
Pygmy right whale	0.10	0	6	6	N.A.
Humpback whale	0.19	1	12	13	0.02
Bryde's whale	0.00	0	0	0	0
Common minke whale	0.14	0	9	9	<0.01
Antarctic minke whale	0.14	0	9	9	<0.01
Sei whale	0.14	0	9	9	0.08
Fin whale	0.25	1	15	16	0.09
Blue whale	0.04	0	3	3	0.08
Sperm whale	2.89	0	183	183	0.51
Cuvier's beaked whale	2.62	0	165	165	0.02
Arnoux's beaked whale	2.62	0	165	165	0.02
Southern bottlenose whale	1.74	0	110	110	0.02
Shepard's beaked whale	1.74	0	110	110	0.02
Hector's beaked whale	1.74	0	110	110	0.02
True's beaked whale	0.87	0	55	55	N.A.
Gray's beaked whale	3.49	0	220	220	0.03
Andrew's beaked whale	1.74	0	110	110	0.02

TABLE 13—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—Continued

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
Strap-toothed whale	2.62	0	165	165	0.02
Blainville's beaked whale	0.87	0	55	55	0.01
Spade-toothed whale	0.87	0	55	55	0.01
Bottlenose dolphin	4.78	1	302	303	N.A.
Short-beaked common dolphin	4.78	1	302	303	N.A.
Dusky dolphin	7.65	1	483	484	3.36
Southern right-whale dolphin	2.87	0	181	181	N.A.
Risso's dolphin	1.91	0	121	121	N.A.
False killer whale	2.87	0	181	181	N.A.
Killer whale	1.91	0	121	121	0.13
Long-finned pilot whale	8.28	1	522	523	0.22
Short-finned pilot whale	1.91	0	121	121	N.A.
Pygmy sperm whale	1.74	4	106	110	N.A.
Hourglass dolphin	4.16	10	253	263	0.15
Hector's dolphin	0.04	0	3	3	0.01
Spectacled porpoise	1.91	5	117	122	N.A.
New Zealand fur seal	22.50	2	1419	1421	0.59
New Zealand sea lion	9.00	1	568	569	4.80
Southern elephant seal	4.50	2	283	285	0.04
Leopard seal	2.25	1	142	143	0.05

TABLE 14—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	0.38
Pygmy right whale	0.10	1	21	22	N.A.
Humpback whale	0.19	3	48	51	0.1
Bryde's whale	0.00	1	22	23	0.04
Common minke whale	0.14	1	31	32	N.A.
Antarctic minke whale	0.14	1	31	32	N.A.
Sei whale	0.14	1	31	32	0.28
Fin whale	0.25	3	52	55	0.3
Blue whale	0.04	0	10	10	0.24
Sperm whale	2.89	1	629	630	1.76
Cuvier's beaked whale	2.62	0	568	568	0.08
Arnoux's beaked whale	2.62	0	568	568	0.08
Southern bottlenose whale	1.74	0	379	379	0.05
Shepard's beaked whale	1.74	0	379	379	0.05
Hector's beaked whale	1.74	0	379	379	0.05
True's beaked whale	0.87	0	190	190	N.A.
Gray's beaked whale	3.49	2	757	759	0.11
Andrew's beaked whale	1.74	0	379	379	0.05
Strap-toothed whale	2.62	0	568	568	0.08
Blainville's beaked whale	0.87	0	190	190	0.03
Spade-toothed whale	0.87	0	190	190	0.03
Bottlenose dolphin	4.78	3	1091	1094	N.A.
Short-beaked common dolphin	4.78	5	1880	1885	N.A.
Dusky dolphin	7.65	3	1272	1275	8.85
Southern right-whale dolphin	2.87	2	655	657	N.A.
Risso's dolphin	1.91	0	437	437	N.A.
False killer whale	2.87	2	655	657	N.A.
Killer whale	1.91	0	416	416	0.44
Long-finned pilot whale	8.28	4	1796	1800	0.75
Short-finned pilot whale	1.91	2	752	754	N.A.
Pygmy sperm whale	1.74	12	367	379	N.A.
Hourglass dolphin	4.16	30	875	905	0.39

TABLE 14—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—Continued

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
Hector's dolphin	0.04	0	3	3	0.01
Spectacled porpoise	1.91	5	117	122	N.A.
New Zealand fur seal	22.50	9	4884	4893	1.59
New Zealand sea lion	9.00	1	568	569	0.38
Southern elephant seal	4.50	6	973	979	N.A.
Leopard seal	2.25	3	487	490	0.1

It should be noted that the proposed take numbers shown in Tables 11, 12, 13 and 14 are expected to be conservative for several reasons. First, in the calculations of estimated take, 50 percent has been added in the form of operational survey days (equivalent to adding 50 percent to the proposed line km to be surveyed) to account for the possibility of additional seismic operations associated with airgun testing and repeat coverage of any areas where initial data quality is sub-standard, and in recognition of the uncertainties in the density estimates used to estimate take as described above. Additionally, marine mammals would be expected to move away from a loud sound source that represents an aversive stimulus, such as an airgun array, potentially reducing the number of Level A takes. 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 in 11, 12, 13 and 14.

For some marine mammal species, we propose to authorize a different number of incidental takes than the number of incidental takes requested by L–DEO (see Tables 18, 19 and 20 in the IHA application for requested take numbers). For instance, for several species, L–DEO increased the take request from the calculated take number to 1 percent of the estimated population size. We do not believe it is likely that 1 percent of the estimated population size of those species will be taken by L–DEO's proposed survey, therefore we do not propose to authorize the take numbers requested by L–DEO in their IHA application (LGL, 2017). However, in recognition of the uncertainties in the density estimates used to estimate take as described above, we believe it is reasonable to assume that actual takes may exceed numbers of takes calculated based on available density estimates; therefore, we have increased take estimates for all marine mammal species by an additional 25 percent, to account for the fact that density estimates used to estimate take may be underestimates of actual densities of marine mammals in the survey area. Additionally, L–DEO requested authorization for 10 takes of Hector's dolphins during the North Island 2–D survey (LGL, 2017). However, we do not propose to authorize any takes of Hector's dolphins during North Island surveys. We believe the likelihood of the proposed North Island 2–D survey encountering a Hector's dolphin is extremely low. As described above, the North Island subpopulation of Hector's dolphin (aka Maui dolphin) is very unlikely to be encountered during either proposed North Island survey due to the very low estimated abundance of the subpopulation and due to the geographic isolation of the subpopulation (currently limited to the west coast of the North Island). Additionally, while it would be extremely unlikely for the proposed surveys to encounter a Hector's dolphin during North Island surveys, any Hector's dolphin encountered in waters off the North Island would possibly be a member of the Maui dolphin subspecies. As described above, the Maui dolphin is facing a high risk of extinction (Manning and Grantz, 2016) and has a population size estimated at just 55–63 individuals (Hamner *et al.* 2014; Baker *et al.* 2016). Therefore, we seek to avoid the remote possibility of exposure of Maui dolphins to airgun sounds. As such, we do not propose to authorize any takes of Hector's dolphins during L–DEO's proposed North Island surveys. Additionally, we propose a mitigation measure that would require shutdown of the airgun array upon observation of a Hector's dolphin at any distance during both proposed North Island surveys (described below in Proposed Mitigation), which further minimizes the potential for any take of Hector's dolphins during the proposed North Island surveys.

Proposed Mitigation

In order to issue an IHA under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, ''and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking'' for certain subsistence uses (latter not applicable for this action). NMFS regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks and their habitat (50 CFR 216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, we carefully consider two primary factors:

(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) the likelihood

of effective implementation (probability implemented as planned), and

(2) the practicability of the measures 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.

L–DEO has reviewed mitigation measures employed during seismic research surveys authorized by NMFS under previous incidental harassment authorizations, as well as recommended best practices in Richardson *et al.* (1995), Pierson *et al.* (1998), Weir and Dolman (2007), Nowacek *et al.* (2013), Wright (2014), and Wright and Cosentino (2015), and has incorporated a suite of proposed mitigation measures into their project description based on the above sources.

To reduce the potential for disturbance from acoustic stimuli associated with the activities, L–DEO has proposed to implement the following mitigation measures for marine mammals:

(1) Vessel-based visual mitigation monitoring;

(2) Vessel-based passive acoustic monitoring;

(3) Establishment of an exclusion zone;

(4) Power down procedures;

(5) Shutdown procedures;

(6) Ramp-up procedures; and

(7) Vessel strike avoidance measures.

In addition to the mitigation measures proposed by L–DEO, NMFS has proposed the following additional measure: Shutdown of the acoustic source is required upon observation of a beaked whale or kogia spp., a large whale with calf, or a Hector's dolphin (during North Island surveys only) at any distance.

Vessel-Based Visual Mitigation Monitoring

Protected Species Observer (PSO) observations would take place during all 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, designated Exclusion Zones (as described below). PSOs would also watch for marine mammals near the vessel for at least 30 minutes prior to the planned start of airgun operations. PSOs would monitor the entire extent of the modeled Level B harassment zone (Table 4) (or, as far as they are able to see, if they cannot see to the extent of the estimated Level B harassment zone). Observations would also be made during daytime periods when the *Langseth* is underway without seismic operations, such as during transits, to allow for comparison of sighting rates and behavior with and without airgun operations and between acquisition periods.

During seismic operations, a minimum of four visual PSOs would be based aboard the *Langseth.* PSOs would be appointed by L–DEO, with NMFS' approval. During the majority of seismic operations, two PSOs would monitor for marine mammals around the seismic vessel. Use of two simultaneous observers would increase the effectiveness of detecting marine mammals around the source vessel. However, during meal times, only one PSO may be on duty. PSO(s) would be on duty in shifts of duration no longer than 4 hours. Other crew would also be instructed to assist in detecting marine mammals and in implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew would be given additional instruction in detecting marine mammals and implementing mitigation requirements. The *Langseth* is a suitable platform for marine mammal observations. When stationed on the observation platform, PSOs would have a good view around the entire vessel. During daytime, the PSO(s) would scan the area around the vessel systematically with reticle binoculars (*e.g.,* 7×50 Fujinon), Big-eye binoculars (25×150), and with the naked eye.

The PSOs must 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 resumes would be provided to NMFS for approval. At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a high energy seismic survey, with no more than eighteen months elapsed since the conclusion of the at-sea experience. One "experienced" visual PSO would be designated as the lead for the entire protected species observation team. The lead would coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO would devise the duty schedule such that "experienced" PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience, to the maximum extent practicable.

The PSOs must have successfully completed relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training program, and must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate training, including (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO. The PSO should demonstrate good standing and consistently good performance of PSO duties.

In summary, a typical daytime cruise would have scheduled two observers (visual) on duty from the observation platform, and an acoustic observer on the passive acoustic monitoring system.

Vessel-Based Passive Acoustic Mitigation Monitoring

Passive acoustic monitoring (PAM) would take place to complement the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustic monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The acoustic monitoring would serve to alert visual observers (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals vocalize, but it can be effective either by day or by night and does not depend on good visibility. It would be monitored in real time so that visual observers can be alerted when marine mammals are detected acoustically.

The PAM system consists of hardware (*i.e.,* hydrophones) and software. The "wet end" of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. A deck cable would connect the tow cable to the electronics unit on board where the acoustic station, signal conditioning, and processing system would be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the software.

At least one acoustic PSO (in addition to the four visual PSOs) would be on board. The towed hydrophones would be monitored 24 hours per day (either by the acoustic PSO or by a visual PSO trained in the PAM system if the acoustic PSO is on break) while at the seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating. However, PAM may not be possible if damage occurs to the array or back-up systems during operations. One PSO would monitor the acoustic detection system at any one time, in shifts no longer than six hours, by listening to the signals via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans.

When a vocalization is detected, while visual observations are in progress, the acoustic PSO would contact the visual PSOs immediately, to alert them to the presence of marine mammals (if they have not already been detected visually), in order to facilitate a power down or shut down, if required. The information regarding the marine mammal acoustic detection would be entered into a database.

Exclusion Zone and Buffer Zone

An exclusion zone (EZ) 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. The PSOs would establish a minimum EZ with a 500 m radius for the 36 airgun array and the 18 airgun array. 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 (see Power Down Procedures below). In addition to the 500 m EZ for the full arrays, a 100 m exclusion zone would be established for the single 40 in ^{3} airgun. 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 shut down entirely (see Shutdown Procedures below). Additionally, power down of the full arrays would last no more than 30 minutes maximum at any given time; thus the arrays would be shut down entirely if, after 30 minutes of the array being powered down, a marine mammal remains inside the 500 m EZ.

In their IHA application, L–DEO proposed to establish EZs based upon modeled radial distances to auditory injury zones (*e.g.,* power down would occur when a marine mammal entered or appeared likely to enter the zone(s) within which auditory injury is expected to occur based on modeling) (Tables 7, 8, 9). However, we instead propose the 500 m EZ as described above. The 500 m EZ is intended to be precautionary in the sense that it would be expected to contain sound exceeding peak pressure injury criteria for all cetacean hearing groups, while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort. Additionally, a 500-m EZ is expected to minimize the likelihood that marine mammals will be exposed to levels likely to result in more severe behavioral responses. Although significantly greater distances may be observed from an elevated platform under good conditions, we believe that 500 m is likely regularly attainable for PSOs using the naked eye during typical conditions.

An appropriate EZ based on cumulative sound exposure level ($\mathrm{SEL_{cum}}$) criteria would be dependent on the animal's applied hearing range and how that overlaps with the frequencies produced by the sound source of interest (*i.e.,* via marine mammal auditory weighting functions) (NMFS, 2016), and may be larger in some cases than the zones calculated on the basis of the peak pressure thresholds (and larger than 500 m) depending on the species in question and the characteristics of the specific airgun array. In particular, the EZ radii would be larger for low-frequency cetaceans, because their most susceptible hearing range overlaps the low frequencies produced by airguns, but the zones would remain very small for mid-frequency cetaceans (*i.e.,* including the ''small delphinoids'' described below), whose range of best hearing largely does not overlap with frequencies produced by airguns.

Use of monitoring and shutdown or power-down measures within defined exclusion zone distances is inherently an essentially instantaneous proposition—a rule or set of rules that requires mitigation action upon detection of an animal. This indicates that definition of an exclusion zone on the basis of cumulative sound exposure level thresholds, which require that an animal accumulate some level of sound energy exposure over some period of time (*e.g.,* 24 hours), has questionable relevance as a standard protocol. A PSO aboard a mobile source will typically have no ability to monitor an animal's position relative to the acoustic source over relevant time periods for purposes of understanding whether auditory injury is likely to occur on the basis of cumulative sound exposure and, therefore, whether action should be taken to avoid such potential.

Cumulative SEL thresholds are more relevant for purposes of modeling the potential for auditory injury than they are for dictating real-time mitigation, though they can be informative (especially in a relative sense). We recognize the importance of the accumulation of sound energy to an understanding of the potential for auditory injury and that it is likely that, at least for low-frequency cetaceans, some potential auditory injury is likely impossible to mitigate and should be considered for authorization.

In summary, our intent in prescribing a standard exclusion zone distance is to (1) encompass zones for most species within which auditory injury could occur on the basis of instantaneous exposure; (2) provide additional protection from the potential for more severe behavioral reactions (*e.g.,* panic, antipredator response) for marine mammals at relatively close range to the acoustic source; (3) provide consistency for PSOs, who need to monitor and implement the exclusion zone; and (4) to define a distance within which detection probabilities are reasonably high for most species under typical conditions.

Our use of 500 m as the EZ is a reasonable combination of factors. This zone is expected to contain all potential auditory injury for all marine mammals (high-frequency, mid-frequency and low-frequency cetacean functional hearing groups and otariid and phocid pinnipeds) as assessed against peak pressure thresholds (NMFS, 2016) (Tables 7, 8, 9). It is also expected to contain all potential auditory injury for high-frequency and mid-frequency cetaceans as well as otariid and phocid pinnipeds as assessed against $\mathrm{SEL_{cum}}$ thresholds (NMFS, 2016) (Tables 7, 8, 9). It has proven to be practicable through past implementation in seismic surveys conducted for the oil and gas industry in the Gulf of Mexico (as regulated by BOEM pursuant to the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. 1331–1356)). In summary, a practicable criterion such as the proposed EZs has the advantage of simplicity while still providing in most cases a zone larger than relevant auditory injury zones, given realistic movement of source and receiver.

The PSOs would also establish and monitor a 1,000 m buffer zone. During operation of the airgun arrays, occurrence of marine mammals within the 1,000 m buffer zone (but outside the

500 m EZ) would be communicated to the vessel operator to prepare for potential power down or shutdown of the acoustic source. The buffer zone is discussed further under Ramp Up Procedures below. PSOs would also monitor the entire extent of the estimated Level B harassment zone (Table 4) (or, as far as they are able to see, if they cannot see to the extent of the estimated Level B harassment zone).

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-in^3 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. In contrast, a shutdown occurs when all airgun activity is suspended (shutdown procedures are discussed below). If a marine mammal is detected outside the 500 m EZ but appears likely to enter the 500 m EZ, the airguns would be powered down before the animal is within the 500 m EZ. Likewise, if a mammal is already within the 500 m EZ when first detected, the airguns would be powered down immediately. During a power down of the airgun array, the 40-in^3 airgun would be operated.

Following a power down, airgun activity would not resume until the marine mammal has cleared the 500 m EZ. The animal would be considered to have cleared the 500 m EZ if the following conditions have been met:

☐ It is visually observed to have departed the 500 m EZ, or

☐ it has not been seen within the 500 m EZ for 15 min in the case of small odontocetes and pinnipeds, or

☐ it has not been seen within the 500 m 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. As defined here, 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 genera of small dolphins —*Tursiops, Delphinus* and *Lissodelphis* — and would only apply if the animals were traveling, including approaching the vessel. If, for example, an animal or group of animals is stationary for some reason (*e.g.,* feeding) and the source vessel approaches the animals, the power down requirement applies. An animal with sufficient incentive to remain in an area rather than avoid an otherwise aversive stimulus could either incur auditory injury or disruption of important behavior. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, the power down or shutdown would be implemented. Note that small dolphins in the genera *Lagenorhynchus* and *Cephalorhynchus* are not included in the proposed power down/shutdown exception.

We include this small delphinoid exception because power-down/shutdown requirements for small delphinoids under all circumstances represent practicability concerns without likely commensurate benefits for the animals in question. Small delphinoids are generally the most commonly observed marine mammals in the specific geographic region and would typically be the only marine mammals likely to intentionally approach the vessel. As described below, auditory injury is extremely unlikely to occur for mid-frequency cetaceans (*e.g.,* delphinids), as this group is relatively insensitive to sound produced at the predominant frequencies in an airgun pulse while also having a relatively high threshold for the onset of auditory injury (*i.e.,* permanent threshold shift). Please see Potential Effects of the Specified Activity on Marine Mammals above for further discussion of sound metrics and thresholds and marine mammal hearing.

A large body of anecdotal evidence indicates that small delphinoids commonly approach vessels and/or towed arrays during active sound production for purposes of bow riding, with no apparent effect observed in those delphinoids (*e.g.,* Barkaszi *et al.,* 2012). The potential for increased shutdowns resulting from such a measure would require the *Langseth* to revisit the missed track line to reacquire data, resulting in an overall increase in the total sound energy input to the marine environment and an increase in the total duration over which the survey is active in a given area. Although other mid-frequency hearing specialists (*e.g.,* large delphinoids) are no more likely to incur auditory injury than are small delphinoids, they are much less likely to approach vessels. Therefore, retaining a power-down/shutdown requirement for large delphinoids would not have similar impacts in terms of either practicability for the applicant or corollary increase in sound energy output and time on the water. We do anticipate some benefit for a power-down/shutdown requirement for large delphinoids in that it simplifies somewhat the total range of decision-making for PSOs and may preclude any potential for physiological effects other than to the auditory system as well as some more severe behavioral reactions for any such animals in close proximity to the source vessel.

A power down could occur for no more than 30 minutes maximum at any given time. If, after 30 minutes of the array being powered down, marine mammals had not cleared the 500 m EZ (as described above), a shutdown of the array would be implemented (see Shut Down Procedures, below). Power down is only allowed in response to the presence of marine mammals within the designated EZ. Thus, the single 40 in^3 airgun, which would be operated during power downs, may not be operated continuously throughout the night or during transits from one line to another.

Shut Down Procedures

The single 40-in^3 operating airgun would be 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 if (1) an animal enters the 100 m EZ of the single 40-in^3 airgun after a power down has been initiated, or (2) an animal is initially seen within the 100 m EZ of the single 40-in^3 airgun when more than one airgun (typically the full array) is operating. Airgun activity would not resume until the marine mammal has cleared the 500 m EZ. Criteria for judging that the animal has cleared the EZ would be as described above. A shutdown of the array would be implemented if, after 30 minutes of the array being powered down, marine mammals have not cleared the 500 m EZ (as described above).

The shutdown requirement, like the power down requirement, would be waived for dolphins of the following genera: *Tursiops, Delphinus* and *Lissodelphis.* The shutdown waiver only applies if the animals are traveling, including approaching the vessel. If animals are stationary and the source vessel approaches the animals, the shutdown requirement would apply. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, the shutdown would be implemented.

In addition to the measures proposed by L–DEO, NMFS also proposes that a shutdown of the acoustic source would also be required, at any distance, upon observation of the following: A large whale (*i.e.,* sperm whale or any baleen whale) with a calf; a beaked whale or kogia spp.; or, a Hector's dolphin (during North Island surveys only). These are the only three potential scenarios that would require shutdown of the array for marine mammals observed beyond the 100 m EZ for the single 40 in^3 airgun. The shutdown requirement for Hector's dolphin during North Island surveys is designed to avoid any potential for exposure of a Maui dolphin to seismic airgun sounds. Maui dolphins are not expected to occur in the proposed survey areas off the North Island based on their current range. However, as described above, there have been occasional sightings and strandings of Hector's dolphins off the east coast of the North Island. While the likelihood of L–DEO's proposed surveys encountering a Maui dolphin is considered extremely low, we nonetheless include this measure to avoid any potential for exposure of a Maui dolphin to airgun sounds. In the event of a shutdown due to observation of a shutdown due to observation of a beaked whale, kogia app., or large whale with calf, ramp-up procedures would not be initiated until the Hector's dolphin has not been seen at any distance for 30 minutes. In the event of a shutdown due to observation of a Hector's dolphin (during North Island surveys only), ramp-up procedures would not be initiated until the Hector's dolphin has not been seen at any distance for 15 minutes.

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. 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. Ramp-up would be required after the array is powered down or shut down due to mitigation. If the airgun array has been shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the buffer zone and no acoustic detections have occurred. This is the only scenario under which ramp up would not be required.

Ramp-up would begin by activating a single airgun of the smallest volume in the array and would continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration.

If airguns have been powered down or shut down due to PSO detection of a marine mammal within or approaching the 500 m EZ, ramp-up would not be initiated until all marine mammals have cleared the EZ, during the day or night. Visual and acoustic PSOs are required to monitor during ramp-up. If a marine mammal were detected by visual PSOs within or approaching the 500 m EZ during ramp-up, a power down (or shut down if appropriate) would be implemented as though the full array were operational. Criteria for clearing the EZ would be as described above.

Thirty minutes of pre-clearance observation are required prior to ramp-up for any power down or shutdown of longer than 30 minutes (*i.e.,* if the array were shut down during transit from one line to another). This 30 minute pre-clearance period may occur during any vessel activity (*i.e.,* transit). If a marine mammal is observed within or approaching the 500 m EZ during this pre-clearance period, ramp-up would not be initiated until all marine mammals have cleared the EZ. Criteria for clearing the EZ would be as described above.

Ramp-up would be planned to occur during periods of good visibility when possible. However, ramp-up would be allowed at night and during poor visibility if the 500 m EZ and 1,000 m buffer zone have been monitored by visual PSOs for 30 minutes prior to ramp-up and if acoustic monitoring has occurred for 30 minutes prior to ramp-up with no acoustic detections during that period.

The operator would be required to notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. The operator must provide information to PSOs documenting that appropriate procedures were followed. Following deactivation of the array for reasons other than mitigation, the operator would be required to communicate the near-term operational plan to the lead PSO with justification for any planned nighttime ramp-up.

L–DEO proposed that ramp up would not occur following an extended power down (LGL 2017). However, as we do not propose to allow extended power downs during the proposed survey, we also do not include this as a proposed mitigation measure and instead propose that ramp up is required after any power down or shutdown of the array, with the one exception as described above. L–DEO also proposed that ramp up would occur when the airgun array begins operating after 8 minutes without airgun operations (LGL 2017). However, we instead propose the criteria for ramp up as described above.

Vessel Strike Avoidance

Vessel strike avoidance measures are intended to minimize the potential for collisions with marine mammals. We note that these requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

The proposed measures include the following: Vessel operator and crew would maintain a vigilant watch for all marine mammals and slow down or stop the vessel or alter course to avoid striking any marine mammal. A visual observer aboard the vessel would monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone would be either third-party observers or crew members, but crew members responsible for these duties would be provided sufficient training to distinguish marine mammals from other phenomena. Vessel strike avoidance measures would be followed during surveys and while in transit.

The vessel would maintain a minimum separation distance of 100 m from large whales (*i.e.,* baleen whales and sperm whales). If a large whale is within 100 m of the vessel the vessel would reduce speed and shift the engine to neutral, and would not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established. If the vessel is stationary, the vessel would not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m. The vessel would maintain a minimum separation distance of 50 m from all other marine mammals (with the exception of delphinids of the genera *Tursiops, Delphinus* and *Lissodelphis* that approach the vessel, as described above). If an animal is encountered during transit, the vessel would attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course. Vessel speeds would be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near the vessel.

Based on our evaluation of the applicant's proposed measures, NMFS has determined that the mitigation measures provide the means effecting the least practicable impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the action area. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to improved understanding of one or more of the following:

☐ Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.,* presence, abundance, distribution, density).

☐ Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) Action or environment (*e.g.,* source characterization, propagation, ambient noise); (2) affected species (*e.g.,* life history, dive patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas).

☐ Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors.

☐ How anticipated responses to stressors impact either: (1) Long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks.

☐ Effects on marine mammal habitat (*e.g.,* marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat).

☐ Mitigation and monitoring effectiveness.

L–DEO submitted a marine mammal monitoring and reporting plan in section XIII of their IHA application. Monitoring that is designed specifically to facilitate mitigation measures, such as monitoring of the EZ to inform potential power downs or shutdowns of the airgun array, are described above and are not repeated here.

L–DEO's monitoring and reporting plan includes the following measures:

Vessel-Based Visual Monitoring

As described above, PSO observations would take place during daytime airgun operations and nighttime start ups (if applicable) of the airguns. During seismic operations, at least four visual PSOs would be based aboard the *Langseth.* PSOs would be appointed by L–DEO with NMFS approval. During the majority of seismic operations, two PSOs would monitor for marine mammals around the seismic vessel. Use of two simultaneous observers would increase the effectiveness of detecting animals around the source vessel. However, during meal times, only one PSO may be on duty. PSOs would be on duty in shifts of duration no longer than 4 hours. Other crew would also be instructed to assist in detecting marine mammals and in implementing mitigation requirements (if practical). During daytime, PSOs would scan the area around the vessel systematically with reticle binoculars (*e.g.,* 7×50 Fujinon), Big-eye binoculars (25×150), and with the naked eye.

PSOs would record data to estimate the numbers of marine mammals exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data would be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They would also provide information needed to order a power down or shutdown of airguns when a marine mammal is within or near the EZ.

When a sighting is made, the following information about the sighting would be recorded:

1. 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.), and behavioral pace.
2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

All observations and power downs or shutdowns 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. The time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare would also be recorded at the start and end of each observation watch, and during a watch whenever there is a change in one or more of the variables.

Results from the vessel-based observations will provide:

1. The basis for real-time mitigation (airgun power down or shut down).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS.
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.

Vessel-Based Passive Acoustic Monitoring

PAM would take place to complement the visual monitoring program as described above. Please see the Mitigation section above for a description of the PAM system and the acoustic PSO's duties. The acoustic PSO would record data collected via the PAM system, including the following: An acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position and water depth when first detected, bearing if determinable, species or species group (*e.g.,* unidentified dolphin, sperm whale), types and nature of sounds heard (*e.g.,* clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information. Acoustic detections would also be recorded for further analysis.

Reporting

A report would be submitted to NMFS within 90 days after the end of the cruise. The report would describe the operations that were conducted and sightings of marine mammals near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). The report would also include estimates of the number and nature of exposures that occurred above the harassment threshold based on PSO observations, including an estimate of those on the trackline but not detected.

Negligible Impact Analysis and Determination

NMFS has defined negligible impact as ''an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival'' (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.,* population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be ''taken'' through harassment, NMFS considers other factors, such as the likely nature of any responses (*e.g.,* intensity, duration), the context of any responses (*e.g.,* critical reproductive time or location, migration), as well as effects on habitat, and the likely effectiveness of the mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS' implementing regulations (54 FR 40338; September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the environmental baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

To avoid repetition, our analysis applies to all the species listed in Table 2, given that NMFS expects the anticipated effects of the proposed seismic survey to be similar in nature. Where there are meaningful differences between species or stocks, or groups of species, in anticipated individual responses to activities, impact of expected take on the population due to differences in population status, or impacts on habitat, NMFS has identified species-specific factors to inform the analysis. As described above, we propose to authorize only the takes estimated to occur outside of New Zealand territorial sea (Tables 11, 12, 13 and 14); however, for the purposes of our negligible impact analysis and determination, we consider the total number of takes that are expected to occur as a result of the proposed survey, including those within territorial sea. Thus, our negligible impact analysis and determination accounts for the takes that are anticipated to occur as a result of the proposed surveys during the portions of those surveys that would occur within the territorial sea (approximately 9 percent of the North Island 2–D survey, 1 percent of the North Island 3–D survey, and 6 percent of the South Island 2–D survey), though we do not propose to authorize the incidental take of marine mammals during those portions of the proposed surveys.

NMFS does not anticipate that serious injury or mortality would occur as a result of L–DEO's proposed survey, even in the absence of proposed mitigation. Thus the proposed authorization does not authorize any mortality. As discussed in the *Potential Effects* section, non-auditory physical effects, stranding, and vessel strike are not expected to occur.

We propose to authorize a limited number of instances of Level A harassment of 21 marine mammal species (Tables 11, 12, 13 and 14). However, we believe that any PTS incurred in marine mammals as a result of the proposed activity would be in the form of only a small degree of PTS, not total deafness, and would be unlikely to affect the fitness of any individuals, because of the constant movement of both the *Langseth* and of the marine mammals in the project area, as well as the fact that the vessel is not expected to remain in any one area in which individual marine mammals would be expected to concentrate for an extended period of time (*i.e.,* since the duration of exposure to loud sounds will be relatively short). Also, as described above, we expect that marine mammals would be likely to move away from a sound source that represents an aversive stimulus, especially at levels that would be expected to result in PTS, given sufficient notice of the *Langseth's* approach due to the vessel's relatively low speed when conducting seismic surveys. We expect that the majority of takes would be in the form of short-term Level B behavioral harassment in the form of temporary avoidance of the area or decreased foraging (if such activity were occurring), reactions that are considered to be of low severity and with no lasting biological consequences (*e.g.,* Southall *et al.,* 2007).

Potential impacts to marine mammal habitat were discussed previously in this document (see *Potential Effects of the Specified Activity on Marine Mammals and their Habitat*). Marine mammal habitat may be impacted by elevated sound levels, but these impacts would be temporary. Feeding behavior is not likely to be significantly impacted, as marine mammals appear to be less likely to exhibit behavioral reactions or avoidance responses while engaged in feeding activities (Richardson *et al.,* 1995). Prey species are mobile and are broadly distributed throughout the project area; therefore, marine mammals that may be temporarily displaced during survey activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the temporary nature of the disturbance, the availability of similar habitat and resources in the surrounding area, and the lack of important or unique marine mammal habitat, the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations. In addition, there are no mating or calving areas known to be biologically important to marine mammals within the proposed project area.

The activity is expected to impact a small percentage of all marine mammal stocks that would be affected by L–DEO's proposed survey (less than 9 percent for dusky dolphin and less than 2 percent for all other marine mammal species). Additionally, the acoustic ''footprint'' of the proposed survey would be small relative to the ranges of the marine mammals that would potentially be affected. Sound levels would increase in the marine environment in a relatively small area surrounding the vessel compared to the range of the marine mammals within the proposed survey area.

The proposed mitigation measures are expected to reduce the number and/or severity of takes by allowing for detection of marine mammals in the vicinity of the vessel by visual and acoustic observers, and by minimizing the severity of any potential exposures via power downs and/or shutdowns of the airgun array. Based on previous monitoring reports for substantially similar activities that have been previously authorized by NMFS, we expect that the proposed mitigation will be effective in preventing at least some extent of potential PTS in marine mammals that may otherwise occur in the absence of the proposed mitigation.

The ESA-listed marine mammal species under our jurisdiction that are likely to be taken by the proposed project include the southern right, sei, fin, blue, and sperm whale (listed as endangered) and the South Island Hector's dolphin (listed as threatened). We propose to authorize very small numbers of takes for these species (Tables 11, 12, 13 and 14), relative to their population sizes, therefore we do not expect population-level impacts to any of these species. The other marine mammal species that may be taken by harassment during the proposed survey are not listed as threatened or endangered under the ESA. There is no designated critical habitat for any ESA-listed marine mammals within the project area; and of the non-listed marine mammals for which we propose to authorize take, none are considered ''depleted'' or ''strategic'' by NMFS under the MMPA.

NMFS concludes that exposures to marine mammal species and stocks due to L–DEO's proposed survey would result in only short-term (temporary and short in duration) effects to individuals exposed. Animals may temporarily avoid the immediate area, but are not expected to permanently abandon the area. Major shifts in habitat use, distribution, or foraging success are not expected. NMFS does not anticipate the proposed take estimates to impact annual rates of recruitment or survival.

In summary and as described above, the following factors primarily support our preliminary determination that the impacts resulting from this activity are not expected to adversely affect the marine mammal species or stocks through effects on annual rates of recruitment or survival:

☐ No serious injury or mortality is anticipated or authorized;

☐ The anticipated impacts of the proposed activity on marine mammals would primarily be temporary behavioral changes due to avoidance of the area around the survey vessel;

☐ The number of instances of PTS that may occur are expected to be very small in number (Tables 11, 12, 13 and 14). Instances of PTS that are incurred in marine mammals would be of a low level, due to constant movement of the vessel and of the marine mammals in the area, and the nature of the survey design (not concentrated in areas of high marine mammal concentration);

☐ The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the proposed survey to avoid exposure to sounds from the activity;

☐ The proposed project area does not contain known areas of significance for mating or calving;

☐ The potential adverse effects on fish or invertebrate species that serve as prey species for marine mammals from the proposed survey would be temporary and spatially limited;

☐ The proposed mitigation measures, including visual and acoustic monitoring, power-downs, and shutdowns, are expected to minimize potential impacts to marine mammals.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the total marine mammal take from the proposed activity will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted above, only small numbers of incidental take may be authorized under Section 101(a)(5)(D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers; so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or stock in our determination of whether an authorization is limited to small numbers of marine mammals. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities. Tables 11, 12, 13 and 14 provide numbers of take by Level A harassment and Level B harassment proposed for authorization. These are the numbers we use for purposes of the small numbers analysis.

The numbers of marine mammals that we propose for authorization to be taken would be considered small relative to the relevant populations (less than 9 percent for all species) for the species for which abundance estimates are available. No known current worldwide or regional population estimates are available for ten species under NMFS' jurisdiction that could be incidentally taken as a result of the proposed surveys: The pygmy right whale; pygmy sperm whale; True's beaked whale; short-finned pilot whale; false killer whale; bottlenose dolphin; short-beaked common dolphin; southern right whale dolphin; Risso's dolphin; and spectacled porpoise.

NMFS has reviewed the geographic distributions and habitat preferences of these species in determining whether the numbers of takes proposed for authorization herein are likely to represent small numbers. Pygmy right whales have a circumglobal distribution and occur throughout coastal and oceanic waters in the Southern Hemisphere (between 30 to 55° South) (Jefferson *et al.,* 2008). Pygmy sperm whales occur in deep waters on the outer continental shelf and slope in tropical to temperate waters of the Atlantic, Indian, and Pacific Oceans. True's beaked whales occur in the Southern hemisphere from the western Atlantic Ocean to the Indian Ocean to the waters of southern Australia and possibly New Zealand (Jefferson *et al.,* 2008). False killer whales generally occur in deep offshore tropical to temperate waters (between 50° North to 50° South) of the Atlantic, Indian, and Pacific Oceans (Jefferson *et al.,* 2008). Southern right whale dolphins have a circumpolar distribution and generally occur in deep temperate to sub-Antarctic waters in the Southern Hemisphere (between 30 to 65° South) (Jefferson *et al.,* 2008). Short-finned Pilot Whales are found in warm temperate to tropical waters throughout the world, generally in deep offshore areas (Olson and Reilly, 2002). Bottlenose dolphins are distributed worldwide through tropical and temperate inshore, coastal, shelf, and oceanic waters (Leatherwood and Reeves 1990, Wells and Scott 1999, Reynolds *et al.* 2000). Spectacled porpoises are believed to have a range that is circumpolar in the sub-Antarctic zone (with water temperatures of at least 1–10° C) (Goodall 2002). The Risso's dolphin is a widely-distributed species, inhabiting primarily deep waters of the continental slope and outer shelf (especially with steep bottom topography), from the tropics through the temperate regions in both hemispheres (Kruse *et al.* 1999). The short-beaked common dolphin is an oceanic species that is widely distributed in tropical to cool temperate waters of the Atlantic and Pacific

Oceans (Perrin 2002), from nearshore waters to thousands of kilometers offshore.

Based on the broad spatial distributions and habitat preferences of these species relative to the areas where the proposed surveys would occur, NMFS preliminarily concludes that the authorized take of these species likely represent small numbers relative to the affected species' overall population sizes, though we are unable to quantify the proposed take numbers as a percentage of population.

Based on the analysis contained herein of the proposed activity (including the proposed mitigation and monitoring measures) and the anticipated take of marine mammals, NMFS preliminarily finds that small numbers of marine mammals will be taken relative to the population size of the affected species.

Unmitigable Adverse Impact Analysis and Determination

There are no relevant subsistence uses of the affected marine mammal stocks or species implicated by this action. Therefore, NMFS has preliminarily determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act (ESA)

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA: 16 U.S.C. 1531 *et seq.*) requires that each Federal agency insure 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. To ensure ESA compliance for the issuance of IHAs, NMFS consults internally, in this case with the ESA Interagency Cooperation Division, whenever we propose to authorize take for endangered or threatened species.

The NMFS Permits and Conservation Division is proposing to authorize the incidental take of six species of marine mammals which are listed under the ESA (the southern right, sei, fin, blue, and sperm whale and South Island Hector's dolphin). We have requested initiation of Section 7 consultation with the Interagency Cooperation Division for the issuance of this IHA. NMFS will conclude the ESA section 7 consultation prior to reaching a determination regarding the proposed issuance of the authorization.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to L–DEO for conducting a seismic survey in the Pacific Ocean offshore New Zealand in 2017/2018, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. This section contains a draft of the IHA itself. The wording contained in this section is proposed for inclusion in the IHA (if issued).

1. This incidental harassment authorization (IHA) is valid for a period of one year from the date of issuance.

2. This IHA is valid only for marine geophysical survey activity, as specified in L–DEO's IHA application and using an array aboard the R/V *Langseth* with characteristics specified in the IHA application, in the Pacific Ocean offshore New Zealand.

3. General Conditions.

(a) A copy of this IHA must be in the possession of L–DEO, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of L–DEO operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 14. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 14. Any taking exceeding the authorized amounts listed in Table 14 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(c) The taking by serious injury or death of any species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) During use of the airgun(s), if marine mammal species other than those listed in Table 1 are detected by PSOs, the acoustic source must be shut down to avoid unauthorized take.

(e) L–DEO shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations.

4. Mitigation Requirements.

The holder of this Authorization is required to implement the following mitigation measures:

(a) L–DEO must use at least five dedicated, trained, NMFS-approved Protected Species Observers (PSOs), including at least four visual PSOs and one acoustic PSO. The PSOs must 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 resumes shall be provided to NMFS for approval.

(b) At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a high energy seismic survey, with no more than eighteen months elapsed since the conclusion of the at-sea experience. At least one of these must have relevant experience as a visual PSO and at least one must have relevant experience as an acoustic PSO. One "experienced" visual PSO shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO shall devise the duty schedule such that "experienced" PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience, to the maximum extent practicable.

(c) Visual Observation.

(i) During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) with the limited exception of meal times during which one PSO may be on duty. PSOs shall monitor the entire extent of the estimated Level B harassment zone (or, as far as they can see, if they cannot see to the extent of the estimated Level B harassment zone).

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up, including for nighttime ramp-ups of the airgun array, and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iv) Visual PSOs shall communicate all observations to the acoustic PSO, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(v) Visual PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24 hour period.

(vi) During good conditions (*e.g.,* daylight hours; Beaufort sea state 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(d) Acoustic Observation—The *R/V Langseth* must use a towed passive acoustic monitoring (PAM) system, which must be monitored beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(i) One acoustic PSO (in addition to the four visual PSOs) must be on board to operate and oversee PAM operations. Either the acoustic PSO or a visual PSO with training in the PAM system must monitor the PAM system at all times while airguns are operating, and when possible during periods when the airguns are not operating, in shifts lasting no longer than six hours.

(ii) Acoustic PSOs shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iii) Survey activity may continue for brief periods of time if the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:

(A) Daylight hours and sea state is less than or equal to Beaufort sea state 4;

(B) No marine mammals (excluding small delphinids) detected solely by PAM in the exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24 hour period.

(e) Exclusion Zone and buffer zone—PSOs shall establish and monitor a 500 m exclusion zone (EZ) and 1,000 m buffer zone. The zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals outside the EZ but within 1,000 m from any element of the airgun array shall be communicated to the operator to prepare for potential further mitigation measures as described below. During use of the acoustic source, occurrence of marine mammals within the EZ, or on a course to enter the EZ, shall trigger further mitigation measures as described below.

(i) Ramp-up—A ramp-up procedure, involving 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, is required at all times as part of the activation of the acoustic source, including following a power down or shutdown of the array, except as described under 4.(e)(v). Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration.

(ii) If the airgun array has been powered down or shut down due to a marine mammal detection, ramp-up shall not occur until all marine mammals have cleared the EZ. A marine mammal is considered to have cleared the EZ if:

(A) It has been visually observed to have left the EZ; or

(B) It has not been observed within the EZ, for 15 minutes (in the case of small odontocetes and pinnipeds) or for 30 minutes (in the case of mysticetes and large odontocetes including sperm, pygmy sperm, dwarf sperm, and beaked whales).

(iii) Thirty minutes of pre-clearance observation of the 500 m EZ and 1,000 m buffer zone are required prior to ramp-up for any power down, shutdown, or combination of power down and shutdown of longer than 30 minutes. This pre-clearance period may occur during any vessel activity. If any marine mammal (including delphinids) is observed within or approaching the 500 m EZ during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and pinnipeds, and 30 minutes for mysticetes and large odontocetes including sperm, pygmy sperm, dwarf sperm, and beaked whales).

(iv) During ramp-up, PSOs shall monitor the 500 m EZ and 1,000 m buffer zone. Ramp-up may not be initiated if any marine mammal (including delphinids) is observed within or approaching the 500 m EZ. If a marine mammal is observed within or approaching the 500 m EZ during ramp-up, a power down or shutdown shall be implemented as though the full array were operational. Ramp-up may not begin again until the animal(s) has been observed exiting the 500 m EZ or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and pinnipeds, and 30 minutes for mysticetes and large odontocetes including sperm, pygmy sperm, dwarf sperm, and beaked whales).

(v) Ramp-up shall only occur at night and at times of poor visibility where operational planning cannot reasonably avoid such circumstances. Ramp-up may occur at night and during poor visibility if the 500 m EZ and 1,000 m buffer zone have been continually monitored by visual PSOs for 30 minutes prior to ramp-up with no marine mammal detections and if acoustic monitoring has occurred for 30 minutes prior to ramp-up with no acoustic detections during that period.

(vi) If the airgun array has been shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the buffer zone and no acoustic detections have occurred.

(vii) The vessel operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.

(f) Power Down Requirements—L–DEO shall power down the airgun array if a PSO detects a marine mammal within, approaching, or entering the 500 m EZ. A power down involves a decrease in the number of operational airguns. During a power down, one 40-in^3 airgun shall be continuously operated.

(i) Any PSO on duty has the authority to call for power down of the airgun array (visual PSOs on duty should be in agreement on the need for power down before requiring such action). When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately.

(ii) When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and initiation of dialogue as necessary.

(iii) The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the airgun array to ensure that power down commands are conveyed swiftly while allowing PSOs to maintain watch.

(iv) When power down is called for by a PSO, the power down must occur and any dispute resolved only following power down.

(v) The power down requirement is waived for dolphins of the following genera: *Tursiops, Delphinus* and *Lissodelphis.* This power down waiver only applies if animals are traveling, including approaching the vessel. If animals are stationary and the vessel approaches the animals, the power down requirement applies. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, power down must be implemented.

(vi) Upon implementation of a power down, the source may be reactivated under the conditions described at 4(e). Where there is no relevant zone (*e.g.,* power down due to observation of a calf), a 30-minute clearance period must be observed following the last observation of the animal(s).

(vii) When only the acoustic PSO is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the airgun array must be powered down as a precaution.

(viii) Power down shall occur for no more than a maximum of 30 minutes at any given time. If, after 30 minutes of the array being powered down, marine mammals have not cleared the 500 m Exclusion Zone as described under 4(e)(iv), the array shall be shut down. Operation of the single 40-in^3 airgun (*i.e.,* a power-down state) shall not occur for any purpose other than in response to a marine mammal in the exclusion zone (pursuant to relevant requirements herein).

(g) Shutdown requirements—An exclusion zone of 100 m for the single 40-in^3 airgun shall be established and monitored by PSOs. If a marine mammal is observed within, entering, or approaching the 100 m exclusion zone for the single 40-in^3 airgun, whether during implementation of a power down or during operation of the full airgun array, all airguns including the 40-in^3 airgun shall be shut down.

(h) If, after 30 minutes of the array being powered down, marine mammals have not cleared the 500 m Exclusion Zone as described under 4(e)(iv), the full array shall be shut down.

(i) Upon implementation of a shutdown, the source may be reactivated under the conditions described at 4(e).

(ii) Measures described for power downs under 4(f)(i-v) shall also apply in the case of a shutdown.

(iii) Shutdown of the acoustic source is required upon observation of a large whale (*i.e.,* sperm whale or any baleen whale) with calf at any distance, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult. Ramp up shall not begin until the whale with calf has not been observed for at least 30 minutes, at any distance.

(iv) Shutdown of the acoustic source is required upon observation of a beaked whale or kogia spp., at any distance. Ramp up shall not begin until the beaked whale or kogia has not been observed for at least 30 minutes, at any distance.

(v) Shutdown of the acoustic source is required upon observation of a Hector's dolphin, at any distance, during the North Island 2–D survey and North Island 3–D survey. Ramp up shall not begin until the Hector's dolphin has not been observed for at least 15 minutes, at any distance.

(i) Vessel Strike Avoidance—Vessel operator and crew must maintain a vigilant watch for all marine mammals and slow down or stop the vessel or alter course to avoid striking any marine mammal. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena. Vessel strike avoidance measures shall be followed during surveys and while in transit.

(i) The vessel must maintain a minimum separation distance of 100 m from large whales (*i.e.,* baleen whales and sperm whales). The following avoidance measures must be taken if a large whale is within 100 m of the vessel:

(A) The vessel must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

(B) If the vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

(ii) The vessel must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for animals described in 4(f)(v) that approach the vessel. If an animal is encountered during transit, the vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

(iii) Vessel speeds must be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near the vessel.

(j) Miscellaneous Protocols.

(i) The airgun array must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

5. Monitoring Requirements.

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

(a) The operator must provide bigeye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.,* Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

(b) PSOs must also be equipped with reticle binoculars (*e.g.,* 7 x 50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.,* Canon or equivalent), compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.

(c) PSO Qualifications.

(i) PSOs must have successfully completed relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training program.

(ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO. The PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection—PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. NMFS requires that, at a minimum, the following information be reported:

(i) PSO names and affiliations.

(ii) Dates of departures and returns to port with port name.

(iii) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort.

(iv) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts.

(v) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change.

(vi) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon.

(vii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions).

(viii) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).

(ix) If a marine mammal is sighted, the following information should be recorded:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform).

(B) PSO who sighted the animal.

(C) Time of sighting.

(D) Vessel location at time of sighting.

(E) Water depth.

(F) Direction of vessel's travel (compass direction).

(G) Direction of animal's travel relative to the vessel.

(H) Pace of the animal.

(I) Estimated distance to the animal and its heading relative to vessel at initial sighting.

(J) Identification of the animal (*e.g.,* genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species.

(K) Estimated number of animals (high/low/best).

(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.).

(M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics).

(N) Detailed behavior observations (*e.g.,* number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior).

(O) Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;.

(P) Platform activity at time of sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other).

(Q) Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded.

(x) If a marine mammal is detected while using the PAM system, the following information should be recorded:

(A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting.

(B) Time when first and last heard.

(C) Types and nature of sounds heard (*e.g.,* clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.).

(D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

6. Reporting.

(a) L–DEO shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the data collected as required under condition 5(d) of this IHA. The report must also provide an estimate of the number (by species) of marine mammals with known exposures to seismic survey activity at received levels greater than or equal to thresholds for Level A and Level B harassment (based on visual observation) including an estimate of those on the trackline but not detected. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments from NMFS on the draft report.

(b) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by this IHA, such as serious injury or mortality, L–DEO shall immediately cease the specified activities and immediately report the incident to the NMFS Office of Protected Resources (301–427–8401) and the New Zealand Department of Conservation (0800–362–468). The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Vessel's speed during and leading up to the incident;

(C) Description of the incident;

(D) Status of all sound source use in the 24 hours preceding the incident;

(E) Water depth;

(F) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(G) Description of all marine mammal observations in the 24 hours preceding the incident;

(H) Species identification or description of the animal(s) involved;

(I) Fate of the animal(s); and

(J) Photographs or video footage of the animal(s).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with L–DEO to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. L–DEO may not resume their activities until notified by NMFS.

(ii) In the event that L–DEO discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), L–DEO shall immediately report the incident to the NMFS Office of Protected Resources (301–427–8401) and the New Zealand Department of Conservation (0800–362–468). The report must include the same information identified in condition 6(b)(i) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with L–DEO to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that L–DEO discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), L–DEO shall report the incident to the NMFS Office of Protected Resources (301–427–8401) and the New Zealand Department of Conservation (0800–362–468) within 24 hours of the discovery. L–DEO shall provide photographs or video footage or other documentation of the sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

Dated: September 22, 2017.

Catherine Marzin,

Acting Deputy Director, Office of Protected Resources, National Marine Fisheries Service.

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