FEDERAL REGISTER

Vol. 81 Tuesday,
No. 75 April 19, 2016

Part III

Department of Commerce

National Oceanic and Atmospheric Administration

Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Southeast Pacific Ocean, 2016–2017; Notice

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XE451

Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Southeast Pacific Ocean, 2016–2017

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

ACTION: Notice; proposed Incidental Harassment Authorization; request for comments.

SUMMARY: NMFS has received an application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation (NSF), for an Incidental Harassment Authorization (Authorization) to take marine mammals, by harassment only, incidental to conducting three marine geophysical (seismic) surveys in the southeast Pacific Ocean, in the latter half of 2016 and/or the beginning half of 2017. The proposed dates are between June 2016 and June 2017, to account for logistical and scheduling needs of the applicant. Per the Marine Mammal Protection Act (MMPA), we are requesting comments on our proposal to issue an Authorization to Lamont-Doherty to incidentally take, by level B harassment, 44 species of marine mammal during the specified activity and to incidentally take, by Level A harassment, 26 species of marine mammals. Although considered unlikely, any Level A harassment potentially incurred would be expected to be in the form of some smaller degree of permanent hearing loss due in part to the required monitoring measures for detecting marine mammals and required mitigation measures for power downs or shut downs of the airgun array if any animal is likely to enter the Level A exclusion zone. NMFS does not expect any serious injury, mortality, or deafness to occur in marine mammals as a result of this proposed survey.

DATES: NMFS must receive comments and information on or before May 19, 2016.

ADDRESSES: Address comments on the application to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is *ITP.Carduner@noaa.gov.* Please include 0648–XE451 in the subject line. Comments sent via email, including all attachments, must not exceed a 25 megabyte file size. NMFS is not responsible for email comments sent to addresses other than the one provided here.

Instructions: All submitted comments are part of the public record, and NMFS will post them to *http://www.nmfs.noaa.gov/pr/permits/incidental/research.htm* without change. All Personal Identifying Information (for example: name, address, etc.) voluntarily submitted by the commenter may also be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

To obtain an electronic copy of Lamont-Doherty's application, NSF's draft environmental analysis, NMFS' draft environmental assessment (EA), and a list of the references used in this document, write to the previously mentioned address, telephone the contact listed below (see **FOR FURTHER INFORMATION CONTACT**), or visit the internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental/research.htm.*

FOR FURTHER INFORMATION CONTACT: Jordan Carduner, NMFS, Office of Protected Resources, NMFS (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Background

Section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq.*) directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if, after NMFS provides a notice of a proposed authorization to the public for review and comment: (1) NMFS makes certain findings; and (2) the taking is limited to harassment.

An Authorization shall be granted for the incidental taking of small numbers of marine mammals if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The Authorization must also set forth the permissible methods of taking; other means of effecting the least practicable adverse impact on the species or stock and its habitat (*i.e.,* mitigation); and requirements pertaining to the monitoring and reporting of such taking. 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.''

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].

Summary of Request

On January 19, 2016, NMFS received an application from Lamont-Doherty requesting that NMFS issue an Authorization for the take of marine mammals, incidental to Oregon State University (OSU) and University of Texas (UT) conducting seismic surveys in the southeast Pacific Ocean, in the latter half of 2016 and/or the first half of 2017. NMFS considered the application and supporting materials adequate and complete on March 21, 2016.

Lamont-Doherty proposes to conduct three two-dimensional (2–D) surveys on the R/V *Marcus G. Langseth* (*Langseth*), a vessel owned by NSF and operated on its behalf by Columbia University's Lamont-Doherty Earth Observatory primarily in international waters of the southeast Pacific Ocean, with a small portion of the surveys occurring within the territorial waters of Chile. All proposed surveys will be conducted within the exclusive economic zone (EEZ) of Chile.

Increased underwater sound generated during the operation of the seismic airgun array is the only aspect of the proposed activity that is likely to result in the take of marine mammals. We anticipate that take, by Level B harassment, of 44 species of marine mammals could result from the specified activity. Although unlikely, NMFS also anticipates that a small amount of take by Level A harassment of 26 species of marine mammals could occur during the proposed survey.

Description of the Specified Activity

Overview

Lamont-Doherty plans to use one source vessel, the *Langseth,* with an array of 36 airguns as the energy source with a total volume of approximately 6,600 cubic inches (in^3). The receiving system would consist of 64 ocean bottom seismometers (OBSs) and a single hydrophone streamer between 8 and 15 kilometers (km) (4.9 and 9.3 miles [mi]) in length. In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated continuously throughout the proposed surveys. A total of approximately 9,633 km (5,986 mi) of transect lines would be surveyed in the southeast Pacific Ocean.

The primary purpose of the northern survey is to image the structure of the upper and lower plates in the region that slipped during the 2014 Pisagua/Iquique earthquake sequence and immediately to the south, where an historic seismic gap remains unruptured in order to better understand how geologic structure controlled the initiation, propagation, and termination of this rupture sequence.

The primary purpose of the central survey is to examine the extent and location of seafloor displacement and related subsurface fault movement related to the recent slip that occurred during the September 16, 2015, Illapel earthquake. The scientists would compare the newly acquired data with previously collected data to determine where displacement occurred, how much occurred, and which sub-seafloor faults were most likely active during this event.

The primary goal of the southern survey is to image the deep plate boundary thrust fault that can produce some of the world's largest earthquakes and tsunamis. This survey will image the characteristics of the plate-boundary thrust, sediment subduction, and upper plate structure within the 2010 Maule rupture segment and the 1960 Valdivia rupture area.

Dates and Duration

The surveys off Chile are proposed for 2016/2017 and would take approximately 60 days with the potential for an additional increase in number of days by 25 percent as a contingency for equipment failures, resurveys, or other operational needs. The surveys may occur at any time during the proposed authorized period of June 2016 to June 2017. The proposed survey off northern Chile would consist of approximately 45 days of science operations that include approximately 28 days of seismic operations, approximately 13 days of ocean bottom seismometer (OBS) deployment/retrieval, and approximately four days of transit and towed equipment deployment/retrieval. The central proposed survey would involve approximately six days, including approximately five days of seismic operations and approximately one day of equipment deployment/retrieval time. The southern proposed survey would involve approximately 32 days of science operations including approximately 27 days of seismic operations, and approximately five days of transit and towed equipment deployment/retrieval. As described above, the proposed surveys may occur at any time during the proposed authorized period of June 2016 to June 2017; however the proposed southern survey would most likely not occur between February and April.

NMFS refers the reader to the Detailed Description of Activities section later in this notice for more information on the scope of the proposed activities.

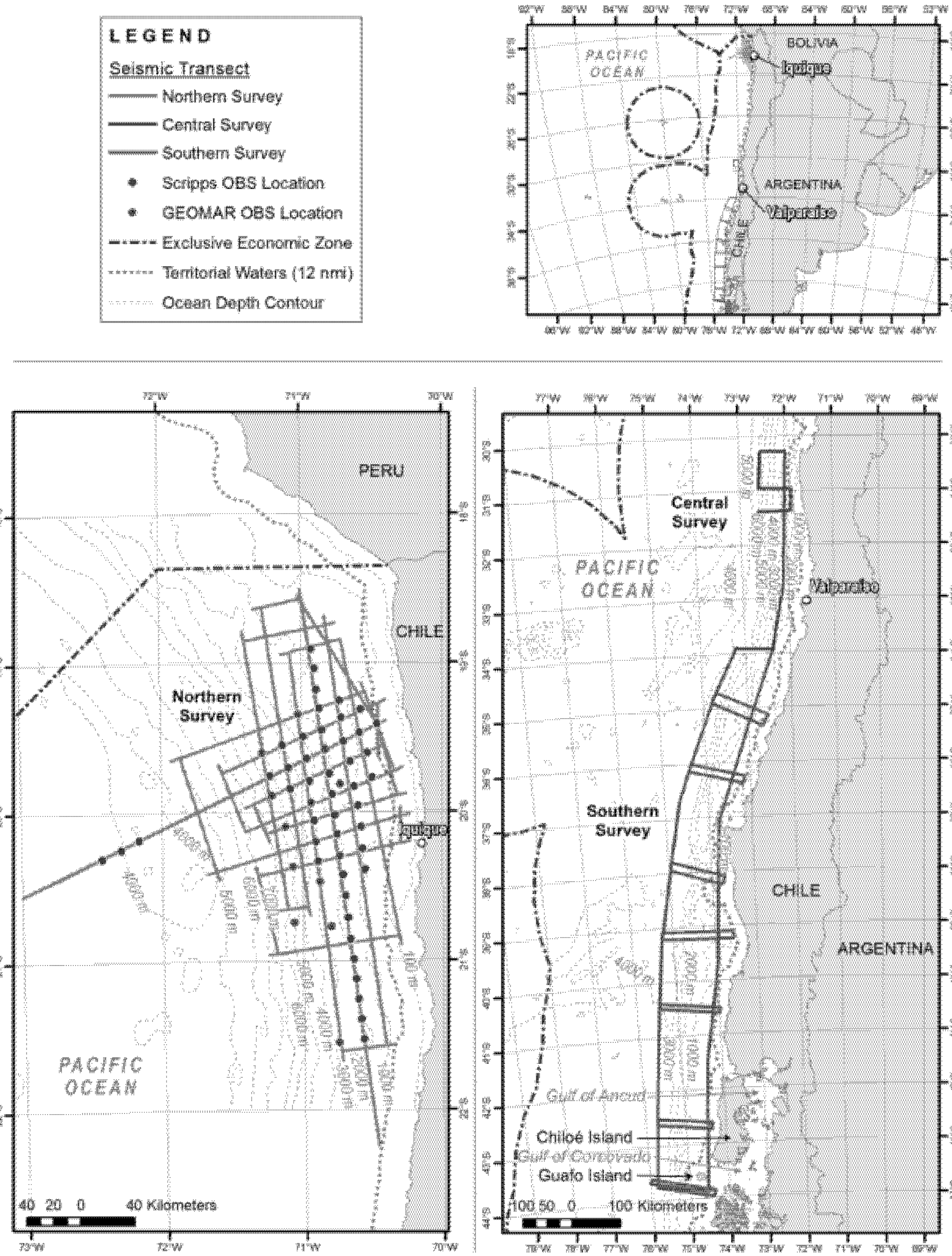
Specified Geographic Region

The proposed survey off northern Chile would occur within the area located at approximately 70.2–73.2° W., 18.3–22.4° S., the central proposed survey would occur within approximately 71.8–73.4° W., 30.1–33.9° S., and the southern proposed survey would occur within approximately 72.2–76.1° W., 33.9–44.1° S.

Representative survey tracklines are shown in Figure 1 in this notice and described further in Lamont-Doherty's application. 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. Water depths in the proposed survey areas range from approximately 50 to 7,600 m (164 to 25,000 ft). The proposed seismic surveys would be conducted within the EEZ of Chile; only a small proportion of the surveys would take place in territorial waters (see Figure 1).

Figure 1—Survey Locations and Sample Tracklines

Figure 1 - Survey locations and sample tracklines



Principal and Collaborating Investigators

The northern survey's Principal Investigator (PI) is Dr. A. Trehu (OSU) collaborating with Drs. E. Contreras-Reyes, E. Vera, and D. Comte (Universidad de Chile) and H. Kopp and D. Lange (Research Center for Marine Geosciences, GEOMAR, Helmholtz Centre for Ocean Research). The central and southern surveys PIs are Drs. N. Bangs (UT) and A. Trehu, participating with Drs. E. Contreras-Reyes and E. Vera.

Detailed Description of the Specified Activities

Transit Activities

The *Langseth* would transit to and from the survey locations from either a local port, or another research survey location in the region. The transit start and return points would be determined as the project schedule becomes finalized and may vary based on logistics, timing, or other factors.

Vessel Specifications

The survey would involve one source vessel, the R/V *Langseth.* The *Langseth,* owned by NSF and operated by Lamont-Doherty, is a seismic research vessel with a quiet propulsion system that avoids interference with the seismic signals emanating from the airgun array. The vessel is 71.5 m (235 ft) long; has a beam of 17.0 m (56 ft); a maximum draft of 5.9 m (19 ft); and a gross tonnage of 3,834 pounds. It has two 3,550 horsepower (hp) Bergen BRG–6 diesel engines that drive two propellers. Each propeller has four blades and the shaft typically rotates at 750 revolutions per minute. The vessel also has an 800-hp bowthruster, which is off during seismic acquisition.

The *Langseth's* speed during seismic operations would be approximately 4.5 knots (kt) (8.3 km/hour [hr]; 5.1 miles per hour [mph]). The vessel's cruising speed outside of seismic operations is approximately 10 kt (18.5 km/hr; 11.5 mph). While the *Langseth* tows the airgun array, its turning rate is limited to five degrees per minute. Thus, the *Langseth's* maneuverability is limited during operations while it tows the streamer.

The vessel also has an observation tower from which protected species visual observers (observers) would watch for marine mammals before and during the proposed seismic acquisition operations. When stationed on the observation platform, the observer's eye level will be approximately 21.5 m (71 ft) above sea level providing the observer an unobstructed view around the entire vessel.

Data Acquisition Activities

A total of approximately 9,633 km (5,986 mi) of transect lines would be surveyed in the southeast Pacific Ocean: Approximately 4,543 km (2,823 mi) off northern Chile, approximately 791 km (491 mi) during the central survey, and approximately 4,299 km (2,671 mi) during the southern survey. There could be additional seismic operations associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard.

During the survey, the *Langseth* would deploy 36 airguns as an energy source with a total volume of 6,600 in^3. The receiving system would consist of up to 68 OBSs deployed for the northern survey site, and a single 8- to 15-km (5–8.3 mi) hydrophone streamer for all surveys. As the *Langseth* tows the airgun array along the survey lines, the OBSs and hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system.

In addition to the operations of the airgun array, the ocean floor would be mapped with the Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. The proposed action will also include the use of an unmanned submersible vehicle for data collection. A Liquid Robotics SV2 Wave Glider could be used during the surveys for a period of several hours to collect data from seafloor sensors. An integrated acoustic transceiver communicates from the platform to a subsea-mounted acoustic data logger (ADL); the ADL then transfers data to a station on the platform, which transmits them to a control center via satellite. The SV2 Wave Glider platform is 2.1 m long and 60 cm wide (6.9 ft by 2ft).

Seismic Airguns

The *Langseth's* full array of airguns consists of four strings with 36 airguns (plus 4 spares), and a total volume of approximately 6,600 in^3. The airguns are a mixture of Bolt 1500LL and Bolt 1900LLX airguns ranging in size from 40 to 220 in^3, with a firing pressure of 1,950 pounds per square inch. The dominant frequency components range from zero to 188 Hertz (Hz). The airguns are fully detailed in § 2.2.3.1 of NSF's PEIS.

During the survey, Lamont-Doherty would plan to use the full array with most of the airguns in inactive mode. The 4-string array would be towed at a depth of 9 to 12 m (30 to 39 ft) during the northern proposed survey; the central and southern proposed surveys would use a tow depth of 9 m (30 ft). The shot intervals would range from 25 to 50 m (82 to 164 ft) for multi-channel seismic (MCS) acquisition, 100–150 m (328–492 ft) for simultaneous MCS and tomography acquisition, and 300 m (984 ft) for tomography acquisition. Airguns function by venting high-pressure air into the water, which creates an air bubble. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by the oscillation of the resulting air bubble. The oscillation of the air bubble transmits sounds downward through the seafloor, and there is also a reduction in the amount of sound transmitted in the near horizontal direction. The airgun array also emits sounds that travel horizontally toward non-target areas.

The nominal source levels of the airgun subarrays on the *Langseth* range from 240 to 247 decibels (dB) re: 1 μPa $_{\text{(peak to peak)}}$. (We express sound pressure level as the ratio of a measured sound pressure and a reference pressure level. The commonly used unit for sound pressure is dB and the commonly used reference pressure level in underwater acoustics is 1 microPascal (μPa)). Briefly, the effective source levels for horizontal propagation are lower than source levels for downward propagation. We refer the reader to Lamont-Doherty's Authorization application and NSF's Environmental Analysis for additional information on downward and horizontal sound propagation related to the airgun's source levels.

Additional Acoustic Data Acquisition Systems

Multibeam Echosounder: The *Langseth* will operate a Kongsberg EM 122 multibeam echosounder concurrently during airgun operations to map characteristics of the ocean floor. However, as stated earlier, Lamont-Doherty will not operate the multibeam echosounder during transits to and from the survey areas (*i.e.,* when the airguns are not operating).

The hull-mounted echosounder emits brief pulses of sound (also called a ping) (10.5 to 13.0 kHz) in a fan-shaped beam that extends downward and to the sides of the ship. The transmitting beamwidth is 1 or 2° fore-aft and 150° athwartship and the maximum source level is 242 dB re: 1 μPa.

Each ping consists of eight (in water greater than 1,000 m; 3,280 ft) or four (in water less than 1,000 m; 3,280 ft) successive, fan-shaped transmissions, from two to 15 milliseconds (ms) in duration and each ensonifying a sector that extends 1° fore-aft. Continuous wave pulses increase from 2 to 15 ms long in water depths up to 2,600 m (8,530 ft). The echosounder uses frequency-modulated chirp pulses up to 100-ms long in water greater than 2,600 m (8,530 ft). The successive transmissions span an overall cross-track angular extent of about 150°, with 2-ms gaps between the pulses for successive sectors.

Sub-bottom Profiler: The *Langseth* will also operate a Knudsen Chirp 3260 sub-bottom profiler concurrently during airgun and echosounder operations to provide information about the sedimentary features and bottom topography. As with the case of the echosounder, Lamont-Doherty will not operate the sub-bottom profiler during transits to and from the survey areas (*i.e.,* when the airguns are not operating).

The profiler is capable of reaching depths of 10,000 m (6.2 mi). The dominant frequency component is 3.5

kHz and a hull-mounted transducer on the vessel directs the beam downward in a 27° cone. The power output is 10 kilowatts (kW), but the actual maximum radiated power is three kilowatts or 222 dB re: 1 μPa. The ping duration is up to 64 ms with a pulse interval of one second, but a common mode of operation is to broadcast five pulses at 1-s intervals followed by a 5-s pause.

Ocean Bottom Seismometers: The *Langseth* would deploy a total of 50–54 OBS during the northern survey at a nominal 15-km (9.3 mi) spacing interval. Lamont-Doherty proposes to use one of two types of OBSs: The Woods Hole Oceanographic Institute (WHOI) or the Scripps Institution of Oceanography (SIO) OBS. The WHOI D2 OBS is approximately 0.9 m (2.9 ft) high with a maximum diameter of 50 centimeters (cm) (20 inches [in]). An anchor, made of a rolled steel bar grate that measures approximately 2.5 by 30.5 by 38.1 cm (1 by 12 by 15 in) and weighs 23 kilograms (kg) (51 pounds [lbs]) would anchor the seismometer to the seafloor. The SIO L-Cheapo OBS is approximately 0.9 m (2.9 ft) high with a maximum diameter of 97 centimeters (cm) (3.1 ft). The SIO anchors consist of 36-kg (79-lb) iron gates and measure approximately 7 by 91 by 91.5 cm (3 by 36 by 36 in).

After the *Langseth* completes the proposed seismic survey, an acoustic signal would trigger the release of each seismometer from the ocean floor. The *Langseth's* acoustic release transponder, located on the vessel, communicates with the seismometer at a frequency of 9 to13 kilohertz (kHz). The maximum source level of the release signal is 242 dB re: 1 μPa with an 8-millisecond pulse length. The received signal activates the seismometer's double burn-wire release assembly which then releases the seismometer from the anchor. The seismometer then floats to the ocean surface for retrieval by the *Langseth.* The steel grate anchors from each of the seismometers would remain on the seafloor.

The *Langseth* crew would deploy the seismometers one-by-one from the stern of the vessel while onboard protected species observers will alert them to the presence of marine mammals and recommend ceasing deploying or recovering the seismometers to avoid potential entanglement with marine mammal.

Hydrophone Streamer: Lamont-Doherty would deploy the single hydrophone streamer for multichannel operations after concluding the OBS operations. As the *Langseth* tows the airgun array along the survey lines, the streamer transfers the data to the on-board processing system.

Description of Marine Mammals in the Area of the Specified Activity

Table 1 in this notice provides the following: All marine mammal species with possible or confirmed occurrence in the proposed activity area; information on those species' regulatory status under the MMPA and the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*); abundance; local occurrence and range; and seasonality in the proposed activity area. Based on the best available information, NMFS expects that there may be a potential for certain cetacean and pinniped species to occur within the survey area (*i.e.,* potentially be taken) and have included additional information for these species in Table 1 of this notice. NMFS will carry forward analyses on the species listed in Table 1 later in this document.

TABLE 1—GENERAL INFORMATION ON MARINE MAMMALS THAT COULD POTENTIALLY OCCUR IN THE THREE PROPOSED SURVEY AREAS WITHIN THE SOUTHEAST PACIFIC OCEAN

Species	Regulatory status [1] [2]	Species abundance [3]	Local occurrence	Habitat
Antarctic minke whale (*Balaenoptera bonaerensis*).	MMPA—NC, ESA—NL	515,000	North—Rare, Central/South—Uncommon.	Coastal, pelagic.
Blue whale (*B. musculus*)	MMPA—D, ESA—EN	10,000 [4]	North—Common, Central/South—Common.	Coastal, shelf, pelagic.
Bryde's whale (*Balaenoptera edeni*)	MMPA—NC, ESA—NL	43,633 [5]	North—Common, Central/South—Common.	Coastal, pelagic.
Common minke whale (*B. acutorostrata*).	MMPA—NC, ESA—NL	515,000	North—Rare, Central/South—Uncommon.	Coastal, pelagic.
Fin whale (*B. physalus*)	MMPA—D, ESA—EN	22,000	North—Rare, Central/South—Common.	Shelf, slope, pelagic.
Humpback whale (*Megaptera novaengliae*).	MMPA—D, ESA—EN	42,000	North—Common, Central/South—Common.	Coastal, shelf, pelagic.
Pygmy right whale (*Caperea marginata*).	MMPA—NC, ESA—NL	Unknown	North—Unknown, Central/South—Rare.	Coastal, oceanic.
Sei whale (*B. borealis*)	MMPA—D, ESA—EN	10,000	North—Uncommon, Central/South—Uncommon.	Pelagic.
Southern right whale (*Eubalaena australis*).	MMPA—D, ESA—EN	12,000	North—Rare, Central/South—Rare.	Coastal, oceanic.
Sperm whale (*Physeter macrocephalus*).	MMPA—D, ESA—EN	355,000 [6]	North—Common, Central/South—Common.	Pelagic, deep seas.
Dwarf sperm whale (*Kogia sima*)	MMPA—NC, ESA—NL	170,309 [7]	North—Rare, Central/South—Rare.	Shelf, pelagic.
Pygmy sperm whale (*K. breviceps*)	MMPA—NC, ESA—NL	170,309 [7]	North—Rare, Central/South—Rare.	Shelf, pelagic.
Andrew's beaked whale (*Mesoplodon bowdoini*).	MMPA—NC, ESA—NL	25,300 [8]	North—Unknown, Central/South—Rare.	Pelagic.
Blainville's beaked whale (*M. densirostris*).	MMPA—NC, ESA—NL	25,300 [8]	North—Uncommon, Central/South—Uncommon.	Pelagic.
Cuvier's beaked whale (*Ziphius cavirostris*).	MMPA—NC, ESA—NL	20,000 [8]	North—Uncommon, Central/South—Uncommon.	Slope, pelagic.
Gray's beaked whale (*M. grayi*)	MMPA—NC, ESA—NL	25,300 [8]	North—Rare, Central/South—Rare.	Pelagic.
Hector's beaked whale (*M. hectori*)	MMPA—NC, ESA—NL	25,300 [8]	North—Unknown, Central/South—Rare.	Pelagic.

TABLE 1—GENERAL INFORMATION ON MARINE MAMMALS THAT COULD POTENTIALLY OCCUR IN THE THREE PROPOSED SURVEY AREAS WITHIN THE SOUTHEAST PACIFIC OCEAN—Continued

Species	Regulatory status [1 2]	Species abundance [3]	Local occurrence	Habitat
Pygmy beaked whale (*Mesoplodon peruvianus*).	MMPA—NC, ESA—NL	25,300 [8]	North—Rare, Central/South—Rare.	Pelagic.
Shepherd's beaked whale (*Tasmacetus shepherdi*).	MMPA—NC, ESA—NL	25,300 [8]	North—Unknown, Central/South—Rare.	Pelagic.
Spade-toothed whale (*Mesoplodon traversii*).	MMPA—NC, ESA—NL	25,300 [8]	North—Unknown, Central/South—Rare.	Pelagic.
Strap-toothed beaked whale (*M. layardii*).	MMPA—NC, ESA—NL	25,300 [8]	North—Unknown, Central/South—Rare.	Pelagic.
Southern bottlenose whale (*Hyperoodon planifrons*).	MMPA—NC, ESA—NL	72,000 [9]	North—Unknown, Central/South—Uncommon.	Pelagic.
Chilean dolphin (*Cephalorhynchus eutropia*).	MMPA—NC, ESA—NL	10,000	North—Unknown, Central/South—Uncommon.	Coastal.
Rough-toothed dolphin (*Steno bredanensis*).	MMPA—NC, ESA—NL	107,633 [10]	North—Rare, Central/South—Unknown.	Oceanic.
Common bottlenose dolphin (*Tursiops truncatus*).	MMPA—NC, ESA—NL	335,834 [10]	North—Abundant, Central/South—Common.	Coastal, pelagic, shelf.
Striped dolphin (*S. coeruleoalba*)	MMPA—NC, ESA—NL	964,362 [10]	North—Abundant, Central/South—Common.	Shelf edge, pelagic.
Short-beaked common dolphin (*Delphinus delphis*).	MMPA—NC, ESA—NL	1,766,551 [11]	North—Abundant, Central/South—Abundant.	Coastal, shelf.
Long-beaked common dolphin (*Delphinus capensis*).	MMPA—NC, ESA—NL	144,000 [12]	North—Uncommon, Central/South—Unknown.	Coastal, shelf.
Dusky dolphin (*Lagenorhynchus obscurus*).	MMPA—NC, ESA—NL	25,880 [13]	North—Abundant, Central/South—Abundant.	Shelf, slope.
Peale's dolphin (*Lagenorhynchus australis*).	MMPA—NC, ESA—NL	Unknown	North—Unknown, Central/South—Uncommon.	Coastal.
Hourglass dolphin (*Lagenorhynchus cruciger*).	MMPA—NC, ESA—NL	144,300 [14]	North—Unknown, Central/South—Rare.	Pelagic.
Southern right whale dolphin (*Lissodelphis peronii*).	MMPA—NC, ESA—NL	Unknown	North—Uncommon, Central/South—Common.	Pelagic.
Risso's dolphin (*Grampus griseus*)	MMPA—NC, ESA—NL	110,457 [10]	North—Common, Central/South—Uncommon.	Shelf, slope.
Pygmy killer whale (*Feresa attenuate*).	MMPA—NC, ESA—NL	38,900 [8]	North—Rare, Central/South—Uncommon.	Oceanic, pantropical.
False killer whale (*Pseudorca crassidens*).	MMPA—NC, ESA—NL	39,800 [8]	North—Uncommon, Central/South—Rare.	Pelagic.
Killer whale (*Orcinus orca*)	MMPA—NC, ESA—NL	50,000	North—Rare, Central/South—Rare.	Coastal, shelf, pelagic.
Long-finned pilot whale (*Globicephala melas*).	MMPA—NC, ESA—NL	200,000 [15]	North—Rare, Central/South—Rare.	Coastal, pelagic.
Short-finned pilot whale (*Globicephala macrorhynchus*).	MMPA—NC, ESA—NL	589,315 [16]	North—Rare, Central/South—Rare.	Coastal, pelagic.
Burmeister's porpoise (*Phocoena spinipinnis*).	MMPA—NC, ESA—NL	Unknown	North—Coastal, Central/South—Coastal.	Coastal.
Juan Fernandez fur seal (*Arctocephalus philippii*).	MMPA—NC, ESA—NL	32,278 [17]	North—Rare, Central/South—Rare.	Coastal, pelagic.
South American fur seal (*Arctocephalus australis*).	MMPA—NC, ESA—NL	250,000	North—Rare, Central/South—Rare.	Coastal, shelf, slope.
South American sea lion (*Otaria byronia*).	MMPA—NC, ESA—NL	397,771 [18]	North—Abundant, Central/South—Abundant.	Coastal, shelf.
Southern elephant seal (*Mirounga leonina*).	MMPA—NC, ESA—NL	640,000 [19]	North—Abundant, Central/South—Abundant.	Coastal, pelagic.

[1] MMPA: NC = Not classified; D = Depleted.
[2] ESA: EN = Endangered, T = Threatened, DL = Delisted, NL = Not listed.
[3] Except where noted best estimate abundance information obtained from the International Whaling Commission's whale population estimates (IWC, 2016) or from the International Union for Conservation of Nature and Natural Resources Red List of Threatened Species Web site (IUCN, 2016). Unknown = Abundance information does not exist for this species.
[4] IUCN's best estimate of the global population is 10,000 to 25,000.
[5] Estimate from IUCN's Web page for Bryde's whales. Southern Hemisphere: Southern Indian Ocean (13,854); western South Pacific (16,585); and eastern South Pacific (13,194) (IWC, 1981).
[6] Whitehead (2002).
[7] Estimate from IUCN's Web page for *Kogia* spp. Eastern Tropical Pacific (ETP) (150,000); Hawaii (19,172); Gulf of Mexico (742); and western Atlantic (395).
[8] Wade and Gerrodette (1993).
[9] South of 60° S. from the 1885/1986–1990/1991 IWC/IDCR and SOWER surveys (Branch and Butterworth, 2001).
[10] ETP, line-transect survey, August–December 2006 (Gerrodette *et al.,* 2008).
[11] ETP, southern stock, 2000 survey (Gerrodette and Forcada 2002).
[12] Gerrodette and Palacios (1996) estimated 55,000 within Pacific coast waters of Mexico, 69,000 in the Gulf of California, and 20,000 off South Africa. IUCN, 2016.
[13] IUCN, 2016 and Markowitz, 2004.
[14] Kasamatsu and Joyce, 1995.

[15] Abundance estimates for beaked, southern bottlenose, and pilot whales south of the Antarctic Convergence in January (Kasamatsu and Joyce, 1995).
[16] Gerrodette and Forcada (2002).
[17] 2005/2006 minimum population estimate (Osman, 2008).
[18] Crespo *et al.* (2012). Current status of the South American sea lion along the distribution range.
[19] Hindell and Perrin (2009).

NMFS refers the public to Lamont-Doherty's application, NSF's draft environmental analysis (see **ADDRESSES**), available online at: *http://www.nmfs.noaa.gov/pr/sars/species.htm* for further information on the biology and local distribution of these species.

Potential Effects of the Specified Activities on Marine Mammals

This section includes a summary and discussion of the ways that components (*e.g.,* seismic airgun operations, vessel movement) of the specified activity may impact marine mammals. The ''Estimated Take by Incidental Harassment'' section later in this document will include a quantitative analysis of the number of individuals that NMFS expects to be taken by this activity. The ''Negligible Impact Analysis'' section will include the analysis of how this specific proposed activity would impact marine mammals and will consider the content of this section, the ''Estimated Take by Incidental Harassment'' section, the ''Proposed Mitigation'' section, and the ''Anticipated Effects on Marine Mammal Habitat'' section to draw conclusions regarding the likely impacts of this activity on the reproductive success or survivorship of individuals and from that on the affected marine mammal populations or stocks.

NMFS intends to provide a background of potential effects of Lamont-Doherty's activities in this section. This section does not consider the specific manner in which Lamont-Doherty would carry out the proposed activity, what mitigation measures Lamont-Doherty would implement, and how either of those would shape the anticipated impacts from this specific activity. Operating active acoustic sources, such as airgun arrays, has the potential for adverse effects on marine mammals. The majority of anticipated impacts would be from the use of the airgun array.

Acoustic Impacts

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Current data indicate that not all marine mammal species have equal hearing capabilities (Richardson *et al.,* 1995; Southall *et al.,* 1997; Wartzok and Ketten, 1999; Au and Hastings, 2008).

Southall *et al.* (2007) designated ''functional hearing groups'' for marine mammals based on available behavioral data; audiograms derived from auditory evoked potentials; anatomical modeling; and other data. Southall *et al.* (2007) also estimated the lower and upper frequencies of functional hearing for each group. However, animals are less sensitive to sounds at the outer edges of their functional hearing range and are more sensitive to a range of frequencies within the middle of their functional hearing range.

The functional groups applicable to this proposed survey and the associated frequencies are:

- Low frequency cetaceans (13 species of mysticetes): Functional hearing estimates occur between approximately 7 Hertz (Hz) and 25 kHz (extended from 22 kHz based on data indicating that some mysticetes can hear above 22 kHz; Au *et al.,* 2006; Lucifredi and Stein, 2007; Ketten and Mountain, 2009; Tubelli *et al.,* 2012);
- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): Functional hearing estimates occur between approximately 150 Hz and 160 kHz;
- High-frequency cetaceans (eight species of true porpoises, six species of river dolphins, *Kogia,* the franciscana, and four species of *cephalorhynchids*): Functional hearing estimates occur between approximately 200 Hz and 180 kHz; and
- Pinnipeds in water: phocid (true seals) functional hearing estimates occur between approximately 75 Hz and 100 kHz (Hemila *et al.,* 2006; Mulsow *et al.,* 2011; Reichmuth *et al.,* 2013) and otariid (seals and sea lions) functional hearing estimates occur between approximately 100 Hz to 40 kHz.

Approximately 44 marine mammals (9 Mysticetes, 31 odontocetes, and 4 pinnipeds) would likely occur in the proposed action area. Table 2 presents the classification of these species into their respected functional hearing group. NMFS considers a species' functional hearing group when analyzing the effects of exposure to sound on marine mammals.

TABLE 2—CLASSIFICATION OF MARINE MAMMALS THAT COULD POTENTIALLY OCCUR IN THE PROPOSED SURVEY AREAS WITHIN THE SOUTHEAST PACIFIC OCEAN, 2016/2017, BY FUNCTIONAL HEARING GROUP

[Southall *et al.,* 2007]

Low Frequency Hearing Range	Antarctic minke, blue, Bryde's, common (dwarf) minke, fin, humpback, Sei, pygmy right, and Southern right whale.
Mid-Frequency Hearing Range	Sperm whale; Cuvier's; Andrew's; Blainville's, Gray's; Hector's; pygmy; and Shepherd's beaked whale; strap toothed; spade toothed; Southern bottlenose whale; bottlenose; hourglass; dusky; Peale's; rough-toothed; striped; Chilean; Risso's; long-beaked common; short-beaked common; and Southern right whale dolphin; pygmy killer whale; false killer whale; killer whale, long-finned pilot whale; and short-finned pilot whale.
High Frequency Hearing Range	Dwarf sperm whale and pygmy sperm whale.
Pinnipeds in Water Hearing Range	Southern elephant seal; Southern American sea lion; Subantarctic fur seal; and Juan Fernandez fur seal.

1. Potential Effects of Airgun Sounds on Marine Mammals

The effects of sounds from airgun operations might include one or more of the following: Tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent impairment, or non-auditory physical or physiological effects (Richardson *et al.,* 1995; Gordon *et al.,* 2003; Nowacek *et al.,* 2007; Southall *et al.,* 2007). The effects of noise on marine mammals are highly variable, often depending on species and contextual factors (based on Richardson *et al.,* 1995).

Tolerance

Studies on marine mammals' tolerance to sound in the natural environment are relatively rare. Richardson *et al.* (1995) defined tolerance as the occurrence of marine mammals in areas where they are exposed to human activities or manmade noise. In many cases, tolerance develops by the animal habituating to the stimulus (*i.e.,* the gradual waning of responses to a repeated or ongoing stimulus) (Richardson, *et al.,* 1995), but because of ecological or physiological requirements, many marine animals may need to remain in areas where they are exposed to chronic stimuli (Richardson, *et al.,* 1995).

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Several studies have also shown that marine mammals at distances of more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of the marine mammal group. Although various baleen whales and toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times marine mammals of all three types have shown no overt reactions (Stone, 2003; Stone and Tasker, 2006; Moulton *et al.,*2005, 2006) and (MacLean and Koski, 2005; Bain and Williams, 2006).

Weir (2008) observed marine mammal responses to seismic pulses from a 24 airgun array firing a total volume of either 5,085 in^3 or 3,147 in^3 in Angolan waters between August 2004 and May 2005. Weir (2008) recorded a total of 207 sightings of humpback whales (n = 66), sperm whales (n = 124), and Atlantic spotted dolphins (n = 17) and reported that there were no significant differences in encounter rates (sightings per hour) for humpback and sperm whales according to the airgun array's operational status (*i.e.,* active versus silent).

Bain and Williams (2006) examined the effects of a large airgun array (maximum total discharge volume of 1,100 in^3) on six species in shallow waters off British Columbia and Washington: Harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), Steller sea lion (*Eumetopias jubatus*), gray whale (*Eschrichtius robustus*), Dall's porpoise (*Phocoenoides dalli*), and harbor porpoise (*Phocoena phocoena*). Harbor porpoises showed reactions at received levels less than 155 dB re: 1 μPa at a distance of greater than 70 km (43 mi) from the seismic source (Bain and Williams, 2006). However, the tendency for greater responsiveness by harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson, *et al.,* 1995; Southall, *et al.,* 2007). In contrast, the authors reported that gray whales seemed to tolerate exposures to sound up to approximately 170 dB re: 1 μPa (Bain and Williams, 2006) and Dall's porpoises occupied and tolerated areas receiving exposures of 170–180 dB re: 1 μPa (Bain and Williams, 2006; Parsons, *et al.,* 2009). The authors observed several gray whales that moved away from the airguns toward deeper water where sound levels were higher due to propagation effects resulting in higher noise exposures (Bain and Williams, 2006). However, it is unclear whether their movements reflected a response to the sounds (Bain and Williams, 2006). Thus, the authors surmised that the lack of gray whale responses to higher received sound levels were ambiguous at best because one expects the species to be the most sensitive to the low-frequency sound emanating from the airguns (Bain and Williams, 2006).

Pirotta *et al.* (2014) observed short-term responses of harbor porpoises to a 2–D seismic survey in an enclosed bay in northeast Scotland which did not result in broad-scale displacement. The harbor porpoises that remained in the enclosed bay area reduced their buzzing activity by 15 percent during the seismic survey (Pirotta *et al.,* 2014). Thus, the authors suggest that animals exposed to anthropogenic disturbance may make trade-offs between perceived risks and the cost of leaving disturbed areas (Pirotta *et al.,* 2014).

Masking

Marine mammals use acoustic signals for a variety of purposes, which differ among species, but include communication between individuals, navigation, foraging, reproduction, avoiding predators, and learning about their environment (Erbe and Farmer, 2000; Tyack, 2000).

The term masking refers to the inability of an animal to recognize the occurrence of an acoustic stimulus because of interference of another acoustic stimulus (Clark *et al.,* 2009). Thus, masking is the obscuring of sounds of interest by other sounds, often at similar frequencies. It is a phenomenon that affects animals that are trying to receive acoustic information about their environment, including sounds from other members of their species, predators, prey, and sounds that allow them to orient in their environment. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations. Introduced underwater sound may, through masking, more specifically reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson *et al.,* 1995).

Evidence suggests that some marine mammals may be able to compensate for communication masking by adjusting their acoustic behavior through shifting call frequencies, increasing call volume, and increasing vocalization rates. For example, blue whales were shown to increase call rates when exposed to noise from seismic surveys in the St. Lawrence Estuary (Di Iorio and Clark, 2010). Other studies reported that some North Atlantic right whales exposed to high shipping noise increased call frequency (Parks *et al.,* 2007) and some humpback whales responded to low-frequency active sonar playbacks by increasing song length (Miller *et al.,* 2000). Additionally, beluga whales change their vocalizations in the presence of high background noise possibly to avoid masking calls (Au *et al.,* 1985; Lesage *et al.,* 1999; Scheifele *et al.,* 2005).

Studies have shown that some baleen and toothed whales continue calling in the presence of seismic pulses, and some researchers have heard these calls between the seismic pulses (*e.g.,* Richardson *et al.,* 1986; McDonald *et al.,* 1995; Greene *et al.,* 1999; Nieukirk *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a, 2005b, 2006; and Dunn and Hernandez, 2009).

In contrast, Clark and Gagnon (2006) reported that fin whales in the northeast Pacific Ocean went silent for an extended period starting soon after the onset of a seismic survey in the area. Similarly, NMFS is aware of one report that observed sperm whales ceasing calls when exposed to pulses from a very distant seismic ship (Bowles *et al.,* 1994). However, more recent studies have found that sperm whales continued calling in the presence of seismic pulses (Madsen *et al.,* 2002; Tyack *et al.,* 2003; Smultea *et al.,* 2004; Holst *et al.,* 2006; and Jochens *et al.,* 2008).

Risch *et al.* (2012) documented reductions in humpback whale vocalizations in the Stellwagen Bank National Marine Sanctuary concurrent with transmissions of the Ocean Acoustic Waveguide Remote Sensing (OAWRS) low-frequency fish sensor system at distances of 200 km (124 mi) from the source. The recorded OAWRS produced series of frequency modulated pulses and the signal received levels ranged from 88 to 110 dB re: 1 μPa (Risch, *et al.,* 2012). The authors hypothesized that individuals did not leave the area but instead ceased singing and noted that the duration and frequency range of the OAWRS signals (a novel sound to the whales) were similar to those of natural humpback whale song components used during mating (Risch *et al.,* 2012). Thus, the novelty of the sound to humpback whales in the study area provided a compelling contextual probability for the observed effects (Risch *et al.,* 2012). However, the authors did not state or imply that these changes had long-term effects on individual animals or populations (Risch *et al.,* 2012).

Several studies have also reported hearing dolphins and porpoises calling while airguns were operating (*e.g.,* Gordon *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a, b; and Potter *et al.,* 2007). The sounds important to small odontocete communication are predominantly at much higher frequencies than the dominant components of airgun sounds, thus limiting the potential for masking in those species.

Although some degree of masking is inevitable when high levels of manmade broadband sounds are present in the sea, marine mammals have evolved systems and behavior that function to reduce the impacts of masking. Odontocete conspecifics may readily detect structured signals, such as the echolocation click sequences of small toothed whales even in the presence of strong background noise because their frequency content and temporal features usually differ strongly from those of the background noise (Au and Moore, 1988, 1990). The components of background noise that are similar in frequency to the sound signal in question primarily determine the degree of masking of that signal.

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The sound localization abilities of marine mammals suggest that, if signal and noise come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Richardson *et al.,* 1995). The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-noise ratio. In the cases of higher frequency hearing by the bottlenose dolphin, beluga whale, and killer whale, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking noise (Penner *et al.,* 1986; Dubrovskiy, 1990; Bain *et al.,* 1993; Bain and Dahlheim, 1994).

Toothed whales and probably other marine mammals as well, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background noise. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient noise toward frequencies with less noise (Au *et al.,* 1974, 1985; Moore and Pawloski, 1990; Thomas and Turl, 1990; Romanenko and Kitain, 1992; Lesage *et al.,* 1999). A few marine mammal species increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Dahlheim, 1987; Au, 1993; Lesage *et al.,* 1993, 1999; Terhune, 1999; Foote *et al.,* 2004; Parks *et al.,* 2007, 2009; Di Iorio and Clark, 2010; Holt *et al.,* 2009).

These data demonstrating adaptations for reduced masking pertain mainly to the very high frequency echolocation signals of toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies or in other types of marine mammals. For example, Zaitseva *et al.* (1980) found that, for the bottlenose dolphin, the angular separation between a sound source and a masking noise source had little effect on the degree of masking when the sound frequency was 18 kHz, in contrast to the pronounced effect at higher frequencies. Studies have noted directional hearing at frequencies as low as 0.5–2 kHz in several marine mammals, including killer whales (Richardson *et al.,* 1995a). This ability may be useful in reducing masking at these frequencies. In summary, high levels of sound generated by anthropogenic activities may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking may be more prominent for lower frequencies. For higher frequencies, such as that used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such masking.

Behavioral Disturbance

Marine mammals may behaviorally react to sound when exposed to anthropogenic noise. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson *et al.,* 1995; Wartzok *et al.,* 2004; Southall *et al.,* 2007; Weilgart, 2007).

Types of behavioral reactions can include the following: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (*e.g.,* pinnipeds flushing into water from haulouts or rookeries).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, one could expect the consequences of behavioral modification to be biologically significant if the change affects growth, survival, and/or reproduction (*e.g.,* Lusseau and Bejder, 2007; Weilgart, 2007). Examples of behavioral modifications that could impact growth, survival, or reproduction include:

- Drastic changes in diving/surfacing patterns (such as those associated with beaked whale stranding related to exposure to military mid-frequency tactical sonar);
- Permanent habitat abandonment due to loss of desirable acoustic environment; and

• Disruption of feeding or social interaction resulting in significant energetic costs, inhibited breeding, or cow-calf separation.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Richardson *et al.,* 1995; Southall *et al.,* 2007).

Baleen Whales

Studies have shown that underwater sounds from seismic activities are often readily detectable by baleen whales in the water at distances of many kilometers (Castellote *et al.,* 2012 for fin whales). Many studies have also shown that marine mammals at distances more than a few kilometers away often show no apparent response when exposed to seismic activities (*e.g.,* Madsen & Mohl, 2000 for sperm whales; Malme *et al.,* 1983, 1984 for gray whales; and Richardson *et al.,* 1986 for bowhead whales). Other studies have shown that marine mammals continue important behaviors in the presence of seismic pulses (*e.g.,* Dunn & Hernandez, 2009 for blue whales; Greene Jr. *et al.,* 1999 for bowhead whales; Holst and Beland, 2010; Holst and Smultea, 2008; Holst *et al.,* 2005; Nieukirk *et al.,* 2004; Richardson, *et al.,* 1986; Smultea *et al.,* 2004).

Observers have seen various species of *Balaenoptera* (blue, sei, fin, and minke whales) in areas ensonified by airgun pulses (Stone, 2003; MacLean and Haley, 2004; Stone and Tasker, 2006), and have localized calls from blue and fin whales in areas with airgun operations (*e.g.,* McDonald *et al.,* 1995; Dunn and Hernandez, 2009; Castellote *et al.,* 2010). Sightings by observers on seismic vessels off the United Kingdom from 1997 to 2000 suggest that, during times of good visibility, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting versus silent (Stone, 2003; Stone and Tasker, 2006). However, these whales tended to exhibit localized avoidance, remaining significantly further (on average) from the airgun array during seismic operations compared with non-seismic periods (Stone and Tasker, 2006).

Ship-based monitoring studies of baleen whales (including blue, fin, sei, minke, and whales) in the northwest Atlantic found that overall, this group had lower sighting rates during seismic versus non-seismic periods (Moulton and Holst, 2010). The authors observed that baleen whales as a group were significantly farther from the vessel during seismic compared with non-seismic periods. Moreover, the authors observed that the whales swam away more often from the operating seismic vessel (Moulton and Holst, 2010). Initial sightings of blue and minke whales were significantly farther from the vessel during seismic operations compared to non-seismic periods and the authors observed the same trend for fin whales (Moulton and Holst, 2010). Also, the authors observed that minke whales most often swam away from the vessel when seismic operations were underway (Moulton and Holst, 2010).

Blue Whales

McDonald *et al.* (1995) tracked blue whales relative to a seismic survey with a 1,600 in^3 airgun array. One whale started its call sequence within 15 km (9.3 mi) from the source, then followed a pursuit track that decreased its distance to the vessel where it stopped calling at a range of 10 km (6.2 mi) (estimated received level at 143 dB re: 1 μPa (peak-to-peak)). After that point, the ship increased its distance from the whale which continued a new call sequence after approximately one hour and 10 km (6.2 mi) from the ship. The authors reported that the whale had taken a track paralleling the ship during the cessation phase but observed the whale moving diagonally away from the ship after approximately 30 minutes continuing to vocalize. Because the whale may have approached the ship intentionally or perhaps was unaffected by the airguns, the authors concluded that there was insufficient data to infer conclusions from their study related to blue whale responses (McDonald, *et al.,* 1995).

Dunn and Hernandez (2009) tracked blue whales in the eastern tropical Pacific Ocean near the northern East Pacific Rise using 25 ocean-bottom-mounted hydrophones and ocean bottom seismometers during the conduct of an academic seismic survey by the R/V *Maurice Ewing* in 1997. During the airgun operations, the authors recorded the airgun pulses across the entire seismic array which they determined were detectable by eight whales that had entered into the area during a period of airgun activity (Dunn and Hernandez, 2009). The authors were able to track each whale call-by-call using the B components of the calls and examine the whales' locations and call characteristics with respect to the periods of airgun activity. The authors tracked the blue whales from 28 to 100 km (17 to 62 mi) away from active air-gun operations, but did not observe changes in call rates and found no evidence of anomalous behavior that they could directly ascribed to the use of the airguns (Dunn and Hernandez, 2009; Wilcock *et al.,* 2014). Further, the authors state that while the data do not permit a thorough investigation of behavioral responses, they observed no correlation in vocalization or movement with the concurrent airgun activity and estimated that the sound levels produced by the *Ewing's* airguns were approximately less than 145 dB re: 1 μPa (Dunn and Hernandez, 2009).

Fin Whales

Castellote *et al.* (2010) observed localized avoidance by fin whales during seismic airgun events in the western Mediterranean Sea and adjacent Atlantic waters from 2006–2009 and reported that singing fin whales moved away from an operating airgun array for a time period that extended beyond the duration of the airgun activity.

Gray Whales

A few studies have documented reactions of migrating and feeding (but not wintering) gray whales (*Eschrichtius robustus*) to seismic surveys. Malme *et al.* (1986, 1988) studied the responses of feeding eastern Pacific gray whales to pulses from a single 100-in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50 percent of feeding gray whales stopped feeding at an average received pressure level of 173 dB re: 1 μPa on an (approximate) root mean square basis, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB re: 1 μPa. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (Malme *et al.,* 1984; Malme and Miles, 1985), and western Pacific gray whales feeding off Sakhalin Island, Russia (Wursig *et al.,* 1999; Gailey *et al.,* 2007; Johnson *et al.,* 2007; Yazvenko *et al.,* 2007a, 2007b), along with data on gray whales off British Columbia (Bain and Williams, 2006).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A in

Malme *et al.,* 1984; Richardson *et al.,* 1995; Allen and Angliss, 2014). The western Pacific gray whale population did not appear affected by a seismic survey in its feeding ground during a previous year (Johnson *et al.,* 2007). Similarly, bowhead whales (*Balaena mysticetus*) have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years (Richardson *et al.,* 1987; Allen and Angliss, 2014). The history of coexistence between seismic surveys and baleen whales suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects.

Humpback Whales

McCauley *et al.* (1998, 2000) studied the responses of humpback whales off western Australia to a full-scale seismic survey with a 16-airgun array (2,678-in^3) and to a single, 20-in^3 airgun with source level of 227 dB re: 1 µPa (peak-to-peak). In the 1998 study, the researchers documented that avoidance reactions began at five to eight km (3.1 to 4.9 mi) from the array, and that those reactions kept most pods approximately three to four km (1.9 to 2.5 mi) from the operating seismic boat. In the 2000 study, McCauley *et al.* (1998, 2000) noted localized displacement during migration of four to five km (2.5 to 3.1 mi) by traveling pods and seven to 12 km (4.3 to 7.5 mi) by more sensitive resting pods of cow-calf pairs. Avoidance distances with respect to the single airgun were smaller but consistent with the results from the full array in terms of the received sound levels. The mean received level for initial avoidance of an approaching airgun was 140 dB re: 1 µPa for humpback pods containing females, and at the mean closest point of approach distance, the received level was 143 dB re: 1 µPa. The initial avoidance response generally occurred at distances of five to eight km (3.1 to 4.9 mi) from the airgun array and 2 km (1.2 mi) from the single airgun. However, some individual humpback whales, especially males, approached within distances of 100 to 400 m (328 to 1,312 ft), where the maximum received level was 179 dB re: 1 µPa.

Data collected by observers during several of Lamont-Doherty's seismic surveys in the northwest Atlantic Ocean showed that sighting rates of humpback whales were significantly greater during non-seismic periods compared with periods when a full array was operating (Moulton and Holst, 2010). In addition, humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic versus non-seismic periods (Moulton and Holst, 2010).

Humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64–L (100-in^3) airgun (Malme *et al.,* 1985). Some humpbacks seemed ''startled'' at received levels of 150 to 169 dB re: 1 µPa. Malme *et al.* (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re: 1 µPa. However, Moulton and Holst (2010) reported that humpback whales monitored during seismic surveys in the northwest Atlantic had lower sighting rates and were most often seen swimming away from the vessel during seismic periods compared with periods when airguns were silent.

Other studies have suggested that south Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel *et al.,* 2004). However, the evidence for this was circumstantial and subject to alternative explanations (IAGC, 2004). Also, the evidence was not consistent with subsequent results from the same area of Brazil (Parente *et al.,* 2006), or with direct studies of humpbacks exposed to seismic surveys in other areas and seasons. After allowance for data from subsequent years, there was ''no observable direct correlation'' between strandings and seismic surveys (IWC, 2007: 236).

Toothed Whales

Few systematic data are available describing reactions of toothed whales to noise pulses. However, systematic work on sperm whales is underway (*e.g.,* Gordon *et al.,* 2006; Madsen *et al.,* 2006; Winsor and Mate, 2006; Jochens *et al.,* 2008; Miller *et al.,* 2009) and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (*e.g.,* Stone, 2003; Smultea *et al.,* 2004; Moulton and Miller, 2005; Bain and Williams, 2006; Holst *et al.,* 2006; Stone and Tasker, 2006; Potter *et al.,* 2007; Hauser *et al.,* 2008; Holst and Smultea, 2008; Weir, 2008; Barkaszi *et al.,* 2009; Richardson *et al.,* 2009; Moulton and Holst, 2010). Reactions of toothed whales to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for mysticetes.

Delphinids

Seismic operators and protected species observers (observers) on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (*e.g.,* Goold, 1996a,b,c; Calambokidis and Osmek, 1998; Stone, 2003; Moulton and Miller, 2005; Holst *et al.,* 2006; Stone and Tasker, 2006; Weir, 2008; Richardson *et al.,* 2009; Barkaszi *et al.,* 2009; Moulton and Holst, 2010). Some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing (*e.g.,* Moulton and Miller, 2005). Nonetheless, there have been indications that small toothed whales sometimes move away or maintain a somewhat greater distance from the vessel when a large array of airguns is operating than when it is silent (*e.g.,* Goold, 1996a,b,c; Stone and Tasker, 2006; Weir, 2008, Barry *et al.,* 2010; Moulton and Holst, 2010). In most cases, the avoidance radii for delphinids appear to be small, on the order of one km or less, and some individuals show no apparent avoidance.

Captive bottlenose dolphins exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran *et al.,* 2000, 2002, 2005). However, the animals tolerated high received levels of sound (pk–pk level > 200 dB re 1 µPa) before exhibiting aversive behaviors.

Killer Whales

Observers stationed on seismic vessels operating off the United Kingdom from 1997–2000 have provided data on the occurrence and behavior of various toothed whales exposed to seismic pulses (Stone, 2003; Gordon *et al.,* 2004). The studies note that killer whales were significantly farther from large airgun arrays during periods of active airgun operations compared with periods of silence. The displacement of the median distance from the array was approximately 0.5 km (0.3 mi) or more. Killer whales also appear to be more tolerant of seismic shooting in deeper water (Stone, 2003; Gordon *et al.,* 2004).

Sperm Whales

Most studies of sperm whales exposed to airgun sounds indicate that the whale shows considerable tolerance of airgun pulses (*e.g.,* Stone, 2003; Moulton *et al.,* 2005, 2006a; Stone and Tasker, 2006; Weir, 2008). In most cases the whales do not show strong avoidance, and they continue to call. However, controlled exposure experiments in the Gulf of Mexico indicate alteration of foraging behavior upon exposure to airgun sounds (Jochens *et al.,* 2008; Miller *et al.,* 2009; Tyack, 2009).

Beaked Whales

There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. Most beaked whales tend to avoid approaching vessels of other types (*e.g.,* Wursig *et al.,* 1998). They may also dive for an extended period when approached by a vessel (*e.g.,* Kasuya, 1986), although it is uncertain how much longer such dives may be as compared to dives by undisturbed beaked whales, which also are often quite long (Baird *et al.,* 2006; Tyack *et al.,* 2006).

Based on a single observation, Aguilar-Soto *et al.* (2006) suggested a reduction in foraging efficiency of Cuvier's beaked whales during a close approach by a vessel. In contrast, Moulton and Holst (2010) reported 15 sightings of beaked whales during seismic studies in the northwest Atlantic and the authors observed seven of those sightings during times when at least one airgun was operating. Because sighting rates and distances were similar during seismic and non-seismic periods, the authors could not correlate changes to beaked whale behavior to the effects of airgun operations (Moulton and Holst, 2010).

Similarly, other studies have observed northern bottlenose whales remain in the general area of active seismic operations while continuing to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys (Gosselin and Lawson, 2004; Laurinolli and Cochrane, 2005; Simard *et al.,* 2005).

Pinnipeds

Pinnipeds are not likely to show a strong avoidance reaction to the airgun sources proposed for use. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior. Monitoring work in the Alaskan Beaufort Sea during 1996–2001 provided considerable information regarding the behavior of Arctic ice seals exposed to seismic pulses (Harris *et al.,* 2001; Moulton and Lawson, 2002). These seismic projects usually involved arrays of 6 to 16 airguns with total volumes of 560 to 1,500 in.[3] The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal (*Phoca hispida*) sightings tended to be farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson, 2002). However, these avoidance movements were relatively small, on the order of 100 m (328 ft) to a few hundred meters, and many seals remained within 100–200 m (328–656 ft) of the trackline as the operating airgun array passed by the animals. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. Similarly, seals are often very tolerant of pulsed sounds from seal-scaring devices (Mate and Harvey, 1987; Jefferson and Curry, 1994; Richardson *et al.,* 1995). However, initial telemetry work suggests that avoidance and other behavioral reactions by two other species of seals to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson *et al.,* 1998).

Hearing Impairment

Exposure to high intensity sound for a sufficient duration may result in auditory effects such as a noise-induced threshold shift—an increase in the auditory threshold after exposure to noise (Finneran *et al.,* 2005). Factors that influence the amount of threshold shift include the amplitude, duration, frequency content, temporal pattern, and energy distribution of noise exposure. The magnitude of hearing threshold shift normally decreases over time following cessation of the noise exposure. The amount of threshold shift just after exposure is the initial threshold shift. If the threshold shift eventually returns to zero (*i.e.,* the threshold returns to the pre-exposure value), it is a temporary threshold shift (Southall *et al.,* 2007).

Threshold Shift (Noise-Induced Loss of Hearing)

When animals exhibit reduced hearing sensitivity (*i.e.,* sounds must be louder for an animal to detect them) following exposure to an intense sound or sound for long duration, it is referred to as a noise-induced threshold shift (TS). An animal can experience temporary threshold shift (TTS) or permanent threshold shift (PTS). TTS can last from minutes or hours to days (*i.e.,* there is complete recovery), can occur in specific frequency ranges (*i.e.,* an animal might only have a temporary loss of hearing sensitivity between the frequencies of 1 and 10 kHz), and can be of varying amounts (for example, an animal's hearing sensitivity might be reduced initially by only 6 dB or reduced by 30 dB). PTS is permanent, but some recovery is possible. PTS can also occur in a specific frequency range and amount as mentioned above for TTS.

The following physiological mechanisms are thought to play a role in inducing auditory TS: Effects to sensory hair cells in the inner ear that reduce their sensitivity, modification of the chemical environment within the sensory cells, residual muscular activity in the middle ear, displacement of certain inner ear membranes, increased blood flow, and post-stimulatory reduction in both efferent and sensory neural output (Southall *et al.,* 2007). The amplitude, duration, frequency, temporal pattern, and energy distribution of sound exposure all can affect the amount of associated TS and the frequency range in which it occurs. As amplitude and duration of sound exposure increase, so, generally, does the amount of TS, along with the recovery time. For intermittent sounds, less TS could occur than compared to a continuous exposure with the same energy (some recovery could occur between intermittent exposures depending on the duty cycle between sounds) (Kryter *et al.,* 1966; Ward, 1997). For example, one short but loud (higher SPL) sound exposure may induce the same impairment as one longer but softer sound, which in turn may cause more impairment than a series of several intermittent softer sounds with the same total energy (Ward, 1997). Additionally, though TTS is temporary, prolonged exposure to sounds strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter, 1985).

PTS is considered an auditory injury (Southall *et al.,* 2007). Irreparable damage to the inner or outer cochlear hair cells may cause PTS; however, other mechanisms are also involved, such as exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of the inner ear fluids (Southall *et al.,* 2007).

Although the published body of scientific literature contains numerous theoretical studies and discussion papers on hearing impairments that can occur with exposure to a loud sound, only a few studies provide empirical information on the levels at which noise-induced loss in hearing sensitivity occurs in non-human animals.

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

For marine mammals, published data are limited to the captive bottlenose dolphin, beluga, harbor porpoise, and Yangtze finless porpoise (Finneran *et al.,* 2000, 2002b, 2003, 2005a, 2007, 2010a, 2010b; Finneran and Schlundt, 2010; Lucke *et al.,* 2009; Mooney *et al.,* 2009a, 2009b; Popov *et al.,* 2011a, 2011b; Kastelein *et al.,* 2012a; Schlundt *et al.,* 2000; Nachtigall *et al.,* 2003, 2004). For pinnipeds in water, data are limited to measurements of TTS in harbor seals, an elephant seal, and California sea lions (Kastak *et al.,* 1999, 2005; Kastelein *et al.,* 2012b).

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

A recent study on bottlenose dolphins (Schlundt, *et al.,* 2013) measured hearing thresholds at multiple frequencies to determine the amount of TTS induced before and after exposure to a sequence of impulses produced by a seismic airgun. The airgun volume and operating pressure varied from 40–150 in^3 and 1000–2000 psi, respectively. After three years and 180 sessions, the authors observed no significant TTS at any test frequency, for any combinations of airgun volume, pressure, or proximity to the dolphin during behavioral tests (Schlundt, *et al.,* 2013). Schlundt *et al. (*2013) suggest that the potential for airguns to cause hearing loss in dolphins is lower than previously predicted, perhaps as a result of the low-frequency content of airgun impulses compared to the high-frequency hearing ability of dolphins.

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 (similar to those discussed in auditory masking, below). 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. Also, depending on the degree and frequency range, the effects of PTS on an animal could range in severity, although it is considered generally more serious because it is a permanent condition. Of note, reduced hearing sensitivity as a simple function of aging has been observed in marine mammals, as well as humans and other taxa (Southall *et al.,* 2007), so one can infer that strategies exist for coping with this condition to some degree, though likely not without cost.

Given the higher level of sound necessary to cause PTS as compared with TTS, it is considerably less likely that PTS would occur during the proposed seismic survey. Cetaceans generally avoid the immediate area around operating seismic vessels, as do some other marine mammals. Some pinnipeds show avoidance reactions to airguns, but their avoidance reactions are generally not as strong or consistent compared to cetacean reactions.

Non-Auditory Physical Effects

Non-auditory physical effects might occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. Some marine mammal species (*i.e.,* beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds.

Classic stress responses begin when an animal's central nervous system perceives a potential threat to its wellbeing. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg, 2000; Sapolsky *et al.,* 2005; Seyle, 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: Behavioral responses; autonomic nervous system responses; neuroendocrine responses; or immune responses.

In the case of many stressors, an animal's first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classic ''fight or flight'' response, which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with stress. These responses have a relatively short duration and may or may not have significant long-term effects on an animal's welfare.

An animal's third line of defense to stressors involves its neuroendocrine or sympathetic nervous systems; the system that has received the most study has been the hypothalamus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, the pituitary hormones regulate virtually all neuroendocrine functions affected by stress—including immune competence, reproduction, metabolism, and behavior. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg, 1987; Rivier, 1995), altered metabolism (Elasser *et al.,* 2000), reduced immune competence (Blecha, 2000), and behavioral disturbance.

Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; see Romano *et al.,* 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that the body quickly replenishes after alleviation of the stressor. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, it diverts energy resources from other biotic functions, which impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state called ''distress'' (*sensu* Seyle, 1950) or ''allostatic loading'' (*sensu* McEwen and Wingfield, 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiment; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005; Reneerkens *et al.,* 2002; Thompson and Hamer, 2000). Although no information has been collected on the physiological responses of marine mammals to anthropogenic sound exposure, studies of other marine animals and terrestrial animals would lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as ''distress'' upon exposure to anthropogenic sounds.

For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (*e.g.,* elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b) identified noise-induced physiological transient stress responses in hearing-specialist fish (*i.e.,* goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Hearing is one of the primary senses marine mammals use to gather information about their environment and communicate with conspecifics. Although empirical information on the relationship between sensory impairment (TTS, PTS, and acoustic masking) on marine mammals remains limited, we assume that reducing a marine mammal's ability to gather information about its environment and communicate with other members of its species would induce stress, based on data that terrestrial animals exhibit those responses under similar conditions (NRC, 2003) and because marine mammals use hearing as their primary sensory mechanism. Therefore, NMFS assumes that acoustic exposures sufficient to trigger onset PTS or TTS would be accompanied by physiological stress responses. More importantly, marine mammals might experience stress responses at received levels lower than those necessary to trigger onset TTS. Based on empirical studies of the time required to recover from stress responses (Moberg, 2000), NMFS also assumes that stress responses could persist beyond the time interval required for animals to recover from TTS and might result in pathological and pre-pathological states that would be as significant as behavioral responses to TTS.

Resonance effects (Gentry, 2002) and direct noise-induced bubble formations (Crum *et al.,* 2005) are implausible in the case of exposure to an impulsive broadband source like an airgun array. If seismic surveys disrupt diving patterns of deep-diving species, this might result in bubble formation and a form of the bends, as speculated to occur in beaked whales exposed to sonar. However, there is no specific evidence of this upon exposure to airgun pulses.

In general, there are few data about the potential for strong, anthropogenic underwater sounds to cause non-auditory physical effects in marine mammals. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.,* 2007) or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. In addition, marine mammals that show behavioral avoidance of seismic vessels, including some pinnipeds, are unlikely to incur non-auditory impairment or other physical effects.

Stranding and Mortality

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 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 is 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.''

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). There is no direct evidence of marine mammal stranding being caused by seismic surveys. We have considered the potential for the proposed seismic surveys to result in marine mammal stranding and have concluded that, based on the best available information, stranding is not expected to occur.

2. Potential Effects of the Multibeam Echosounder

Lamont-Doherty would operate the Kongsberg EM 122 multibeam echosounder from the source vessel during the planned survey. Sounds from the multibeam echosounder are very short pulses, occurring for two to 15 ms once every five to 20 s, depending on water depth. Most of the energy in the sound pulses emitted by this echosounder is at frequencies near 12 kHz, and the maximum source level is 242 dB re: 1 µPa. The beam is narrow (1 to 2°) in fore-aft extent and wide (150°) in the cross-track extent. Each ping consists of eight (in water greater than 1,000 m/3280 ft deep) or four (less than 1,000 m/3280 ft deep) successive fan-shaped transmissions (segments) at different cross-track angles. Any given mammal at depth near the trackline would be in the main beam for only one or two of the segments. Also, marine mammals that encounter the Kongsberg EM 122 are unlikely to be subjected to repeated pulses because of the narrow fore-aft width of the beam and will receive only limited amounts of pulse energy because of the short pulses. Animals close to the vessel (where the beam is narrowest) are especially unlikely to be ensonified for more than one 2- to 15-ms pulse (or two pulses if in the overlap area). Similarly, Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when an echosounder emits a pulse is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pulses that might result in sufficient exposure to cause temporary threshold shift.

NMFS has considered the potential for behavioral responses such as stranding and indirect injury or mortality from Lamont-Doherty's use of the multibeam echosounder. In 2013, an International Scientific Review Panel (ISRP) investigated a 2008 mass stranding of approximately 100 melon-headed whales in a Madagascar lagoon system (Southall *et al.,* 2013) associated with the use of a high-frequency mapping system. The report indicated that the use of a 12-kHz multibeam echosounder was the most plausible and likely initial behavioral trigger of the mass stranding event. This was the first time that a relatively high-frequency mapping sonar system had been associated with a stranding event. However, the report also notes that there were several site- and situation-specific secondary factors that may have contributed to the avoidance responses that led to the eventual entrapment and mortality of the whales within the Loza Lagoon system (*e.g.,* the survey vessel transiting in a north-south direction on the shelf break parallel to the shore may have trapped the animals between the sound source and the shore driving them towards the Loza Lagoon). They concluded that for odontocete cetaceans that hear well in the 10–50 kHz range, where ambient noise is typically quite low, high-power active sonars operating in this range may be more easily audible and have potential effects over larger areas than low frequency systems that have more typically been considered in terms of anthropogenic noise impacts (Southall, *et al.,* 2013). However, the risk may be very low given the extensive use of these systems worldwide on a daily basis and the lack of direct evidence of such responses previously reported (Southall, *et al.,* 2013).

Navy sonars linked to avoidance reactions and stranding of cetaceans: (1) Generally have longer pulse duration than the Kongsberg EM 122; and (2) are often directed close to horizontally versus more downward for the echosounder. The area of possible influence of the echosounder is much smaller—a narrow band below the source vessel. Also, the duration of exposure for a given marine mammal can be much longer for naval sonar. During Lamont-Doherty's operations, the individual pulses will be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes by the animal. The following section outlines possible effects of an echosounder on marine mammals.

Masking

Marine mammal communications would not be masked appreciably by the echosounder's signals given the low duty cycle of the echosounder and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of baleen whales, the echosounder's signals (12 kHz) do not overlap with the predominant frequencies in the calls, which would avoid any significant masking.

Behavioral Responses

Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included increased vocalizations and no dispersal by pilot whales (Rendell and Gordon, 1999), and strandings by beaked whales. During exposure to a 21 to 25 kHz ''whale-finding'' sonar with a source level of 215 dB re: 1 µPa, gray whales reacted by orienting slightly away from the source and being deflected from their course by approximately 200 m (656 ft)(Frankel, 2005). When a 38-kHz echosounder and a 150-kHz acoustic Doppler current profiler were transmitting during studies in the eastern tropical Pacific Ocean, baleen whales showed no significant responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis, 2005).

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1-s tonal signals at frequencies similar to those emitted by Lamont-Doherty's echosounder and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt *et al.,* 2000; Finneran *et al.,* 2002; Finneran and Schlundt, 2004). The relevance of those data to free-ranging odontocetes is uncertain, and in any case, the test sounds were quite different in duration as compared with those from an echosounder.

Hearing Impairment and Other Physical Effects

Given recent stranding events associated with the operation of mid-frequency tactical sonar, there is concern that mid-frequency sonar sounds can cause serious impacts to marine mammals (see earlier discussion). However, the echosounder proposed for use by the *Langseth* is quite different from sonar used for naval operations. The echosounder's pulse duration is very short relative to the naval sonar. Also, at any given location, an individual marine mammal would be in the echosounder's beam for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; navy sonar often uses near-horizontally-directed sound. Those factors would all reduce the sound energy received from the echosounder relative to that from naval sonar.

3. Potential Effects of the Sub-Bottom Profiler

Lamont-Doherty would also operate a sub-bottom profiler from the source vessel during the proposed survey. The profiler's sounds are very short pulses, occurring for one to four ms once every second. Most of the energy in the sound pulses emitted by the profiler is at 3.5 kHz, and the beam is directed downward. The sub-bottom profiler on the *Langseth* has a maximum source level of 222 dB re: 1 μPa. Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when a bottom profiler emits a pulse is small—even for a profiler more powerful than that on the *Langseth.* If the animal was in the area, it would have to pass the transducer at close range and be subjected to sound levels that could cause temporary threshold shift.

Masking

Marine mammal communications would not be masked appreciably by the profiler's signals given the directionality of the signal and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of most baleen whales, the profiler's signals do not overlap with the predominant frequencies in the calls, which would avoid significant masking.

Behavioral Responses

Responses to the profiler are likely to be similar to the other pulsed sources discussed earlier if received at the same levels. However, the pulsed signals from the profiler are considerably weaker than those from the echosounder.

Hearing Impairment and Other Physical Effects

It is unlikely that the profiler produces pulse levels strong enough to cause hearing impairment or other physical injuries even in an animal that is (briefly) in a position near the source. The profiler operates simultaneously with other higher-power acoustic sources. Many marine mammals would move away in response to the approaching higher-power sources or the vessel itself before the mammals would be close enough for there to be any possibility of effects from the less intense sounds from the profiler.

4. Potential Effects of Vessel Movement and Collisions

Vessel movement in the vicinity of marine mammals has the potential to result in either a behavioral response or a direct physical interaction. We discuss both scenarios here.

Behavioral Responses to Vessel Movement

There are limited data concerning marine mammal behavioral responses to vessel traffic and vessel noise, and a lack of consensus among scientists with respect to what these responses mean or whether they result in short-term or long-term adverse effects. In those cases where there is a busy shipping lane or where there is a large amount of vessel traffic, marine mammals may experience acoustic masking (Hildebrand, 2005) if they are present in the area (*e.g.,* killer whales in Puget Sound; Foote *et al.,* 2004; Holt *et al.,* 2008). In cases where vessels actively approach marine mammals (*e.g.,* whale watching or dolphin watching boats), scientists have documented that animals exhibit altered behavior such as increased swimming speed, erratic movement, and active avoidance behavior (Bursk, 1983; Acevedo, 1991; Baker and MacGibbon, 1991; Trites and Bain, 2000; Williams *et al.,* 2002; Constantine *et al.,* 2003), reduced blow interval (Ritcher *et al.,* 2003), disruption of normal social behaviors (Lusseau, 2003; 2006), and the shift of behavioral activities which may increase energetic costs (Constantine *et al.,* 2003; 2004). A detailed review of marine mammal reactions to ships and boats is available in Richardson *et al.* (1995). For each of the marine mammal taxonomy groups, Richardson *et al.* (1995) provides the following assessment regarding reactions to vessel traffic:

Toothed whales: In summary, toothed whales sometimes show no avoidance reaction to vessels, or even approach them. However, avoidance can occur, especially in response to vessels of types used to chase or hunt the animals. This may cause temporary displacement, but we know of no clear evidence that toothed whales have abandoned significant parts of their range because of vessel traffic.

Baleen whales: When baleen whales receive low-level sounds from distant or stationary vessels, the sounds often seem to be ignored. Some whales approach the sources of these sounds. When vessels approach whales slowly and non-aggressively, whales often exhibit slow and inconspicuous avoidance maneuvers. In response to strong or rapidly changing vessel noise, baleen whales often interrupt their normal behavior and swim rapidly away. Avoidance is especially strong when a boat heads directly toward the whale.

Behavioral responses to stimuli are complex and influenced to varying degrees by a number of factors, such as species, behavioral contexts, geographical regions, source characteristics (moving or stationary, speed, direction, etc.), prior experience of the animal, and physical status of the animal. For example, studies have shown that beluga whales' reactions varied when exposed to vessel noise and traffic. In some cases, naive beluga whales exhibited rapid swimming from ice-breaking vessels up to 80 km (49.7 mi) away, and showed changes in surfacing, breathing, diving, and group composition in the Canadian high Arctic where vessel traffic is rare (Finley *et al.,* 1990). In other cases, beluga whales were more tolerant of vessels, but responded differentially to certain vessels and operating characteristics by reducing their calling rates (especially older animals) in the St. Lawrence River where vessel traffic is common (Blane and Jaakson, 1994). In Bristol Bay, Alaska, beluga whales continued to feed when surrounded by fishing vessels and resisted dispersal even when purposefully harassed (Fish and Vania, 1971).

In reviewing more than 25 years of whale observation data, Watkins (1986) concluded that whale reactions to vessel traffic were ''modified by their previous experience and current activity: Habituation often occurred rapidly, attention to other stimuli or preoccupation with other activities sometimes overcame their interest or wariness of stimuli.'' Watkins noticed that over the years of exposure to ships in the Cape Cod area, minke whales changed from frequent positive interest (*e.g.,* approaching vessels) to generally uninterested reactions; fin whales changed from mostly negative (*e.g.,* avoidance) to uninterested reactions; right whales apparently continued the same variety of responses (negative, uninterested, and positive responses) with little change; and humpbacks dramatically changed from mixed responses that were often negative to reactions that were often strongly positive. Watkins (1986) summarized that ''whales near shore, even in regions with low vessel traffic, generally have become less wary of boats and their noises, and they have appeared to be less easily disturbed than previously. In particular locations with intense shipping and repeated approaches by boats (such as the whale-watching areas of Stellwagen Bank), more and more whales had positive reactions to familiar vessels, and they also occasionally approached other boats and yachts in the same ways.'' Based on the best available information, we do not believe vessel traffic associated with the proposed activities will result in the take of marine mammals; therefore vessel traffic is not discussed further in this document.

Vessel Strike

Ship strikes of cetaceans can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or a vessel's propeller could injure an animal just below the surface. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (*e.g.,* the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.,* 2004). These species are primarily large, slow moving whales. Smaller marine mammals (*e.g.,* bottlenose dolphin) move quickly through the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records with known vessel speeds, Laist *et al.* (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 24.1 km/h (14.9 mph; 13 kts). During seismic operations the *Langseth* will travel at approximately 4.5 kts (5.1 mph); the vessel's cruising speed outside of seismic operations is approximately 10 kts (11.5 mph). Based on the best available information, we do not believe marine mammals will be struck by vessels as a result of the proposed activities; therefore vessel strike is not discussed further in this document.

Entanglement

Entanglement can occur if wildlife becomes immobilized in survey lines, cables, nets, or other equipment that is moving through the water column. The proposed seismic survey would require towing approximately 8.0 km (4.9 mi) of equipment and cables. This size of the array generally carries a relatively low risk of entanglement for marine mammals. Wildlife, especially slow moving animals, such as large whales, have a low probability of entanglement due to the low amount of slack in the lines, the slow speed of the survey vessel, and onboard monitoring. Pinnipeds and odontocetes are even less likely to be entangled than large whales due to their size, speed and agility. Lamont-Doherty has no recorded cases of entanglement of marine mammals during their conduct of over 12 years of seismic surveys (NSF, 2015). Based on the best available information, we do not believe entanglement of marine mammals will occur as a result of the proposed activities; therefore entanglement is not discussed further in this document.

Anticipated Effects on Marine Mammal Habitat

The primary potential impacts to marine mammal habitat and other marine species are associated with elevated sound levels produced by airguns. This section describes the potential impacts to marine mammal habitat from the specified activity.

Anticipated Effects on Fish as Prey Species

NMFS considered the effects of the survey on marine mammal prey (*i.e.,* fish and invertebrates), as a component of marine mammal habitat in the following subsections. There are three types of potential effects of exposure to seismic surveys: (1) Pathological, (2) physiological, and (3) behavioral. Pathological effects involve lethal and temporary or permanent sub-lethal injury. Physiological effects involve temporary and permanent primary and secondary stress responses, such as changes in levels of enzymes and proteins. Behavioral effects refer to temporary and (if they occur) permanent changes in exhibited behavior (*e.g.,* startle and avoidance behavior). The three categories are interrelated in complex ways. For example, it is possible that certain physiological and behavioral changes could potentially lead to an ultimate pathological effect on individuals (*i.e.,* mortality).

The available information on the impacts of seismic surveys on marine fish is from studies of individuals or portions of a population. There have been no studies at the population scale. The studies of individual fish have often been on caged fish that were exposed to airgun pulses in situations not representative of an actual seismic survey. Thus, available information provides limited insight on possible real-world effects at the ocean or population scale.

Hastings and Popper (2005), Popper (2009), and Popper and Hastings (2009) provided recent critical reviews of the known effects of sound on fish. The following sections provide a general synopsis of the available information on the effects of exposure to seismic and other anthropogenic sound as relevant to fish. The information comprises results from scientific studies of varying degrees of rigor plus some anecdotal information. Some of the data sources may have serious shortcomings in methods, analysis, interpretation, and reproducibility that must be considered when interpreting their results (see Hastings and Popper, 2005). Potential adverse effects of the program's sound sources on marine fish are noted.

Pathological Effects: The potential for pathological damage to hearing structures in fish depends on the energy level of the received sound and the physiology and hearing capability of the species in question. For a given sound to result in hearing loss, the sound must exceed, by some substantial amount, the hearing threshold of the fish for that sound (Popper, 2005). The consequences of temporary or permanent hearing loss in individual fish on a fish population are unknown; however, they likely depend on the number of individuals affected and whether critical behaviors involving sound (*e.g.,* predator avoidance, prey capture, orientation and navigation, reproduction, *etc.*) are adversely affected.

There are few data about the mechanisms and characteristics of damage impacting fish by exposure to seismic survey sounds. Peer-reviewed scientific literature has presented few data on this subject. NMFS is aware of only two papers with proper experimental methods, controls, and careful pathological investigation that implicate sounds produced by actual seismic survey airguns in causing adverse anatomical effects. One such study indicated anatomical damage, and the second indicated temporary threshold shift in fish hearing. The anatomical case is McCauley *et al.* (2003), who found that exposure to airgun sound caused observable anatomical damage to the auditory maculae of pink snapper (*Pagrus auratus*). This damage in the ears had not been repaired in fish sacrificed and examined almost two months after exposure. On the other hand, Popper *et al.* (2005) documented only temporary threshold shift (as determined by auditory brainstem response) in two of three fish species from the Mackenzie River Delta. This study found that broad whitefish (*Coregonus nasus*) exposed to five airgun shots were not significantly different from those of controls. During both studies, the repetitive exposure to sound was greater than what would have occurred during a typical seismic survey. However, the substantial low-frequency energy produced by the airguns (less than 400 Hz in the study by McCauley *et al.* (2003) and less than approximately 200 Hz in Popper *et al.* (2005)) likely did not propagate to the fish because the water in the study areas was very shallow (approximately 9 m [29.5 ft] in the former case and less than 2 m [6.5 ft] in the latter). Water depth sets a lower limit on the lowest sound frequency that will propagate (*i.e.,* the cutoff frequency) at about one-quarter wavelength (Urick, 1983; Rogers and Cox, 1988).

Wardle *et al.* (2001) suggested that in water, acute injury and death of organisms exposed to seismic energy depends primarily on two features of the sound source: (1) The received peak pressure and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. According to Buchanan *et al.* (2004), for the types of seismic airguns and arrays involved with the proposed program, the pathological (mortality) zone for fish would be expected to be within a few meters of the seismic source. Numerous other studies provide examples of no fish mortality upon exposure to seismic sources (Falk and Lawrence, 1973; Holliday *et al.,* 1987; La Bella *et al.,* 1996; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b, 2003; Bjarti, 2002; Thomsen, 2002; Hassel *et al.,* 2003; Popper *et al.,* 2005; Boeger *et al.,* 2006).

The National Park Service conducted an experiment of the effects of a single 700 in^3 airgun in Lake Meade, Nevada (USGS, 1999) to understand the effects of a marine reflection survey of the Lake Meade fault system (Paulson *et al.,* 1993, in USGS, 1999). The researchers suspended the airgun 3.5 m (11.5 ft) above a school of threadfin shad in Lake Meade and fired three successive times at a 30 s interval. Neither surface inspection nor diver observations of the water column and bottom found any dead fish.

For a proposed seismic survey in Southern California, USGS (1999) conducted a review of the literature on the effects of airguns on fish and fisheries. They reported a 1991 study of the Bay Area Fault system from the continental shelf to the Sacramento River, using a 10 airgun (5,828 in^3) array. Brezzina and Associates, hired by USGS to monitor the effects of the surveys, concluded that airgun operations were not responsible for the death of any of the fish carcasses observed, and the airgun profiling did not appear to alter the feeding behavior of sea lions, seals, or pelicans observed feeding during the seismic surveys.

Some studies have reported that mortality of fish, fish eggs, or larvae can occur close to seismic sources (Kostyuchenko, 1973; Dalen and Knutsen, 1986; Booman *et al.,* 1996; Dalen *et al.,* 1996). Some of the reports claimed seismic effects from treatments quite different from actual seismic survey sounds or even reasonable surrogates. However, Payne *et al.* (2009) reported no statistical differences in mortality/morbidity between control and exposed groups of capelin eggs or monkfish larvae. Saetre and Ona (1996) applied a worst-case scenario, mathematical model to investigate the effects of seismic energy on fish eggs and larvae. The authors concluded that mortality rates caused by exposure to seismic surveys were low, as compared to natural mortality rates, and suggested that the impact of seismic surveying on recruitment to a fish stock was not significant.

Physiological Effects: Physiological effects refer to cellular and/or biochemical responses of fish to acoustic stress. Such stress potentially could affect fish populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses of fish after exposure to seismic survey sound appear to be temporary in all studies done to date (Sverdrup *et al.,* 1994; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b). The periods necessary for the biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects—Behavioral effects include changes in the distribution, migration, mating, and catchability of fish populations. Studies investigating the possible effects of sound (including seismic survey sound) on fish behavior have been conducted on both uncaged and caged individuals (*e.g.,* Chapman and Hawkins, 1969; Pearson *et al.,* 1992; Santulli *et al.,* 1999; Wardle *et al.,* 2001; Hassel *et al.,* 2003). Typically, in these studies fish exhibited a sharp startle response at the onset of a sound followed by habituation and a return to normal behavior after the sound ceased.

The former Minerals Management Service (MMS, 2005) assessed the effects of a proposed seismic survey in Cook Inlet, Alaska. The seismic survey proposed using three vessels, each towing two, four-airgun arrays ranging from 1,500 to 2,500 in^3. The Minerals Management Service noted that the impact to fish populations in the survey area and adjacent waters would likely be very low and temporary and also concluded that seismic surveys may displace the pelagic fishes from the area temporarily when airguns are in use. However, fishes displaced and avoiding the airgun noise are likely to backfill the survey area in minutes to hours after cessation of seismic testing. Fishes not dispersing from the airgun noise (*e.g.,* demersal species) may startle and move short distances to avoid airgun emissions.

In general, any adverse effects on fish behavior or fisheries attributable to seismic testing may depend on the species in question and the nature of the fishery (season, duration, fishing method). They may also depend on the age of the fish, its motivational state, its size, and numerous other factors that are difficult, if not impossible, to quantify at this point, given such limited data on effects of airguns on fish, particularly under realistic at-sea conditions (Lokkeborg *et al.,* 2012; Fewtrell and McCauley, 2012). NMFS would expect prey species to return to their pre-exposure behavior once seismic firing ceased (Lokkeborg *et al.,* 2012; Fewtrell and McCauley, 2012).

Anticipated Effects on Invertebrates

The existing body of information on the impacts of seismic survey sound on marine invertebrates is very limited. However, there is some unpublished and very limited evidence of the potential for adverse effects on invertebrates, thereby justifying further discussion and analysis of this issue. The three types of potential effects of exposure to seismic surveys on marine invertebrates are pathological, physiological, and behavioral. Based on the physical structure of their sensory organs, marine invertebrates appear to be specialized to respond to particle displacement components of an impinging sound field and not to the pressure component (Popper *et al.,* 2001). The only information available on the impacts of seismic surveys on marine invertebrates involves studies of individuals; there have been no studies at the population scale. Thus, available information provides limited insight on possible real-world effects at the regional or ocean scale.

Moriyasu *et al.* (2004) and Payne *et al.* (2008) provide literature reviews of the effects of seismic and other underwater sound on invertebrates. The following sections provide a synopsis of available information on the effects of exposure to seismic survey sound on species of decapod crustaceans and cephalopods, the two taxonomic groups of invertebrates on which most such studies have been conducted. The available information is from studies with variable degrees of scientific soundness and from anecdotal information. A more detailed review of the literature on the effects of seismic survey sound on invertebrates is in Appendix E of NSF's 2011 Programmatic Environmental Impact Statement (NSF/USGS, 2011).

Pathological Effects: In water, lethal and sub-lethal injury to organisms exposed to seismic survey sound appears to depend on at least two features of the sound source: (1) The received peak pressure; and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. For the type of airgun array planned for the proposed program, the pathological (mortality) zone for crustaceans and cephalopods is expected to be within a few meters of the seismic source, at most; however, very few specific data are available on levels of seismic signals that might damage these animals. This premise is based on the peak pressure and rise/decay time characteristics of seismic airgun arrays currently in use around the world.

Some studies have suggested that seismic survey sound has a limited pathological impact on early developmental stages of crustaceans (Pearson *et al.,* 1994; Christian *et al.,* 2003; DFO, 2004). However, the impacts appear to be either temporary or insignificant compared to what occurs under natural conditions. Controlled field experiments on adult crustaceans (Christian *et al.,* 2003, 2004; DFO, 2004) and adult cephalopods (McCauley *et al.,* 2000a,b) exposed to seismic survey sound have not resulted in any significant pathological impacts on the animals. It has been suggested that exposure to commercial seismic survey activities has injured giant squid (Guerra *et al.,* 2004), but the article provides little evidence to support this claim.

Tenera Environmental (2011) reported that Norris and Mohl (1983, summarized in Mariyasu *et al.,* 2004) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246 to 252 dB after 3 to 11 minutes. Another laboratory study observed abnormalities in larval scallops after exposure to low frequency noise in tanks (de Soto *et al.,* 2013).

Andre *et al.* (2011) exposed four cephalopod species (*Loligo vulgaris, Sepia officinalis, Octopus vulgaris,* and *Ilex coindetii*) to two hours of continuous sound from 50 to 400 Hz at 157 +/− 5 dB re: 1 μPa. They reported lesions to the sensory hair cells of the statocysts of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound. The received sound pressure level was 157 ± 5 dB re: 1 μPa, with peak levels at 175 dB re: 1 μPa. As in the McCauley *et al.* (2003) paper on sensory hair cell damage in pink snapper as a result of exposure to seismic sound, the cephalopods were subjected to higher sound levels than they would be under natural conditions, and they were unable to swim away from the sound source.

Physiological Effects: Physiological effects refer mainly to biochemical responses by marine invertebrates to acoustic stress. Such stress potentially could affect invertebrate populations by increasing mortality or reducing reproductive success. Studies have noted primary and secondary stress responses (*i.e.,* changes in haemolymph levels of enzymes, proteins, etc.) of crustaceans occurring several days or months after exposure to seismic survey sounds (Payne *et al.,* 2007). The authors noted that crustaceans exhibited no behavioral impacts (Christian *et al.,* 2003, 2004; DFO, 2004). The periods necessary for these biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects: There is increasing interest in assessing the possible direct and indirect effects of seismic and other sounds on invertebrate behavior, particularly in relation to the consequences for fisheries. Changes in behavior could potentially affect such aspects as reproductive success, distribution, susceptibility to predation, and catchability by fisheries. Studies investigating the possible behavioral effects of exposure to seismic survey sound on crustaceans and cephalopods have been conducted on both uncaged and caged animals. In some cases, invertebrates exhibited startle responses (*e.g.,* squid in McCauley *et al.,* 2000). In other cases, the authors observed no behavioral impacts (*e.g.,* crustaceans in Christian *et al.,* 2003, 2004; DFO, 2004). There have been anecdotal reports of reduced catch rates of shrimp shortly after exposure to seismic surveys; however, other studies have not observed any significant changes in shrimp catch rate (Andriguetto-Filho *et al.,* 2005). Similarly, Parry and Gason (2006) did not find any evidence that lobster catch rates were affected by seismic surveys. Any adverse effects on crustacean and cephalopod behavior or fisheries attributable to seismic survey sound depend on the species in question and the nature of the fishery (season, duration, fishing method).

In examining impacts to fish and invertebrates as prey species for marine mammals, we expect fish to exhibit a range of behaviors including no reaction or habituation (Peña *et al.,* 2013) to startle responses and/or avoidance (Fewtrell and McCauley, 2012). We expect that the seismic survey would have no more than a temporary and minimal adverse effect on any fish or invertebrate species. Although there is a potential for injury to fish or marine life in close proximity to the vessel, we expect that the impacts of the seismic survey on fish and other marine life specifically related to acoustic activities would be temporary in nature, negligible, and would not result in substantial impact to these species or to their role in the ecosystem. Based on the preceding discussion, NMFS does not anticipate that the proposed activity would have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations.

Proposed Mitigation

In order to issue an Incidental Harassment Authorization 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 adverse 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 (where relevant).

Lamont-Doherty has reviewed the following source documents and has incorporated a suite of proposed mitigation measures into their project description:

(1) Protocols used during previous Lamont-Doherty and NSF-funded

seismic research cruises as approved by us and detailed in the NSF's 2011 PEIS and 2016 draft environmental analysis;

(2) Previous incidental harassment authorizations applications and authorizations that NMFS has approved and authorized; and

(3) Recommended best practices in Richardson *et al.* (1995), Pierson *et al.* (1998), and Weir and Dolman, (2007).

To reduce the potential for disturbance from acoustic stimuli associated with the activities, Lamont-Doherty, and/or its designees have proposed to implement the following mitigation measures for marine mammals:

(1) Vessel-based visual mitigation monitoring;

(2) Proposed exclusion zones;

(3) Power down procedures;

(4) Shutdown procedures;

(5) Ramp-up procedures; and

(6) Speed and course alterations.

NMFS reviewed Lamont-Doherty's proposed mitigation measures and has proposed an additional measure to effect the least practicable adverse impact on marine mammals. They are:

(1) Expanded power down procedures for concentrations of six or more whales that do not appear to be traveling (*e.g.,* feeding, socializing, etc.).

Vessel-Based Visual Mitigation Monitoring

Lamont-Doherty would position observers aboard the seismic source vessel to watch for marine mammals near the vessel during daytime airgun operations and during any start-ups at night. Observers would also watch for marine mammals near the seismic vessel for at least 30 minutes prior to the start of airgun operations after an extended shutdown (*i.e.,* greater than approximately eight minutes for this proposed cruise). When feasible, the observers would conduct observations during daytime periods when the seismic system is not operating for comparison of sighting rates and behavior with and without airgun operations and between acquisition periods. Based on the observations, the *Langseth* would power down or shutdown the airguns when marine mammals are observed within or about to enter a designated exclusion zone for cetaceans or pinnipeds.

During seismic operations, at least four protected species observers would be aboard the *Langseth.* Lamont-Doherty would appoint the observers with NMFS' concurrence, and they would conduct observations during ongoing daytime operations and nighttime ramp-ups of the airgun array. During the majority of seismic operations, two observers would be on duty from the observation tower to monitor marine mammals near the seismic vessel. Using two observers would increase the effectiveness of detecting animals near the source vessel. However, during mealtimes and bathroom breaks, it is sometimes difficult to have two observers on effort, but at least one observer would be on watch during bathroom breaks and mealtimes. Observers would be on duty in shifts of no longer than four hours in duration.

Two observers on the *Langseth* would also be on visual watch during all nighttime ramp-ups of the seismic airguns. A third observer would monitor the passive acoustic monitoring equipment 24 hours a day to detect vocalizing marine mammals present in the action area. In summary, a typical daytime cruise would have scheduled two observers (visual) on duty from the observation tower, and an observer (acoustic) on the passive acoustic monitoring system. Before the start of the seismic survey, Lamont-Doherty would instruct the vessel's crew to assist in detecting marine mammals and implementing mitigation requirements.

The *Langseth* is a suitable platform for marine mammal observations. When stationed on the observation platform, the eye level would be approximately 21.5 m (70.5 ft) above sea level, and the observer would have a good view around the entire vessel. During daytime, the observers would scan the area around the vessel systematically with reticle binoculars (*e.g.,* 7 x 50 Fujinon), Big-eye binoculars (25 x 150), and with the naked eye. During darkness, night vision devices would be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), when required. Laser range-finding binoculars (Leica LRF 1200 laser rangefinder or equivalent) would be available to assist with distance estimation. They are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly. The user measures distances to animals with the reticles in the binoculars.

Lamont-Doherty would immediately power down or shutdown the airguns when observers see marine mammals within or about to enter the designated exclusion zone. The observer(s) would continue to maintain watch to determine when the animal(s) are outside the exclusion zone by visual confirmation. Airgun operations would not resume until the observer has confirmed that the animal has left the zone, or if not observed after 15 minutes for species with shorter dive durations (small odontocetes and pinnipeds) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

Proposed Mitigation Exclusion Zones

Lamont-Doherty would use safety radii to designate exclusion zones and to estimate take for marine mammals. Table 3 shows the distances at which one would expect to receive sound levels (160-, 180-, and 190-dB,) from the airgun array and a single airgun. If the protected species visual observer detects marine mammal(s) within or about to enter the appropriate exclusion zone, the *Langseth* crew would immediately power down the airgun array, or perform a shutdown if necessary (see Shut-down Procedures).

TABLE 3—PREDICTED DISTANCES TO WHICH SOUND LEVELS GREATER THAN OR EQUAL TO 160 re: 1 μPa COULD BE RECEIVED DURING THE PROPOSED SURVEY AREAS WITHIN THE SOUTHEAST PACIFIC OCEAN

Source and volume (in³)	Tow depth (m)	Water depth (m)	Predicted RMS distances [1] (m)		
			190 dB	180 dB	160 dB
Single Bolt airgun (40 in³)	9 or 12	<100	[2] 100	[2] 100	1,041
		100 to 1,000	100	100	647
		>1,000	100	100	431
36-Airgun Array (6,600 in³)	9	<100	591	2,060	22,580
		100 to 1,000	429	1,391	8,670
		>1,000	286	927	5,780

TABLE 3—PREDICTED DISTANCES TO WHICH SOUND LEVELS GREATER THAN OR EQUAL TO 160 re: 1 μPa COULD BE RECEIVED DURING THE PROPOSED SURVEY AREAS WITHIN THE SOUTHEAST PACIFIC OCEAN—Continued

Source and volume (in^3)	Tow depth (m)	Water depth (m)	Predicted RMS distances [1] (m)		
			190 dB	180 dB	160 dB
36-Airgun Array (6,600 in^3)	12	<100	710	2,480	27,130
		100 to 1,000	522	1,674	10,362
		>1,000	348	1,116	6,908

[1] Predicted distances based on information presented in Lamont-Doherty's application.
[2] NMFS required Lamont-Doherty to expand the exclusion zone for the mitigation airgun to 100 m (328 ft) in shallow water.

The 180- or 190-dB level shutdown criteria are applicable to cetaceans and pinnipeds respectively as specified by NMFS (2000). Lamont-Doherty used these levels to establish the exclusion zones as presented in their application.

Lamont-Doherty used a process to develop and confirm the conservativeness of the mitigation radii for a shallow-water seismic survey in the northeast Pacific Ocean offshore Washington in 2012. Crone *et al.* (2014) analyzed the received sound levels from the 2012 survey and reported that the actual distances to received levels that would constitute the exclusion and buffer zones were two to three times smaller than what Lamont-Doherty's modeling approach had predicted. While these results confirm the role that bathymetry plays in propagation, they also confirm that empirical measurements from the Gulf of Mexico survey likely over-estimated the size of the exclusion zones for the 2012 Washington shallow-water seismic surveys. NMFS reviewed this preliminary information in consideration of how these data reflect on the accuracy of Lamont-Doherty's current modeling approach and we have concluded that the modeling of RMS distances likely results in predicted distances to acoustic thresholds (Table 3) that are conservative, *i.e.,* if actual distances to received sound levels deviate from distances predicted via modeling, actual distances are expected to be lesser, not greater, than predicted distances

Power-Down Procedures

A power down involves decreasing the number of airguns in use such that the radius of the 180-dB or 190-dB exclusion zone is smaller to the extent that marine mammals are no longer within or about to enter the exclusion zone. A power down of the airgun array can also occur when the vessel is moving from one seismic line to another. During a power down for mitigation, the *Langseth* would operate one airgun (40 in^3). The continued operation of one airgun would alert marine mammals to the presence of the seismic vessel in the area. A shutdown occurs when the *Langseth* suspends all airgun activity.

If the observer detects a marine mammal outside the exclusion zone and the animal is likely to enter the zone, the crew would power down the airguns to reduce the size of the 180-dB or 190-dB exclusion zone before the animal enters that zone. Likewise, if a mammal is already within the zone after detection, the crew would power-down the airguns immediately. During a power down of the airgun array, the crew would operate a single 40-in^3 airgun which has a smaller exclusion zone. If the observer detects a marine mammal within or near the smaller exclusion zone around the airgun (Table 3), the crew would shut down the single airgun (see next section).

Resuming Airgun Operations After a Power Down

Following a power-down, the *Langseth* crew would not resume full airgun activity until the marine mammal has cleared the 180-dB or 190-dB exclusion zone. The observers would consider the animal to have cleared the exclusion zone if:

- The observer has visually observed the animal leave the exclusion zone; or
- An observer has not sighted the animal within the exclusion zone for 15 minutes for species with shorter dive durations (*i.e.,* small odontocetes or pinnipeds), or 30 minutes for species with longer dive durations (*i.e.,* mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales); or

The *Langseth* crew would resume operating the airguns at full power after 15 minutes of sighting any species with short dive durations (*i.e.,* small odontocetes or pinnipeds). Likewise, the crew would resume airgun operations at full power after 30 minutes of sighting any species with longer dive durations (*i.e.,* mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales).

NMFS estimates that the *Langseth* would transit outside the original 180-dB or 190-dB exclusion zone after an 8-minute wait period. This period is based on the average speed of the *Langseth* while operating the airguns (8.5 km/h; 5.3 mph). Because the vessel has transited away from the vicinity of the original sighting during the 8-minute period, implementing ramp-up procedures for the full array after an extended power down (*i.e.,* transiting for an additional 35 minutes from the location of initial sighting) would not meaningfully increase the effectiveness of observing marine mammals approaching or entering the exclusion zone for the full source level and would not further minimize the potential for take. The *Langseth's* observers are continually monitoring the exclusion zone for the full source level while the mitigation airgun is firing. On average, observers can observe to the horizon (10 km; 6.2 mi) from the height of the *Langseth's* observation deck and should be able to say with a reasonable degree of confidence whether a marine mammal would be encountered within this distance before resuming airgun operations at full power.

Shutdown Procedures

The *Langseth* crew would shut down the operating airgun(s) if they see a marine mammal within or approaching the exclusion zone for the single airgun. The crew would implement a shutdown:

(1) If an animal enters the exclusion zone of the single airgun after the crew has initiated a power down; or

(2) If an observer sees the animal is initially within the exclusion zone of the single airgun when more than one airgun (typically the full airgun array) is operating.

Resuming Airgun Operations After a Shutdown

Following a shutdown in excess of eight minutes, the *Langseth* crew would initiate a ramp-up with the smallest airgun in the array (40-in^3). The crew would turn on additional airguns in a sequence such that the source level of the array would increase in steps not exceeding 6 dB per five-minute period over a total duration of approximately 30 minutes. During ramp-up, the observers would monitor the exclusion zone, and if he/she sees a marine mammal, the *Langseth* crew would implement a power down or shutdown as though the full airgun array were operational.

During periods of active seismic operations, there are occasions when the *Langseth* crew would need to temporarily shut down the airguns due to equipment failure or for maintenance. In this case, if the airguns are inactive longer than eight minutes, the crew would follow ramp-up procedures for a shutdown described earlier and the observers would monitor the full exclusion zone and would implement a power down or shutdown if necessary.

If the full exclusion zone is not visible to the observer for at least 30 minutes prior to the start of operations in either daylight or nighttime, the *Langseth* crew would not commence ramp-up unless at least one airgun (40-in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the vessel's crew would not ramp up the airgun array from a complete shutdown at night or in thick fog, because the outer part of the zone for that array would not be visible during those conditions.

If one airgun has operated during a power down period, ramp-up to full power would be permissible at night or in poor visibility, on the assumption that marine mammals would be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. The vessel's crew would not initiate a ramp-up of the airguns if an observer sees the marine mammal within or near the applicable exclusion zones during the day or close to the vessel at night.

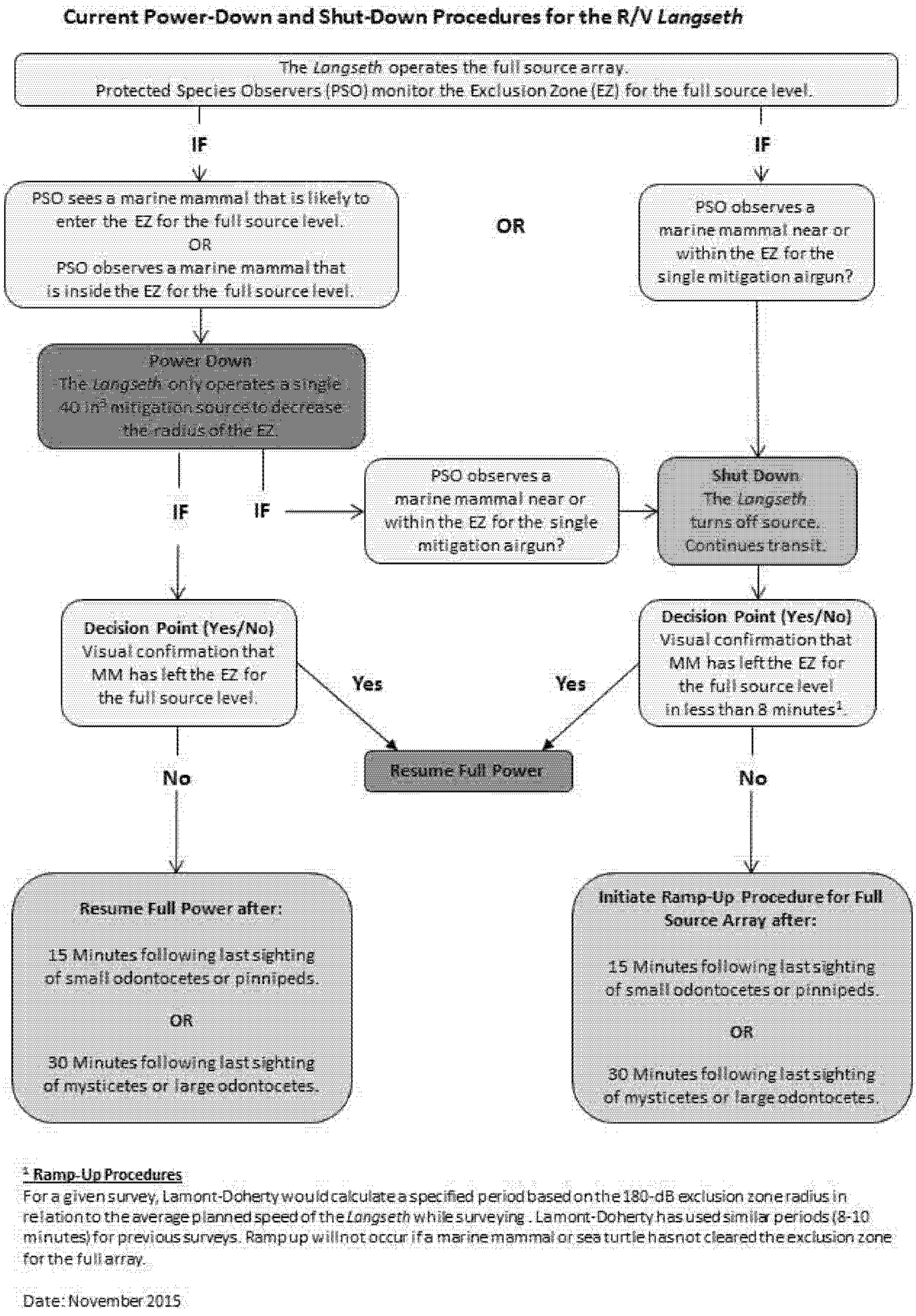
Ramp-Up Procedures

Ramp-up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume of the airgun array is achieved. The purpose of a ramp-up is to ''warn'' marine mammals in the vicinity of the airguns, and to provide the time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities. Lamont-Doherty would follow a ramp-up procedure when the airgun array begins operating after an 8 minute period without airgun operations or when shut down has exceeded that period. Lamont-Doherty has used similar waiting periods (approximately eight to 10 minutes) during previous seismic surveys.

Ramp-up would begin with the smallest airgun in the array (40 in^3). The crew would add airguns in a sequence such that the source level of the array would increase in steps not exceeding six dB per five minute period over a total duration of approximately 30 to 35 minutes. During ramp-up, the observers would monitor the exclusion zone, and if marine mammals are sighted, Lamont-Doherty would implement a power-down or shut-down as though the full airgun array were operational.

If the complete exclusion zone has not been visible for at least 30 minutes prior to the start of operations in either daylight or nighttime, Lamont-Doherty would not commence the ramp-up unless at least one airgun (40 in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the crew would not ramp up the airgun array from a complete shut-down at night or in thick fog, because the outer part of the exclusion zone for that array would not be visible during those conditions. If one airgun has operated during a power-down period, ramp-up to full power would be permissible at night or in poor visibility, on the assumption that marine mammals would be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. Lamont-Doherty would not initiate a ramp-up of the airguns if an observer sights a marine mammal within or near the applicable exclusion zones. NMFS refers the reader to Figure 2, which presents a flowchart representing the ramp-up, power down, and shut down protocols described in this notice.

Figure 2—Ramp-Up, Power Down, and Shut-Down Procedures for the Langseth



Special Procedures for Concentrations of Large Whales

The *Langseth* would avoid exposing concentrations of large whales to sounds greater than 160 dB re: 1 μPa within the 160-dB zone and would power down the array, if necessary. For purposes of this proposed survey, a concentration or group of whales would consist of six or more individuals visually sighted that do not appear to be traveling (*e.g.*, feeding, socializing, etc.).

Speed and Course Alterations

If during seismic data collection, Lamont-Doherty detects marine mammals outside the exclusion zone and, based on the animal's position and direction of travel, is likely to enter the exclusion zone, the *Langseth* would change speed and/or direction if this does not compromise operational safety. Due to the limited maneuverability of the primary survey vessel, altering speed, and/or course can result in an extended period of time to realign the *Langseth* to the transect line. However, if the animal(s) appear likely to enter the exclusion zone, the *Langseth* would undertake further mitigation actions, including a power down or shut down of the airguns.

Mitigation Conclusions

NMFS has carefully evaluated Lamont-Doherty's proposed mitigation measures in the context of ensuring that we prescribe the means of effecting the least practicable impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another:

• The manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals;

• The proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and

• The practicability of the measure for applicant implementation.

Any mitigation measure(s) prescribed by NMFS should be able to accomplish, have a reasonable likelihood of accomplishing (based on current science), or contribute to the accomplishment of one or more of the general goals listed here:

1. Avoidance or minimization of injury or death of marine mammals wherever possible (goals 2, 3, and 4 may contribute to this goal).

2. A reduction in the numbers of marine mammals (total number or number at biologically important time or location) exposed to airgun operations that we expect to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

3. A reduction in the number of times (total number or number at biologically important time or location) individuals would be exposed to airgun operations that we expect to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

4. A reduction in the intensity of exposures (either total number or number at biologically important time or location) to airgun operations that we expect to result in the take of marine mammals (this goal may contribute to a, above, or to reducing the severity of harassment takes only).

5. Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time.

6. For monitoring directly related to mitigation—an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Based on the evaluation of Lamont-Doherty's proposed measures, as well as other measures proposed by NMFS (*i.e.,* special procedures for concentrations of large whales), NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on marine mammal species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring

In order to issue an Incidental Harassment Authorization 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 we expect to be present in the proposed action area.

Lamont-Doherty submitted a marine mammal monitoring plan in section XIII of the Authorization application. NMFS, NSF, or Lamont-Doherty may modify or supplement the plan based on comments or new information received from the public during the public comment period.

Monitoring measures prescribed by NMFS should accomplish one or more of the following general goals:

1. An increase in the probability of detecting marine mammals, both within the mitigation zone (thus allowing for more effective implementation of the mitigation) and during other times and locations, in order to generate more data to contribute to the analyses mentioned later;

2. An increase in our understanding of how many marine mammals would be affected by seismic airguns and other active acoustic sources and the likelihood of associating those exposures with specific adverse effects, such as behavioral harassment, temporary or permanent threshold shift;

3. An increase in our understanding of how marine mammals respond to stimuli that we expect to result in take and how those anticipated adverse effects on individuals (in different ways and to varying degrees) may impact the population, species, or stock (specifically through effects on annual rates of recruitment or survival) through any of the following methods:

a. Behavioral observations in the presence of stimuli compared to observations in the absence of stimuli (*i.e.,* to be able to accurately predict received level, distance from source, and other pertinent information);

b. Physiological measurements in the presence of stimuli compared to observations in the absence of stimuli (*i.e.,* to be able to accurately predict received level, distance from source, and other pertinent information);

c. Distribution and/or abundance comparisons in times or areas with concentrated stimuli versus times or areas without stimuli;

4. An increased knowledge of the affected species; and

5. An increase in our understanding of the effectiveness of certain mitigation and monitoring measures.

Proposed Monitoring Measures

Lamont-Doherty proposes to conduct marine mammal monitoring during the proposed project to supplement the proposed mitigation measures that include real-time monitoring (see ''Vessel-based Visual Mitigation Monitoring'' above), and to satisfy the monitoring requirements of the Authorization. Lamont-Doherty understands that NMFS would review the monitoring plan and may require refinements to the plan.

Vessel-Based Passive Acoustic Monitoring

Passive acoustic monitoring would complement the visual mitigation monitoring program, when practicable. 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. Passive acoustic monitoring can improve detection, identification, and localization of cetaceans when used in conjunction with visual observations. The passive acoustic monitoring would serve to alert visual observers (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals call, but it can be effective either by day or by night, and does not depend on good visibility. The acoustic observer would monitor the system in real time so that he/she can advise the visual observers if they acoustically detect cetaceans.

The passive acoustic monitoring system consists of hardware (*i.e.,* hydrophones) and software. The ''wet end'' of the system consists of a towed hydrophone array connected to the vessel by a tow cable. The tow cable is 250 m (820.2 ft) long and the hydrophones are fitted in the last 10 m (32.8 ft) of cable. A depth gauge, attached to the free end of the cable, typically towed at depths less than 20 m (65.6 ft). The *Langseth* crew would deploy the array from a winch located on the back deck. A deck cable would connect the tow cable to the electronics unit in the main computer lab where the acoustic station, signal conditioning, and processing system would be located. The Pamguard software amplifies, digitizes, and then processes the acoustic signals received by the hydrophones. The system can detect marine mammal vocalizations at frequencies up to 250 kHz.

One acoustic observer, an expert bioacoustician with primary responsibility for the passive acoustic monitoring system would be aboard the *Langseth* in addition to the other visual observers who would rotate monitoring duties. The acoustic observer would monitor the towed hydrophones 24 hours per day during airgun operations and during most periods when the *Langseth* is underway while the airguns are not operating. However, passive acoustic monitoring may not be possible if damage occurs to both the primary and back-up hydrophone arrays during operations. The primary passive acoustic monitoring streamer on the *Langseth* is a digital hydrophone streamer. Should the digital streamer fail, back-up systems should include an analog spare streamer and a hull-mounted hydrophone.

One acoustic observer would monitor the acoustic detection system by listening to the signals from two channels via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans. The observer monitoring the acoustical data would be on shift for one to six hours at a time. The other observers would rotate as an acoustic observer, although the expert acoustician would be on passive acoustic monitoring duty more frequently.

When the acoustic observer detects a vocalization while visual observations are in progress, the acoustic observer on duty would contact the visual observer immediately, to alert him/her to the presence of cetaceans (if they have not already been seen), so that the vessel's crew can initiate a power down or shutdown, if required. The observer would enter the information regarding the call into a database. Data entry would include 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. Acousticians record the acoustic detection for further analysis.

Observer Data and Documentation

Observers 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. They would use the data to help better understand the impacts of the activity on marine mammals and to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They will also provide information needed to order a power down or shut down of the airguns when a marine mammal is within or near the exclusion zone.

When an observer makes a sighting, they will record the following information:

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.
3. The observer will record the data listed under (2) 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.
4. Observers will record all observations and power downs or shutdowns in a standardized format and will enter data into an electronic database. The observers will verify the accuracy of the data entry by computerized data validity checks during data entry and by subsequent manual checking of the database. These procedures will allow the preparation of initial summaries of data during and shortly after the field program, and will facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations will provide:

1. The basis for real-time mitigation (airgun power down or shutdown).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which Lamont-Doherty must report to the Office of Protected Resources.
3. Data on the occurrence, distribution, and activities of marine mammals and turtles in the area where Lamont-Doherty would conduct the seismic study.
4. Information to compare the distance and distribution of marine mammals and turtles relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals detected during non-active and active seismic operations.

Proposed Reporting

Lamont-Doherty would submit a report to us and to NSF within 90 days after the end of the cruise. The report would describe the operations 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 the observations.

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by the authorization (if issued), such as an injury, serious injury, or mortality (*e.g.,* ship-strike, gear interaction, and/or entanglement), Lamont-Doherty shall immediately cease the specified activities and immediately report the take to the Chief Permits and Conservation Division, Office of Protected Resources, NMFS. The report must include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Lamont-Doherty shall not resume its activities until we are able to review the circumstances of the prohibited take. We shall work with Lamont-Doherty to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. Lamont-Doherty may not resume their activities until notified by us via letter, email, or telephone.

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.,* in less than a moderate state of decomposition as we describe in the next paragraph), Lamont-Doherty will immediately report the incident to the Chief Permits and Conservation Division, Office of Protected Resources, NMFS. The report must include the same information identified in the paragraph above this section. Activities may continue while NMFS reviews the circumstances of the incident. NMFS would work with Lamont-Doherty to determine whether modifications in the activities are appropriate.

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the injury or death is not associated with or related to the authorized activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Lamont-Doherty would report the incident to the Chief Permits and Conservation Division, Office of Protected Resources, NMFS, within 24 hours of the discovery. Lamont-Doherty would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

Estimated Take by Incidental Harassment

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].

Acoustic stimuli (*i.e.,* increased underwater sound) generated during the operation of the airgun array may have the potential to result in the behavioral disturbance of some marine mammals and may have an even smaller potential to result in permanent threshold shift (non-lethal injury) of some marine mammals. NMFS expects that the proposed mitigation and monitoring measures would minimize the possibility of injurious or lethal takes. However, NMFS cannot discount the possibility (albeit small) that exposure to sound from the proposed survey could result in non-lethal injury (Level A harassment). Thus, NMFS proposes to authorize take by Level B harassment and Level A harassment resulting from the operation of the sound sources for the proposed seismic survey based upon the current acoustic exposure criteria shown in Table 4, subject to the limitations in take described in Tables 5–8 later in this notice.

TABLE 4—NMFS' CURRENT ACOUSTIC EXPOSURE CRITERIA

Criterion	Criterion definition	Threshold
Level A Harassment (Injury)	Permanent Threshold Shift (PTS), (Any level above that which is known to cause TTS).	180 dB re 1 microPa-m (cetaceans)/190 dB re 1 microPa-m (pinnipeds) root mean square (rms).
Level B Harassment	Behavioral Disruption (for impulse noises)	160 dB re 1 microPa-m (rms).

NMFS' practice is to apply the 160 dB re: 1 μPa received level threshold for underwater impulse sound levels to predict whether behavioral disturbance that rises to the level of Level B harassment is likely to occur. NMFS' practice is to apply the 180 dB or 190 dB re: 1 μPa (for cetaceans and pinnipeds, respectively) received level threshold for underwater impulse sound levels to predict whether permanent threshold shift (auditory injury), which we consider as harassment (Level A), is likely to occur.

Acknowledging Uncertainties in Estimating Take

Given the many uncertainties in predicting the quantity and types of impacts of sound on marine mammals, it is common practice for us to estimate how many animals are likely to be present within a particular distance of a given activity, or exposed to a particular level of sound. We use this information to predict how many animals potentially could be taken. In practice, depending on the amount of information available to characterize daily and seasonal movement and distribution of affected marine mammals, distinguishing between the numbers of individuals harassed and the instances of harassment can be difficult to parse. Moreover, when one considers the duration of the activity, in the absence of information to predict the degree to which individual animals are likely exposed repeatedly on subsequent days, one assumption is that entirely new animals could be exposed every day, which results in a take estimate that in some circumstances overestimates the number of individuals harassed.

The following sections describe Lamont-Doherty and NMFS' methods to estimate take by incidental harassment. We base these estimates on the number of marine mammals that are estimated to be exposed to seismic airgun sound levels above the Level B harassment threshold of 160 dB during a total of approximately 9,633 km (5,986 mi) of transect lines in the southeast Pacific Ocean.

Density Estimates: Lamont-Doherty was unable to identify any systematic aircraft- or ship-based surveys conducted for marine mammals in waters of the southeast Pacific Ocean offshore Chile. Lamont-Doherty used densities from NMFS' Southwest Fisheries Science Center (SWFSC) cruises (Ferguson and Barlow, 2001, 2003; Barlow 2003, 2010; Forney, 2007) in the California Current which is similar to the Humboldt Current Coastal area in which the proposed surveys are located. Both are eastern boundary currents that feature narrow continental shelves, upwelling, high productivity, and fluctuating fishery resources (sardines and anchovies). The densities used were survey effort-weighted means for the locations (blocks or states). In cases where multiple density estimates existed for an area, Lamont-Doherty used the highest density range (summer/fall) for each species within the survey area. We refer the reader to Lamont-Doherty's application for detailed information on how Lamont-Doherty calculated densities for marine mammals from the SWFSC cruises.

For blue whales in the southern survey area, NMFS used the density (9.56/km^2) reported by Galletti Vernazzani *et al.* (2012) for approximately four days of the proposed southern survey to account for potential survey operations occurring near a known foraging area between 39° S. and 44° S. For the remaining 31 days of the proposed survey, NMFS used the density estimate presented in Lamont-Doherty's application (2.07/km^2). NMFS considers Lamont-Doherty's approach to calculating densities for the remaining marine mammal species in the survey areas as the best available information. We present the estimated densities (when available) in Tables 5, 6, and 7 in this notice.

Modeled Number of Instances of Exposures: Lamont-Doherty would conduct the proposed seismic surveys offshore Chile in the southeast Pacific Ocean and presents estimates of the anticipated numbers of instances that marine mammals could be exposed to sound levels greater than or equal to 160, 180, and 190 dB re: 1 μPa during the proposed seismic survey in Tables 3, 4, and 5 in their application. NMFS has independently reviewed these estimates and presents revised estimates (described in the following subsections) of the anticipated numbers of instances that marine mammals could be exposed to sound levels greater than or equal to 160, 180, and 190 dB re: 1 μPa during the proposed seismic survey in Tables 5, 6, and 7 in this notice. Table 8 presents the total numbers of instances of take that NMFS proposes to authorize.

Take Estimate Method for Species with Density Information: Briefly, we take the estimated density of marine mammals within an area (animals/km^2) and multiply that number by the daily ensonified area (km^2). The product (rounded) is the number of instance of take within one day. We then multiply the number of instances of take within one day by the number of survey days (plus 25 percent contingency). The result is an estimate of the potential number of instances that marine mammals could be exposed to airgun sounds above the Level B harassment threshold (*i.e.,* the 160 dB ensonified area minus the 180/190-dB ensonified area) and the Level A harassment threshold (*i.e.,* the 180/190-dB ensonified area only) over the duration of each proposed survey.

There is some uncertainty about the representativeness of the estimated density data and the assumptions used in their calculations. Oceanographic conditions, including occasional El Niño and La Niña events, influence the distribution and numbers of marine mammals present in the eastern tropical Pacific Ocean, resulting in considerable year-to-year variation in the distribution and abundance of many marine mammal species. Thus, for some species, the densities derived from past surveys may not be representative of the densities that would be encountered during the proposed seismic surveys. However, the approach used is based on the best available data.

In many cases, this estimate of instances of exposures is likely an overestimate of the number of individuals that are taken, because it assumes 100 percent turnover in the area every day, (*i.e.,* that each new day results in takes of entirely new individuals with no repeat takes of the same individuals over the three periods (northern: 35 days; central: 6 days; and southern: 34 days) including contingency. It is difficult to quantify to what degree this method overestimates the number of individuals potentially taken. Except as described later for a few specific species, NMFS uses this number of instances as the estimate of individuals (and authorized take).

Take Estimates for Species with Less than One Instance of Exposure: Using the approach described earlier, the model generated instances of take for some species that were less than one over the 75 total survey days. Those species include: Bryde's, dwarf sperm, killer, and sei whale. NMFS used data based on dedicated survey sighting information from the Atlantic Marine Assessment Program for Protected Species (AMAPPS) surveys in 2010, 2011, and 2013 (AMAPPS, 2010, 2011, 2013) to estimate take and assumed that Lamont-Doherty could potentially encounter one group of each species during the proposed seismic survey. NMFS believes it is reasonable to use the average (mean) group size (weighted by effort and rounded up) from the AMMAPS surveys for Bryde's whale (2), dwarf sperm whale (2), killer whale (4), and sei whale (3) to derive a reasonable estimate of take for eruptive occurrences of each these species only once for each survey.

Take Estimates for Species with No Density Information: Density information for the southern right whale, pygmy right whale, Antarctic minke whale, sei whale, dwarf sperm whale, Shephard's beaked whale, pygmy beaked whale, southern bottlenose whale, hourglass dolphin, pygmy killer whale, false killer whale; short-finned pilot whale, Juan Fernandez fur seal, and southern elephant seal in the southeast Pacific Ocean is data poor or non-existent. When density estimates were not available for a particular survey leg, NMFS used data based on dedicated survey sighting information from the Atlantic Marine Assessment Program for Protected Species (AMAPPS) surveys in 2010, 2011, and 2013 (AMAPPS, 2010, 2011, 2013) and from Santora (2012) to estimate mean group size and take for these species. NMFS assumed that Lamont-Doherty could potentially encounter one group of each species each day during the seismic survey. NMFS believes it is reasonable to use the average (mean) group size (weighted by effort and rounded up) for each species multiplied by the number of survey days to derive an estimate of take from potential encounters.

TABLE 5—DENSITIES OF MARINE MAMMALS AND ESTIMATES OF INCIDENTS OF EXPOSURE TO ≥160 AND 180 OR 190 dB re 1 μPa rms PREDICTED DURING THE NORTHERN PROPOSED SEISMIC SURVEY IN THE SOUTHEAST PACIFIC OCEAN IN 2016/2017

Species	Density estimate [1]	Modeled number of instances of exposures to sound levels ≥160, 180, and 190 dB [2]	Proposed Level A take [3]	Proposed Level B take
Southern right whale	0	105, 0, -	0	105
Humpback whale	0.32	35, 0, -	0	35
Common (dwarf) minke whale	0.34	35, 0 -	0	35
Antarctic minke whale	0	70, 0, -	0	70
Bryde's whale	0.47	35, 0, 0	0	35
Sei whale	0	105, 0, -	0	105
Fin whale	1.4	105, 35, -	35	105
Blue whale	0.54	35, 0, -	0	35
Sperm whale	1.19	70, 0, -	0	70
Dwarf sperm whale	8.92	630, 105, -	105	630
Pygmy sperm whale	2.73	210, 35, -	35	210
Cuvier's beaked whale	2.36	175, 35, -	35	175
Pygmy beaked whale	0.7	35, 0, -	0	35
Gray's beaked whale	1.95	140, 35, -	35	140
Blainville's beaked whale	1.95	140, 35, -	35	140
Rough-toothed dolphin	7.05	490, 105, -	105	490
Common bottlenose dolphin	18.4	1,330, 245, -	245	1,330
Striped dolphin	61.4	4,410, 805, -	805	4,410
Short-beaked common dolphin	356.3	25,515, 4,725, -	4,725	25,515
Long-beaked common dolphin	50.3	3,605, 665, -	665	3,605
Dusky dolphin	13.7	980, 175, -	175	980
Southern right whale dolphin	3.34	245, 35, -	35	245
Risso's dolphin	29.8	2,135, 385, -	385	2,135
Pygmy killer whale	1.31	105, 0, -	0	105
False killer whale	0.63	35, 0, -	0	35
Killer whale	0.23	4, 0, -	0	4
Short-finned pilot whale	0	700, 0, -	0	700
Long-finned pilot whale	1.09	70, 0, -	0	70
Burmeister's porpoise	5.15	385, 70, -	70	385
Juan Fernandez fur seal	0	70, -, 0	0	70
South American fur seal	37.9	2,730, -, 490	490	2,730
South American sea lion	393	28,140, -, 5,215	5,215	28,140

[1] Densities shown (when available) are 1,000 animals per km^2. See Lamont-Doherty's application and text in this notice for a summary of how Lamont-Doherty derived density estimates for certain species. For species without density estimates, see text in this notice for an explanation of NMFS' methodology to derive take estimates.

[2] Take modeled using a daily method for calculating ensonified area: Estimated density multiplied by the daily ensonified area to derive instances of take in one day (rounded) multiplied by the number of survey days with 25 percent contingency (35) Level B take = modeled instances of exposure within the 160-dB ensonified area minus the 180-dB or 190-dB ensonified area. Level A take = modeled instances of exposures within the 180-dB or 190-dB ensonified area only. Modeled instances of exposures include adjustments for species with no density information or with species having less than one instance of exposure (see text for sources).

[3] The Level A estimates are overestimates of predicted impacts to marine mammals as the estimates do not take into consideration the required mitigation measures for shutdowns or power downs if a marine mammal is likely to enter the 180 or 190 dB exclusion zone while the airguns are active.

TABLE 6—DENSITIES OF MARINE MAMMALS AND ESTIMATES OF INCIDENTS OF EXPOSURE TO ≥160 AND 180 OR 190 dB re 1 μPa rms PREDICTED DURING THE CENTRAL PROPOSED SEISMIC SURVEY IN THE SOUTHEAST PACIFIC OCEAN IN 2016/2017

Species	Density estimate [1]	Modeled number of instances of exposures to sound levels ≥160, 180, and 190 dB [2]	Proposed Level A take [3]	Proposed Level B take
Southern right whale	0	18, 0, -	0	18
Pygmy right whale	0	18, 0, -	0	18
Humpback whale	0.43	6, 0, -	0	6
Common (dwarf) minke whale	0.34	6, 0, -	0	6
Antarctic minke whale	0	12, 0, -	0	12
Bryde's whale	0.41	6, 0, -	0	6
Sei whale	0	18, 0, -	0	18
Fin whale	1.96	18, 6, -	6	18
Blue whale	2.1	18, 6, -	6	18
Sperm whale	1.22	12, 0, -	0	12

TABLE 6—DENSITIES OF MARINE MAMMALS AND ESTIMATES OF INCIDENTS OF EXPOSURE TO ≥160 AND 180 OR 190 dB re 1 μPa rms PREDICTED DURING THE CENTRAL PROPOSED SEISMIC SURVEY IN THE SOUTHEAST PACIFIC OCEAN IN 2016/2017—Continued

Species	Density estimate [1]	Modeled number of instances of exposures to sound levels ≥160, 180, and 190 dB [2]	Proposed Level A take [3]	Proposed Level B take
Dwarf sperm whale	7.98	78, 12, -	12	78
Pygmy sperm whale	2.98	30, 6, -	6	30
Cuvier's beaked whale	3.02	30, 6, -	6	30
Shepard's beaked whale	0	18, 0, -	0	18
Hector's beaked whale	1.54	18, 0, -	0	18
Pygmy beaked whale	0.55	6, 0, -	0	6
Gray's beaked whale	1.54	18, 0, -	0	18
Blainville's beaked whale	1.54	18, 0, -	0	18
Andrew's beaked whale	1.54	18, 0, -	0	18
Strap-toothed beaked whale	1.54	18, 0, -	0	18
Spade-toothed beaked whale	1.54	18, 0, -	0	18
Chilean dolphin	21.2	210, 36, -	36	210
Common bottlenose dolphin	12.3	120, 24, -	24	120
Striped dolphin	46.7	462, 84, -	84	462
Short-beaked common dolphin	503.5	4,998, 908, -	906	4,998
Dusky dolphin	14.8	144, 24, -	24	144
Peale's dolphin	21.2	210, 36, -	36	210
Hourglass dolphin	0	30, 0, -	0	30
Southern right whale dolphin	6.07	60, 12, -	12	60
Risso's dolphin	21.2	210, 36, -	36	210
Pygmy killer whale	0	12, 0, -	0	12
False killer whale	0.54	6, 0, -	0	6
Killer whale	0.28	4, 0, -	0	4
Short-finned pilot whale	0	120, 0, -	0	120
Long-finned pilot whale	0.94	12, 0, -	0	12
Burmeister's porpoise	4.92	48, 6, -	6	48
Juan Fernandez fur seal	0	12, -, 0	0	12
South American fur seal	37.9	378, -, 66	66	378
South American sea lion	393	3,900, -, 708	708	3,900
Southern elephant seal	0	24, -, 0	0	24

[1] Densities shown (when available) are 1,000 animals per km^2. See Lamont-Doherty's application and text in this notice for a summary of how Lamont-Doherty derived density estimates for certain species. For species without density estimates, see text in this notice for an explanation of NMFS' methodology to derive take estimates.

[2] Take modeled using a daily method for calculating ensonified area: Estimated density multiplied by the daily ensonified area to derive instances of take in one day (rounded) multiplied by the number of survey days with 25 percent contingency (35) Level B take = modeled instances of exposure within the 160-dB ensonified area minus the 180-dB or 190-dB ensonified area. Level A take = modeled instances of exposures within the 180-dB or 190-dB ensonified area only. Modeled instances of exposures include adjustments for species with no density information or with species having less than one instance of exposure (see text for sources).

[3] The Level A estimates are overestimates of predicted impacts to marine mammals as the estimates do not take into consideration the required mitigation measures for shutdowns or power downs if a marine mammal is likely to enter the 180 or 190 dB exclusion zone while the airguns are active.

TABLE 7—DENSITIES OF MARINE MAMMALS AND ESTIMATES OF INCIDENTS OF EXPOSURE TO ≥160 AND 180 OR 190 dB re 1 μPa rms PREDICTED DURING THE SOUTHERN PROPOSED SEISMIC SURVEY IN THE SOUTHEAST PACIFIC OCEAN IN 2016/2017

Species	Density estimate [1]	Modeled number of instances of exposures to sound levels ≥160, 180, and 190 dB [2]	Proposed Level A take [3]	Proposed Level B take
Southern right whale	0	102, 0, -	0	102
Pygmy right whale	0	102, 0, -	0	102
Humpback whale	1.22	102, 0, -	0	102
Common (dwarf) minke whale	0.61	34, 0, -	0	34
Antarctic minke whale	0	68, 0, -	0	68
Bryde's whale	0.03	2, 0, -	0	2
Sei whale	0.02	3, 0, -	0	3
Fin whale	2.43	170, 34, -	34	170
Blue whale (Feb–Apr)	9.56	80, 12, -	12	80
Blue whale (May–Jan)	2.07	124, 31, -	31	124
Sperm whale	1.32	102, 0, -	0	102
Dwarf sperm whale	0	68, 0, -	0	68
Pygmy sperm whale	4.14	306, 34, -	34	306
Cuvier's beaked whale	4.02	272, 34, -	34	272

TABLE 7—DENSITIES OF MARINE MAMMALS AND ESTIMATES OF INCIDENTS OF EXPOSURE TO ≥160 AND 180 OR 190 dB re 1 μPa rms PREDICTED DURING THE SOUTHERN PROPOSED SEISMIC SURVEY IN THE SOUTHEAST PACIFIC OCEAN IN 2016/2017—Continued

Species	Density estimate [1]	Modeled number of instances of exposures to sound levels ≥160, 180, and 190 dB [2]	Proposed Level A take [3]	Proposed Level B take
Shepard's beaked whale	0	102, 0, -	0	102
Hector's beaked whale	0.31	34, 0, -	0	34
Pygmy beaked whale	0	102, 0, -	0	102
Gray's beaked whale	1.95	136, 34, -	34	136
Blainville's beaked whale	0.31	34, 0, -	0	34
Andrew's beaked whale	0.31	34, 0, -	0	34
Strap-toothed beaked whale	0.31	34, 0, -	0	34
Spade-toothed beaked whale	0.31	34, 0, -	0	34
Southern bottlenose whale	0	102, 0, -	0	102
Chilean dolphin	10.9	748, 136, 0	136	748
Common bottlenose dolphin	2.72	204, 34, -	34	204
Striped dolphin	17.7	1,224, 204, -	204	1,224
Short-beaked common dolphin	516.9	36,210, 5,950, -	5,950	36,210
Dusky dolphin	29.9	2,108, 340, -	340	2,108
Peale's dolphin	10.9	748, 136, -	136	748
Hourglass dolphin	0	170, 0, -	0	170
Southern right whale dolphin	9.79	680, 102, -	102	680
Risso's dolphin	10.9	748, 136, -	136	748
Pygmy killer whale	0	68, 0, -	0	68
False killer whale	0	238, 0, -	0	238
Killer whale	0.73	68, 0, -	0	68
Short-finned pilot whale	0	680, 0, -	0	680
Long-finned pilot whale	0.53	34, 0, -	0	34
Burmeister's porpoise	55.4	3,876, 646, -	646	3,876
Juan Fernandez fur seal	0	68, -, 0	0	68
South American fur seal	37.9	2,652, -, 442	442	2,652
South American sea lion	393	27,540, -, 4,522	4,522	27,540
Southern elephant seal	0	136, -, 0	0	136

[1] Densities shown (when available) are 1,000 animals per km^2. See Lamont-Doherty's application and text in this notice for a summary of how Lamont-Doherty derived density estimates for certain species. For species without density estimates, see text in this notice for an explanation of NMFS' methodology to derive take estimates.

[2] Take modeled using a daily method for calculating ensonified area: Estimated density multiplied by the daily ensonified area to derive instances of take in one day (rounded) multiplied by the number of survey days with 25 percent contingency (35) Level B take = modeled instances of exposure within the 160-dB ensonified area minus the 180-dB or 190-dB ensonified area. Level A take = modeled instances of exposures within the 180-dB or 190-dB ensonified area only. Modeled instances of exposures include adjustments for species with no density information or with species having less than one instance of exposure (see text for sources).

[3] The Level A estimates are overestimates of predicted impacts to marine mammals as the estimates do not take into consideration the required mitigation measures for shutdowns or power downs if a marine mammal is likely to enter the 180 or 190 dB exclusion zone while the airguns are active.

TABLE 8—TAKE ESTIMATES BASED ON TOTAL PREDICTED INCIDENTS OF EXPOSURE TO ≥160 AND 180 OR 190 dB re 1 μPa rms DURING THE NORTHERN, CENTRAL, AND SOUTHERN PROPOSED SEISMIC SURVEY OFF CHILE IN THE SOUTHEAST PACIFIC OCEAN IN 2016/2017

Species	Proposed Level A take [1]	Proposed Level B take	Total proposed take	Percent of population [2]
Southern right whale	0	225	225	1.875
Pygmy right whale	0	120	120	Unknown
Humpback whale	0	143	143	0.340
Common (dwarf) minke whale	0	75	75	0.015
Antarctic minke whale	0	41	41	0.008
Bryde's whale	0	43	43	0.099
Sei whale	0	126	126	1.260
Fin whale	75	293	368	1.673
Blue whale	49	257	306	3.060
Sperm whale	0	184	184	0.051
Dwarf sperm whale	117	776	893	0.524
Pygmy sperm whale	75	546	621	0.365
Cuvier's beaked whale	75	477	552	2.760
Shepard's beaked whale	0	120	120	0.474
Pygmy beaked whale	0	143	143	0.565
Gray's beaked whale	69	294	363	1.435
Blainville's beaked whale	35	192	227	0.897
Hector's beaked whale	0	52	52	0.206
Gray's beaked whale	69	294	363	1.435

TABLE 8—TAKE ESTIMATES BASED ON TOTAL PREDICTED INCIDENTS OF EXPOSURE TO ≥160 AND 180 OR 190 dB re 1 µPa rms DURING THE NORTHERN, CENTRAL, AND SOUTHERN PROPOSED SEISMIC SURVEY OFF CHILE IN THE SOUTHEAST PACIFIC OCEAN IN 2016/2017—Continued

Species	Proposed Level A take [1]	Proposed Level B take	Total proposed take	Percent of population [2]
Andrew's beaked whale	0	52	52	0.206
Strap-toothed beaked whale	0	52	52	0.206
Spade-toothed beaked whale	0	52	52	0.206
Southern bottlenose whale	0	102	102	0.142
Chilean dolphin	172	958	1,130	11.300
Rough-toothed dolphin	105	490	595	0.553
Common bottlenose dolphin	303	1,654	1,957	0.583
Striped dolphin	1,093	6,096	7,189	0.745
Short-beaked common dolphin	11,581	66,723	78,304	4.433
Long-beaked common dolphin	665	3,605	4,270	2.965
Dusky dolphin	539	3,232	3,771	14.571
Peale's dolphin	172	958	1,130	Unknown
Hourglass dolphin	0	200	200	0.139
Southern right whale dolphin	149	985	1,134	Unknown
Risso's dolphin	557	3,093	3,650	3.304
Pygmy killer whale	0	185	185	0.476
False killer whale	0	279	279	0.701
Killer whale	0	76	76	0.152
Short-finned pilot whale	0	1,500	1,500	0.255
Long-finned pilot whale	0	116	116	0.058
Burmeister's porpoise	722	4,309	5,031	Unknown
Juan Fernandez fur seal	0	150	150	0.465
South American fur seal	998	5,760	6,758	2.703
South American sea lion	10,445	59,580	70,025	17.604
Southern elephant seal	0	160	160	0.040

[1] The Level A estimates are overestimates of predicted impacts to marine mammals as the estimates do not take into consideration the required mitigation measures for shutdowns or power downs if a marine mammal is likely to enter the 180 or 190 dB exclusion zone while the airguns are active.

[2] Proposed authorized Level A and B takes (used by NMFS as proxy for number of individuals exposed) expressed as the percent of the population listed in Table 1 in this notice. Unknown = Abundance size not available.

Lamont-Doherty did not estimate any additional take from sound sources other than airguns. NMFS does not expect the sound levels produced by the echosounder and sub-bottom profiler to exceed the sound levels produced by the airguns.

As described above, NMFS considers the probability for entanglement of marine mammals to be so low as to be discountable, because of the vessel speed and the monitoring efforts onboard the survey vessel. Therefore, NMFS does not propose to authorize additional takes for entanglement.

As described above, the *Langseth* will operate at a relatively slow speed (typically 4.6 knots [8.5 km/h; 5.3 mph]) when conducting the survey. Protected species observers would monitor for marine mammals, which would trigger mitigation measures, including vessel avoidance where safe. Therefore, NMFS does not anticipate nor do we propose to authorize takes of marine mammals as a result of vessel strike.

There is no evidence that the planned survey activities could result in serious injury or mortality within the specified geographic area for the requested proposed Authorization. The required mitigation and monitoring measures would minimize any potential risk for serious injury or mortality.

Preliminary Analysis and Determinations

Negligible Impact

Negligible impact is ''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). The lack of likely adverse effects on annual rates of recruitment or survival (*i.e.,* population level effects) forms the basis of a negligible impact finding. Thus, 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 behavioral harassment, NMFS must consider other factors, such as the likely nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), as well as the number and nature of estimated Level A harassment takes, the number of estimated mortalities, effects on habitat, and the status of the species.

In making a negligible impact determination, NMFS considers:

- The number of anticipated injuries, serious injuries, or mortalities;
- The number, nature, and intensity, and duration of harassment; and
- The context in which the takes occur (*e.g.,* impacts to areas of significance, impacts to local populations, and cumulative impacts when taking into account successive/contemporaneous actions when added to baseline data);
- The status of stock or species of marine mammals (*i.e.,* depleted, not depleted, decreasing, increasing, stable, impact relative to the size of the population);
- Impacts on habitat affecting rates of recruitment/survival; and
- The effectiveness of monitoring and mitigation measures to reduce the number or severity of incidental takes.

To avoid repetition, our analysis applies to all the species listed in Table 8, given that NMFS expects the anticipated effects of the seismic airguns 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.

Given the required mitigation and related monitoring, NMFS does not anticipate that serious injury or mortality would occur as a result of Lamont-Doherty's proposed seismic survey in the southeast Pacific Ocean. Thus the proposed authorization does not authorize any mortality. NMFS' predicted estimates for Level A harassment take for some species are likely overestimates of the injury that will occur, as NMFS expects that successful implementation of the proposed mitigation measures would avoid Level A take in some instances. Also, NMFS expects that some individuals would avoid the source at levels expected to result in injury, given sufficient notice of the *Langseth's* approach due to the vessel's relatively low speed when conducting seismic surveys. Though NMFS expects that Level A harassment is unlikely to occur at the numbers proposed to be authorized, is difficult to quantify the degree to which the mitigation and avoidance will reduce the number of animals that might incur PTS, therefore we propose to authorize, and have included in our analyses, the modeled number of Level A takes, which does not take the mitigation or avoidance into consideration. However, because of the constant movement of the *Langseth* and of the animals, as well as the fact that the vessel is not expected to remain in any one area in which individuals would be expected to concentrate for any extended amount of time (*i.e.,* since the duration of exposure to loud sounds will be relatively short), we anticipate that any PTS that may be incurred in marine mammals would be in the form of only a small degree of permanent threshold shift, and not total deafness, that would not be likely to affect the fitness of any individuals.

Of the marine mammal species under our jurisdiction that are known to occur or likely to occur in the study area, the following species are listed as endangered under the ESA: Blue, fin, humpback, sei, Southern right, and sperm whales. The other marine mammal species that may be taken by harassment during Lamont-Doherty's seismic survey program are not listed as threatened or endangered under the ESA.

Cetaceans. Odontocete reactions to seismic energy pulses are usually thought to be limited to shorter distances from the airgun(s) than are those of mysticetes, in part because odontocete low-frequency hearing is assumed to be less sensitive to the low frequency signals of these airguns than that of mysticetes. NMFS generally expects cetaceans to move away from a noise source that is annoying prior to its becoming potentially injurious, and this expectation is expected to hold true in the case of the proposed activities, especially given the relatively slow travel speed of the *Langseth* while seismic surveys are being conducted (4.5 kt; 5.1 mph). The relatively slow ship speed is expected to provide cetaceans with sufficient notice of the oncoming vessel and thus sufficient opportunity to avoid the seismic sound source before it reaches a level that would be potentially injurious to the animal. However, as described above, Level A takes for a small group of cetacean species are proposed for authorization here.

Potential impacts to marine mammal habitat were discussed previously in this document (see the "Anticipated Effects on Habitat" section). Although some disturbance is possible to food sources of marine mammals, the impacts are anticipated to be minor enough as to not affect the feeding success of any individuals long-term. Regarding direct effects on cetacean feeding, based on the fact that the action footprint does not include any areas recognized specifically for higher value feeding habitat, the mobile and ephemeral nature of most prey sources, and the size of the southeast Pacific Ocean where feeding by marine mammals occurs versus the localized area of the marine survey activities, any missed feeding opportunities in the direct project area are expected to be minor based on the fact that other equally valuable feeding opportunities likely exist nearby.

Taking into account the planned mitigation measures, effects on cetaceans are generally expected to be restricted to avoidance of a limited area around the survey operation and short-term changes in behavior, falling within the MMPA definition of "Level B harassment." Animals are not expected to permanently abandon any area that is surveyed, and based on the best available information, any behaviors that are interrupted during the activity are expected to resume once the activity ceases. For example, as described above, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration in that area for decades (Appendix A in Malme *et al.,* 1984; Richardson *et al.,* 1995; Allen and Angliss, 2014). Similarly, bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years (Richardson *et al.,* 1987; Allen and Angliss, 2014). The history of coexistence between seismic surveys and baleen whales suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects. Only a small portion of marine mammal habitat will be affected at any time, and other areas within the southeast Pacific Ocean would be available for necessary biological functions. Overall, the consequences of behavioral modification are not expected to affect cetacean growth, survival, and/or reproduction, and therefore are not expected to be biologically significant.

Pinnipeds. Generally speaking, pinnipeds may react to a sound source in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the exposure, with behavioral responses to sound ranging from a mild orienting response, or a shifting of attention, to flight and panic. However, research and monitoring observations from activities similar to those proposed have shown that pinnipeds in the water are generally tolerant of anthropogenic noise and activity. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior (Harris *et al.,* 2001; Moulton and Lawson, 2002). During foraging trips, extralimital pinnipeds may not react at all to the sound from the proposed survey or may alert, ignore the stimulus, change their behavior, or avoid the immediate area by swimming away or diving. Behavioral effects to sound are generally more likely to occur at higher received levels (*i.e.,* within a few kilometers of a sound source). However, the slow speed of the *Langseth* while conducting seismic surveys (approximately 4.5 kt; 5.1 mph) is expected to provide ample opportunity for pinnipeds to avoid and keep some distance between themselves and the loudest sources of sound associated with the proposed activities. Additionally, underwater sound from the proposed survey would not be audible at pinniped haulouts or rookeries, therefore the consequences of behavioral responses in these areas are expected to be minimal. Overall, the consequences of behavioral modification are not expected to affect pinniped growth, survival, and/or reproduction, and therefore are not expected to be biologically significant.

Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (*i.e.,* 24 hour cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). While NMFS anticipates that the seismic operations would occur on consecutive days, the estimated duration of the survey would last no more than 75 days but would increase sound levels in the marine environment in a relatively small area surrounding the vessel (compared to the range of most of the marine mammals within the proposed survey area), which is constantly travelling over distances, and some animals may only be exposed to and harassed by sound for less than a day.

For reasons stated previously in this document and based on the following factors, Lamont-Doherty's proposed activities are not likely to cause long-term behavioral disturbance, serious injury, or death, or other effects that would be expected to adversely affect reproduction or survival of any individuals. They include:

- The anticipated impacts of Lamont-Doherty's survey activities on marine mammals are temporary behavioral changes due, primarily, to avoidance of the area around the seismic vessel;
- The likelihood that, given the constant movement of boat and animals and the nature of the survey design (not concentrated in areas of high marine mammal concentration), any PTS that is incurred would be of a low level;
- The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the operation of the airgun(s) to avoid acoustic harassment;
- The expectation that the seismic survey would have no more than a temporary and minimal adverse effect on any fish or invertebrate species that serve as prey species for marine mammals, and therefore consider the potential impacts to marine mammal habitat minimal.

Tables 5–8 in this document outlines the number of requested Level A and Level B harassment takes that we anticipate as a result of these activities.

Required mitigation measures, such as special shutdowns for large whales, vessel speed, course alteration, and visual monitoring would be implemented to help reduce impacts to marine mammals. Based on the analysis 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 finds that Lamont-Doherty's proposed seismic survey would have a negligible impact on the affected marine mammal species or stocks.

Small Numbers

As mentioned previously, NMFS estimates that Lamont-Doherty's activities could potentially affect, by Level B harassment, 44 species of marine mammals under our jurisdiction. NMFS estimates that Lamont-Doherty's activities could potentially affect, by Level A harassment, up to 26 species of marine mammals under our jurisdiction.

For each species, the numbers of take being proposed for authorization are small relative to the population sizes: Less than 18 percent for South American sea lion, less than 15 percent for the dusky dolphin, less than 11.5 percent for Chilean dolphin, and less than 5 percent for all other species (Table 8).

NMFS is not aware of reliable abundance estimates for four species of marine mammals (Burmeister's porpoise, Peale's dolphin, pygmy right whale, and southern right whale dolphin) for which incidental take authorization is proposed. Therefore we rely on the best available information on these species to make determinations as to whether the proposed authorized take numbers represent small numbers of the total populations of these species.

The Burmeister's porpoise is distributed from the Atlantic Ocean in southern Brazil to the Pacific Ocean in northern Peru (Reyes 2009). While there are no quantitative data on abundance, the best available information suggest the species is assumed to be numerous throughout South American coastal waters (Brownell Jr. and Clapham 1999), with groups estimated at approximately 150 individuals observed off of Peru (Van Waerebeek et al. 2002). In addition the species is typically found shoreward of the 60 m isobath (Hammond et al. 2012), suggesting that the proposed number of authorized takes is likely conservative as the species is unlikely to be encountered throughout the full survey area. The species' wide distribution and apparent abundance suggest the proposed number of authorized takes would represent a small number of individuals relative to the species' total abundance.

Peale's dolphin is a coastal species that is known to inhabit waters very near to shore, commonly within or shoreward of kelp beds, while in the waters of southern Chile and Tierra del Fuego they appear to prefer channels, fjords and deep bays (Goodall 2009). Their apparent habitat preference for waters very near to shore suggests that the number of proposed authorized takes is likely very conservative as the species is unlikely to be encountered throughout much of the survey area. While no abundance estimate exists for the species, Peale's dolphin is reportedly the most common cetacean found around the coast of the Falkland Islands and Chile (Brownell Jr. et al. 1999). The combination of the species' apparent abundance and the species' apparent preference for habitats that would not be surveyed by Lamont-Doherty suggests the proposed number of authorized takes would represent a small number of individuals relative to the species' total abundance.

The full distribution of the southern right whale dolphin is not known, but the species appears to be circumpolar and fairly common throughout its range. Survey data and stranding and fishery interaction data in northern Chile suggest that the species may be one of the most common cetaceans in the region (Van Waerebeek et al. 1991). The species' apparent abundance and its broad distribution suggest the proposed number of authorized takes would represent a small number of individuals relative to the species' total abundance.

The pygmy right whale has a circumpolar distribution, between about 30° and 55° S., with records from southern South America as well as Africa, Australia and New Zealand (Kemper 2009). There are no estimates of abundance for the species, but judging by the number of strandings in Australia and New Zealand, it is likely to be reasonably common in that region (Kemper 2009), with aggregations of up to approximately 80 individuals reported (Matsuoka 1996). The species' apparent abundance and its broad distribution suggest the proposed number of authorized takes would represent a small number of individuals relative to the species' total abundance.

NMFS finds that the proposed incidental take described in Table 8 for the proposed activity would be limited to small numbers relative to the affected species or stocks.

Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

There are no relevant subsistence uses of marine mammals implicated by this action.

Endangered Species Act (ESA)

There are six marine mammal species listed as endangered under the Endangered Species Act that may occur in the proposed survey area. Under section 7 of the ESA, NSF has initiated formal consultation with NMFS on the proposed seismic survey. NMFS (*i.e.,* National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division) will also consult internally with NMFS on the proposed issuance of an Authorization under section 101(a)(5)(D) of the MMPA. NMFS and the NSF will conclude the consultation prior to a determination on the proposed issuance of the Authorization.

National Environmental Policy Act (NEPA)

NSF has prepared a draft environmental analysis titled, *Draft Environmental Analysis of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Southeast Pacific Ocean, 2016/2017.* NMFS has posted this document on our Web site concurrently with the publication of this notice. NMFS has independently evaluated the draft environmental analysis and has prepared a draft Environmental Assessment (DEA) titled, *Proposed Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Southeast Pacific Ocean, 2016/2017.* Information in Lamont-Doherty's application, NSF's draft environmental analysis, NMFS' DEA and this notice collectively provide the environmental information related to proposed issuance of an Authorization for public review and comment. NMFS will review all comments submitted in response to this notice as we complete the NEPA process, including a decision of whether to sign a Finding of No Significant Impact (FONSI), prior to a final decision on the proposed Authorization request.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes issuing an Authorization to Lamont-Doherty for conducting a seismic survey in the Southeast Pacific Ocean, between June 2016 and June 2017, provided they incorporate the proposed mitigation, monitoring, and reporting requirements.

Draft Proposed Authorization

This section contains the draft text for the proposed Authorization. NMFS proposes to include this language in the Authorization if issued.

Incidental Harassment Authorization

We hereby authorize the Lamont-Doherty Earth Observatory (Lamont-Doherty), Columbia University, P.O. Box 1000, 61 Route 9W, Palisades, New York 10964–8000, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to incidentally harass small numbers of marine mammals incidental to a marine geophysical survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) marine geophysical survey in the Southeast Pacific Ocean between June 2016 and June 2017.

1. Effective Dates

This Authorization is valid between June 2016 and June 2017.

2. Specified Geographic Region

This Authorization is valid only for specified activities associated with the R/V *Marcus G. Langseth's* (*Langseth*) seismic operations as specified in Lamont-Doherty's Incidental Harassment Authorization (Authorization) application and environmental analysis in the following specified geographic area:

a. In the Southeast Pacific Ocean, located approximately within the exclusive economic zone of Chile, between 18° and 44° S. as specified in Lamont-Doherty's application and the National Science Foundation's environmental analysis.

3. Species Authorized and Level of Takes

a. This authorization limits the incidental taking of marine mammals, by harassment only, to the species in the area described in Tables 5–8 in this notice.

i. During the seismic activities, if the Holder of this Authorization encounters any marine mammal species that are not listed in Condition 3(a) for authorized taking and are likely to be exposed to sound pressure levels greater than or equal to 160 decibels (dB) re: 1 μPa, then the Holder must alter speed or course or shut-down the airguns to avoid take.

b. The taking by serious injury or death of any of the species listed in Condition 3(a) or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this Authorization.

c. This Authorization limits the methods authorized for taking by harassment to the following acoustic sources:

i. A sub-airgun array with a total capacity of 6,600 in^3 (or smaller);

4. Reporting Prohibited Take

The Holder of this Authorization must report the taking of any marine mammal in a manner prohibited under this Authorization immediately to the Office of Protected Resources, National Marine Fisheries Service, at 301–427–8401 and/or by email to the Chief, Permits and Conservation Division.

5. Cooperation

We require the Holder of this Authorization to cooperate with the Office of Protected Resources, National Marine Fisheries Service, and any other Federal, state, or local agency monitoring the impacts of the activity on marine mammals.

6. Mitigation and Monitoring Requirements

We require the Holder of this Authorization to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable adverse impact on affected marine mammal species or stocks:

Visual Observers

a. Utilize two, National Marine Fisheries Service-qualified, vessel-based Protected Species Visual Observers (visual observers) to watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during start-ups of airguns day or night.

i. At least one visual observer will be on watch during meal times and restroom breaks.

ii. Observer shifts will last no longer than four hours at a time.

iii. Visual observers will also conduct monitoring while the *Langseth* crew deploy and recover the airgun array and streamers from the water.

iv. When feasible, visual observers will conduct observations during daytime periods when the seismic system is not operating for comparison of sighting rates and behavioral reactions during, between, and after airgun operations.

v. The *Langseth's* vessel crew will also assist in detecting marine mammals, when practicable. Visual observers will have access to reticle binoculars (7x50 Fujinon), and big-eye binoculars (25x150).

Exclusion Zones

b. Establish a 180-decibel (dB) or 190-dB exclusion zone for cetaceans and pinnipeds, respectively, before starting the airgun subarray (6,660 in^3); and a 180-dB or 190-dB exclusion zone for cetaceans and pinnipeds, respectively for the single airgun (40 in^3). Observers will use the predicted radius distance for the 180-dB or 190-dB exclusion zones for cetaceans and pinnipeds.

Visual Monitoring at the Start of Airgun Operations

c. Monitor the entire extent of the exclusion zones for at least 30 minutes (day or night) prior to the ramp-up of airgun operations after a shutdown.

d. Delay airgun operations if the visual observer sees a cetacean within the 180-dB exclusion zone for cetaceans or 190-dB exclusion zone for pinnipeds until the marine mammal(s) has left the area.

i. If the visual observer sees a marine mammal that surfaces, then dives below the surface, the observer shall wait 30 minutes. If the observer sees no marine mammals during that time, he/she should assume that the animal has moved beyond the 180-dB exclusion zone for cetaceans or 190-dB exclusion zone for pinnipeds.

ii. If for any reason the visual observer cannot see the full 180-dB exclusion zone for cetaceans or the 190-dB exclusion zone for pinnipeds for the entire 30 minutes (*i.e.,* rough seas, fog, darkness), or if marine mammals are near, approaching, or within zone, the *Langseth* may not resume airgun operations.

iii. If one airgun is already running at a source level of at least 180 dB re: 1 μPa or 190 dB re: 1 μPa, the *Langseth* may start the second gun–and subsequent airguns–without observing relevant exclusion zones for 30 minutes, provided that the observers have not seen any marine mammals near the relevant exclusion zones (in accordance with Condition 6(b)).

Passive Acoustic Monitoring

e. Utilize the passive acoustic monitoring (PAM) system, to the maximum extent practicable, to detect and allow some localization of marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. One visual observer and/or bioacoustician will monitor the PAM at all times in shifts no longer than 6 hours. A bioacoustician shall design and set up the PAM system and be present to operate or oversee PAM, and available when technical issues occur during the survey.

f. Do and record the following when an observer detects an animal by the PAM:

i. Notify the visual observer immediately of a vocalizing marine mammal so a power-down or shut-down can be initiated, if required;

ii. enter the information regarding the vocalization into a database. The data to be entered include 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, water depth when first detected, bearing if determinable, species or species group (*e.g.,* unidentified dolphin, sperm whale, monk seal), types and nature of sounds heard (*e.g.,* clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

Ramp-Up Procedures

g. Implement a ''ramp-up'' procedure when starting the airguns at the beginning of seismic operations or any time after the entire array has been shutdown, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the observers will monitor the exclusion zone, and if marine mammals are sighted, a course/speed alteration, power-down, or shutdown will be implemented as though the full array were operational.

Recording Visual Detections

h. Visual observers must record the following information when they have sighted a marine mammal:

i. 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 including responses to ramp-up), and behavioral pace; and

ii. Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or shut-down), Beaufort sea state and wind force, visibility, and sun glare; and

iii. The data listed under 6(f)(ii) 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.

Speed or Course Alteration

i. Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant exclusion zone. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the exclusion zone, the Holder of this Authorization will implement further mitigation measures, such as a shutdown.

Power-Down Procedures

j. Power down the airguns if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zones. A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun. This would reduce the exclusion zone to the degree that the animal(s) is outside of it.

Resuming Airgun Operations After a Power-Down

k. Following a power-down, if the marine mammal approaches the smaller designated exclusion zone, the airguns must then be completely shut-down. Airgun activity will not resume until the observer has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

l. Following a power-down and subsequent animal departure, the *Langseth* may resume airgun operations at full power. Initiation requires that the observers can effectively monitor the full exclusion zones described in Condition 6(b). If the observer sees a marine mammal within or about to enter the relevant zones then the *Langseth* will implement a course/speed alteration, power-down, or shutdown.

Shutdown Procedures

m. Shutdown the airgun(s) if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zone. A shutdown means that the *Langseth* turns off all operating airguns.

Resuming Airgun Operations After a Shutdown

n. Following a shutdown, if the observer has visually confirmed that the animal has departed the 180-dB zone for cetaceans or the 190-dB zone for pinnipeds within a period of less than or equal to 8 minutes after the shutdown, then the *Langseth* may resume airgun operations at full power.

o. If the observer has not seen the animal depart the 180-dB zone for cetaceans or the 190-dB zone for pinnipeds, the *Langseth* shall not resume airgun activity until 15 minutes has passed for species with shorter dive times (*i.e.,* small odontocetes and pinnipeds) or 30 minutes has passed for species with longer dive durations (*i.e.,* mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales). The *Langseth* will follow the ramp-up procedures described in Conditions 6(g).

Survey Operations at Night

p. The *Langseth* may continue marine geophysical surveys into night and low-light hours if the Holder of the Authorization initiates these segment(s) of the survey when the observers can view and effectively monitor the full relevant exclusion zones.

q. This Authorization does not permit the Holder of this Authorization to initiate airgun array operations from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the visual observers cannot view and effectively monitor the full relevant exclusion zones.

Mitigation Airgun

s. The *Langseth* may operate a small-volume airgun (*i.e.,* mitigation airgun) during turns and maintenance at approximately one shot per minute. The *Langseth* would not operate the small-volume airgun for longer than three hours in duration during turns. During turns or brief transits between seismic tracklines, one airgun would continue to operate.

Special Procedures for Concentrations of Large Whales

t. The *Langseth* will power-down the array and avoid concentrations of large whales if possible (*i.e.,* avoid exposing concentrations of these animals to sounds greater than 160 dB re: 1 μPa). For purposes of the survey, a concentration or group of whales will consist of six or more individuals visually sighted that do not appear to be traveling (*e.g.,* feeding, socializing, etc.). The *Langseth* will follow the procedures described in Conditions 6(k) for resuming operations after a power down.

7. Reporting Requirements

This Authorization requires the Holder of this Authorization to:

a. Submit a draft report on all activities and monitoring results to the Office of Protected Resources, National Marine Fisheries Service, within 90 days of the completion of the *Langseth's* cruise. This report must contain and summarize the following information:

i. Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings.

ii. Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of shutdowns), observed throughout all monitoring activities.

iii. An estimate of the number (by species) of marine mammals with known exposures to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 μPa and/or 180 dB re 1 μPa for cetaceans and 190-dB re 1 μPa for pinnipeds and a discussion of any specific behaviors those individuals exhibited.

iv. An estimate of the number (by species) of marine mammals with estimated exposures (based on modeling results and accounting for animals at the surface but not detected [*i.e.,* g(0) values] and for animals present but underwater and not available for sighting [*i.e.,* f(0) values]) to the seismic activity at received levels greater than or equal to 160 dB re: 1 μPa and/or 180 dB re 1 μPa for cetaceans and 190-dB re 1 μPa for pinnipeds with a discussion of the nature of the probable consequences of that exposure on the individuals.

v. A description of the implementation and effectiveness of the: (A) Terms and conditions of the Biological Opinion's Incidental Take Statement (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report will confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on Endangered Species Act listed marine mammals.

b. Submit a final report to the Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, within 30 days after receiving comments from us on the draft report. If we decide that the draft report needs no comments, we will consider the draft report to be the final report.

8. Reporting Prohibited Take

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by the authorization (if issued), such as an injury, serious injury, or mortality (*e.g.,* ship-strike, gear interaction, and/or entanglement), Lamont-Doherty shall immediately cease the specified activities and immediately report the take to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email. The report must include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Lamont-Doherty shall not resume its activities until we are able to review the circumstances of the prohibited take. We shall work with Lamont-Doherty to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. Lamont-Doherty may not resume their activities until notified by us via letter, email, or telephone.

9. Reporting an Injured or Dead Marine Mammal With an Unknown Cause of Death

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.,* in less than a moderate state of decomposition as we describe in the next paragraph), Lamont-Doherty will immediately report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email. The report must include the same information identified in the paragraph above this section. Activities may continue while NMFS reviews the circumstances of the incident. NMFS would work with Lamont-Doherty to determine whether modifications in the activities are appropriate.

10. Reporting an Injured or Dead Marine Mammal Unrelated to the Activities

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the injury or death is not associated with or related to the authorized activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Lamont-Doherty would report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email, within 24 hours of the discovery. Lamont-Doherty would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

11. Endangered Species Act Biological Opinion and Incidental Take Statement

Lamont-Doherty is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to the Endangered Species Act Biological Opinion issued to the National Science Foundation and NMFS' Office of Protected Resources, Permits and Conservation Division. A copy of this Authorization and the Incidental Take Statement must be in the possession of all contractors and protected species observers operating under the authority of this Incidental Harassment Authorization.

Request for Public Comments

NMFS invites comments on our analysis, the draft authorization, and any other aspect of the Notice of proposed Authorization for Lamont-Doherty's activities. Please include any supporting data or literature citations with your comments to help inform our final decision on Lamont-Doherty's request for an application.

Dated: April 12, 2016.

Donna Wieting,

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

[FR Doc. 2016–09008 Filed 4–18–16; 8:45 am]

BILLING CODE 3510–22–P