DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XD394

Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014

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

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

SUMMARY: NMFS has received an application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation (Foundation), for an Incidental Harassment Authorization (Authorization) to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the northwest Atlantic Ocean off the North Carolina coast from September through October, 2014. The proposed dates for this action would be September 15, 2014 through October 31, 2014, to account for minor deviations due to logistics and weather. In accordance with the Marine Mammal Protection Act, we are requesting comments on our proposal to issue an Authorization to Lamont-Doherty to incidentally take, by Level B harassment only, 24 species of marine mammals during the specified activity.

DATES: NMFS must receive comments and information on or before September 2, 2014.

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.Cody@noaa.gov.* Please include 0648–XD394 in the subject line. Comments sent via email to *ITP.Cody@noaa.gov,* 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 a part of the public record and NMFS will post them to *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications* without change. All Personal Identifying Information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

To obtain an electronic copy of the application containing a list of the references used in this document, visit the internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.*

The Foundation has prepared a draft Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA) and the regulations published by the Council on Environmental Quality. The EA titled ‘‘Draft Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off Cape Hatteras, September–October 2014,’’ prepared by LGL, Ltd. environmental research associates, on behalf of the Foundation and Lamont-Doherty is available at the same internet address. Information in the Lamont-Doherty's application, the Foundation's EA, and this notice collectively provide the environmental information related to proposed issuance of the Authorization for public review and comment.

FOR FURTHER INFORMATION CONTACT: Jeannine Cody, 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.

Through the authority delegated by the Secretary, NMFS (hereinafter, we) shall grant an Authorization for the incidental taking of small numbers of marine mammals if we find 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 prescribe, where applicable, the permissible methods of taking by harassment pursuant to the activity; other means of effecting the least practicable adverse impact on the species or stock and its habitat, and on the availability of such species or stock for taking for subsistence uses (where applicable); the measures that we determine are necessary to ensure no unmitigable adverse impact on the availability for the species or stock for taking for subsistence purposes (where applicable); and requirements pertaining to the mitigation, monitoring and reporting of such taking. We have 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 February 26, 2014, we received an application from Lamont-Doherty requesting that we issue an Authorization for the take of marine mammals, incidental to conducting a seismic survey offshore Cape Hatteras, NC September through October, 2014. NMFS determined the application complete and adequate on July 15, 2014.

Lamont-Doherty proposes to conduct a high-energy, 2-dimensional (2–D) seismic survey on the R/V *Langseth* in the Atlantic Ocean approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, NC for approximately 38 days from September 15 to October 22, 2014. The following specific aspect of the proposed activity has the potential to take marine mammals: increased underwater sound generated during the operation of the seismic airgun arrays. Thus, we anticipate that take, by Level B harassment only, of 24 species of marine mammals could result from the specified activity.

Description of the Specified Activity

Overview

Lamont-Doherty plans to use one source vessel, the R/V Marcus *G.* Langseth (*Langseth*), seismic airgun arrays configured with 18 or 36 airguns as the energy source, one hydrophone streamer, and 90 ocean bottom seismometers (seismometers) to conduct the conventional seismic survey. In addition to the operations of the airguns, Lamont-Doherty proposes to operate a multibeam echosounder, a sub-bottom profiler, and acoustic Doppler current profiler on the *Langseth* continuously throughout the proposed survey.

The purpose of the survey is to collect and analyze data on the mid-Atlantic coast of the East North America Margin (ENAM). The study would cover a portion of the rifted margin of the eastern U.S. and the results would allow scientists to investigate how the continental crust stretched and separated during the opening of the Atlantic Ocean and magnetism's role during the continental breakup. The proposed seismic survey is purely scientific in nature and not related to oil and natural gas exploration on the outer continental shelf of the Atlantic Ocean.

Dates and Duration

Lamont-Doherty proposes to conduct the seismic survey from the period of September 15 through October 22, 2014. The proposed study (e.g., equipment testing, startup, line changes, repeat coverage of any areas, and equipment recovery) would include approximately 792 hours of airgun operations (i.e., a 24-hour operation over 33 days). Some minor deviation from Lamont-Doherty's requested dates of September 15 through October 22, 2014, is possible, depending on logistics, weather conditions, and the need to repeat some lines if data quality is substandard. Thus, the proposed Authorization, if issued, would be effective from September 15, 2014 through October 31, 2014. Lamont-Doherty will not conduct the survey after October 31, 2014 to avoid exposing North Atlantic right whales (*Eubalaena glacialis*) to sound at the beginning of their migration season.

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

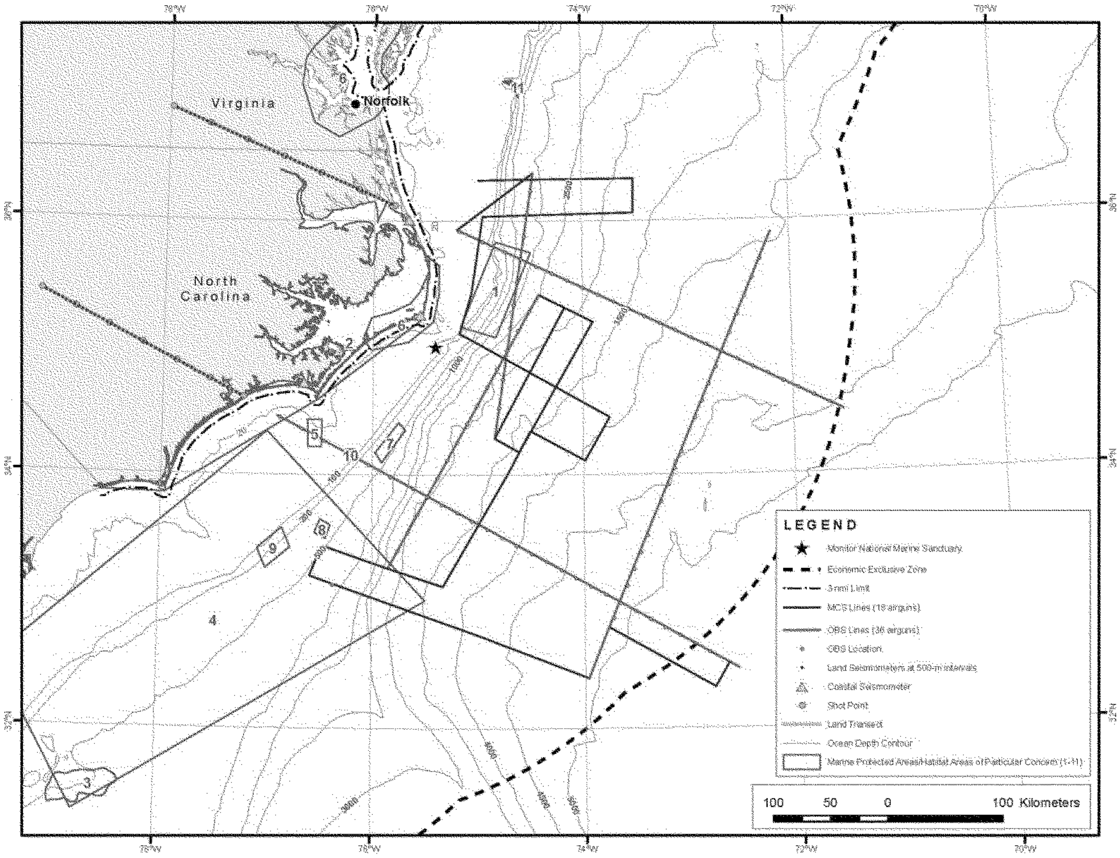
Specified Geographic Region

Lamont-Doherty proposes to conduct the seismic survey in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, NC between approximately 32—37° N and approximately 71.5—77° W (see Figure 1 in this notice). Water depths in the survey area are approximately 20 to 5,300 m (66 feet (ft) to 3.3 mi). They would conduct the proposed survey outside of North Carolina state waters, within the U.S. Exclusive Economic Zone, and partly in international waters.

Principal Investigators

The proposed study's principal investigators are: Drs. H. Van Avendonk and G. Christeson (University of Texas at Austin). B. Magnani (University of Memphis), D. Shillington, A. Bécel, and J. Gaherty (Lamont-Doherty), M. Hornbach (Southern Methodist University), B. Dugan (Rice University), M. Long (Yale University), M. Benoit (The College of New Jersey), and S. Harder (University of Texas at El Paso).

Figure 1 - Proposed location of the seismic survey in the Atlantic Ocean offshore Cape Hatteras, NC during September through October, 2014[1].



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[1] This figure represents modifications to the tracklines as proposed by Lamont-Doherty in Figure 1of their application. Modifications based on recommendations from NMFS to reduce the total ensonified area to effect the least practicable adverse impact.

Detailed Description of Activities

Transit Activities

The *Langseth* would depart from Norfolk, VA on September 15, 2014, and transit for approximately one day to the proposed survey area. Setup, deployment, and streamer ballasting would occur over approximately three days and seismic acquisition would take approximately 33 days. At the conclusion of the proposed survey, the *Langseth* would take approximately one day to retrieve gear. At the conclusion of the proposed survey activities, the *Langseth* would return to Norfolk, VA on October 22, 2014.

Vessel Specifications

The survey would involve one source vessel, the R/V *Langseth,* and two support vessels. The *Langseth,* owned by the Foundation 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 which drive two propellers. Each propeller has four blades and the shaft typically rotates at 750 revolutions per minute (rpm). The vessel also has an 800-hp bowthruster, which is not active 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 and the hydrophone streamer, its turning rate is limited to five degrees per minute, limiting its maneuverability during operations while it tows the hydrophone streamer.

The *Langseth* also has an observation tower from which protected species visual observers (observer) will 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.

The University of Rhode Island's Graduate School of Oceanography operates the first support vessel, the R/V Endeavor (*Endeavor*) which has a length of 56.4 m (184 ft), a beam of 10.1 m (33 ft), and a maximum draft of 5.6 m (18.3 ft). The *Endeavor* has one diesel engine that produces 3050 hp and drives the single propeller directly at a maximum of 900 rpm. The *Endeavor* can cruise at approximately 10 kt (18.5 km/hr; 11.5 mph).

The second support vessel would be a multi-purpose offshore utility vessel similar to the *Northstar Commander,* which is 28 m (91.9 ft) long with a beam of 8 m (26.2 ft) and a draft of 2.6 m (8.5 ft). The chase vessel has twin 450-hp screws (Volvo D125–E).

Data Acquisition Activities

The proposed survey would cover approximately 5,185 km (3,221 mi) of transect lines (approximately 3,425 km for the multi-channel seismic and approximately 1,760 km for the seismometer acquisition operations) within the survey area. This represents a 1,165 km reduction in transect lines from Lamont-Doherty's original proposal that totaled 6,350 km (3,946 mi) of transect lines within the survey area.

During the survey, the *Langseth* crew would deploy a four-string array consisting of 36 airguns with a total discharge volume of approximately 6,600 cubic inches (in^3), or a two-string array consisting of 18 airguns with a total discharge volume of 3,300 in^3 as an energy source. The *Langseth* would tow the four-string array at a depth of approximately 9 m (30 ft) and would tow the two-string array at a depth of 6 m (20 ft). The shot interval during seismometer acquisition would be approximately 65 seconds every 150 m (492 ft) and 22 seconds every 50 m (164 ft) during multi-channel acquisition operations. During acquisition, the airguns will emit a brief (approximately 0.1 second) pulse of sound and during the intervening periods of operations, the airguns are silent. The receiving system would consist of one 8-km (5-mi) hydrophone streamer which would receive the returning acoustic signals and transfer the data to the on-board processing system. In addition to the hydrophone, the study would also use approximately 90 seismometers placed on the seafloor to record the returning acoustic signals from the airgun array internally for later analysis.

Seismic Airguns

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).

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. However, the airgun array also emits sounds that travel horizontally toward non-target areas.

The nominal source levels of the airgun array on the *Langseth* range from 246 to 253 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)). The effective source levels for horizontal propagation are lower than source levels for downward propagation and the relative sound intensities given in dB in water are not the same as relative sound intensities given in dB in air. We refer the reader to the Foundation's 2014 EA for this project and their 2011 Programmatic Environmental Impact Statement (PEIS) for a detailed description of the airguns and airgun configurations proposed for use in this study.

Ocean Bottom Seismometers

Lamont-Doherty proposes to place 90 seismometers on the sea floor prior to the initiation of the seismic survey. Each seismometer is approximately 0.9 m (2.9 ft) high with a maximum diameter of 97 centimeters (cm) (3.1 ft). An anchor, made of a rolled steel bar grate which measures approximately 7 by 91 by 91.5 cm (3 by 36 by 36 inches) and weighs 45 kilograms (99 pounds) would anchor the seismometer to the seafloor. We refer the reader to section 2.1.3.2 in the Foundation's 2011 PEIS for a detailed description of this passive acoustic recording system.

The *Endeavor* crew would deploy and retrieve 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 mammals.

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. 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. 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.

Acoustic Doppler Current Profiler: Lamont-Doherty would measure currents using a Teledyne OS75 75-kilohertz (kHz) Acoustic Doppler current profiler (ADCP). The ADCP's configuration consists of a 4-beam phased array with a beam angle of 30°. The source level is proprietary information but has a maximum acoustic source level of 224 dB.

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' status under the MMPA and the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.); abundance; occurrence and seasonality in the activity area.

Lamont-Doherty presented species information in Table 2 of their application but excluded information on harbor seals and four other cetacean species because they anticipated that these species would have a more northerly distribution during the summer and thus would have a low likelihood of occurring in the survey area. The excluded cetacean species include: Bryde's whale (*Balaenoptera edeni*), northern bottlenose whale (*Hyperoodon ampullatus*), Sowerby's beaked whale (*Mesoplodon bidens*), and the white-beaked dolphin (*Lagenorhynchus albirostris*).

Based on the best available information (DoN, 2012), we expect that Bryde's whale may have the potential to occur within the survey area and have included additional information for this species in Table 1 of this notice. However, we agree with Lamont-Doherty that the other species identified earlier have a low likelihood of occurrence in the action area during September and October.

TABLE 1—GENERAL INFORMATION ON MARINE MAMMALS THAT COULD POTENTIALLY OCCUR IN THE PROPOSED ACTIVITY AREA IN SEPTEMBER THROUGH OCTOBER, 2014

Species	Stock name	Regulatory status [1] [2]	Stock/Species Abundance [3]	Range	Occurrence in summer/fall
North Atlantic right whale (*Eubalaena glacialis*).	Western Atlantic	MMPA–D, ESA–EN	455	Coastal/shelf	Uncommon.
Humpback whale (*Megaptera novaeangliae*).	Gulf of Maine	MMPA–D, ESA–EN	823	Pelagic	Uncommon.
Minke whale (*Balaenoptera acutorostrata*).	Canadian East Coast	MMPA–D, ESA–NL	20,741	Coastal/shelf	Uncommon.
Sei whale (*Balaenoptera borealis*).	Nova Scotia	MMPA–D, ESA–EN	357	Offshore	Rare.
Fin whale (*Balaenoptera physalus*).	Western North Atlantic	MMPA–D, ESA–EN	3,522	Pelagic	Rare.
Blue whale (*Balaenoptera musculus).*	Western North Atlantic	MMPA–D, ESA–EN	[4] 440	Coastal/pelagic	Rare.
Bryde's whale (*Balaenoptera edeni*).	NA	MMPA–D, ESA–NL	[5] 11,523	Shelf/pelagic	Uncommon.
Sperm whale (*Physeter macrocephalus*).	Nova Scotia	MMPA–D, ESA–EN	2,288	Pelagic	Common.
Dwarf sperm whale (*Kogia sima*).	Western North Atlantic	MMPA–NC, ESA–NL	3,785	Off Shelf	Uncommon.
Pygmy sperm whale (*K. breviceps*).	Western North Atlantic	MMPA–NC, ESA–NL	3,785	Off Shelf	Uncommon.
Blainville's beaked whale (*Mesoplodon densirostris*).	Western North Atlantic	MMPA–NC, ESA–NL	7,092	Pelagic	Rare.
Cuvier's beaked whale (*Ziphius cavirostris*).	Western North Atlantic	MMPA–NC, ESA–NL	7,092	Pelagic	Uncommon.
Gervais' beaked whale (*M. europaeus*).	Western North Atlantic	MMPA–NC, ESA–NL	7,092	Pelagic	Rare.
True's beaked whale (*M. mirus*).	Western North Atlantic	MMPA–NC, ESA–NL	7,092	Pelagic	Rare.
Rough-toothed dolphin (*Steno bredanensis*).	Western North Atlantic	MMPA–NC, ESA–NL	271	Pelagic	Uncommon.
Bottlenose dolphin (*Tursiops truncatus*).	Western North Atlantic Offshore.	MMPA–NC, ESA–NL	77,532	Pelagic	Common.
	Western North Atlantic Southern Migratory Coastal.	MMPA–D, S, ESA–NL	9,173	Coastal	Common.
	WNA Southern NC Estuarine System.	MMPA–D, S, ESA–NL	188	Coastal	Common.
	WNA Northern NC Estuarine System.	MMPA–D, S, ESA–NL	950	Coastal	Common.
Pantropical spotted dolphin (*Stenella attenuata*).	Western North Atlantic	MMPA–NC, ESA–NL	3,333	Pelagic	Common.
Atlantic spotted dolphin (*S. frontalis*).	Western North Atlantic	MMPA–NC, ESA–NL	44,715	Shelf/slope pelagic	Common.
Spinner dolphin (*S. longirostris*).	Western North Atlantic	MMPA–NC, ESA–NL	[6] 11,441	Coastal/pelagic	Rare.
Striped dolphin (*S. coeruleoalba*).	Western North Atlantic	MMPA–NC, ESA–NL	54,807	Off shelf	Common.
Clymene dolphin (*S. clymene*).	Western North Atlantic	MMPA–NC, ESA–NL	[7] 6,086	Slope	Uncommon.
Short-beaked common dolphin (*Delphinus delphis*).	Western North Atlantic	MMPA–NC, ESA–NL	173,486	Shelf/pelagic	Common.
Atlantic white-sided-dolphin (*L. acutus*).	Western North Atlantic	MMPA–NC, ESA–NL	48,819	Shelf/slope	Rare.
Fraser's dolphin (*Lagenodelphis hosei*).	Western North Atlantic	MMPA–NC, ESA–NL	[8] 726	Pelagic	Rare.
Risso's dolphin (*Grampus griseus*).	Western North Atlantic	MMPA–NC, ESA–NL	18,250	Shelf/slope	Common.

TABLE 1—GENERAL INFORMATION ON MARINE MAMMALS THAT COULD POTENTIALLY OCCUR IN THE PROPOSED ACTIVITY AREA IN SEPTEMBER THROUGH OCTOBER, 2014—Continued

Species	Stock name	Regulatory status [1] [2]	Stock/Species Abundance [3]	Range	Occurrence in summer/fall
Melon-headed whale (*Peponocephala electra*).	Western North Atlantic	MMPA–NC, ESA–NL	[9] 2,283	Pelagic	Rare.
False killer whale (Pseudorca crassidens).	Northern Gulf of Mexico	MMPA–NC, ESA–NL	[10] 177	Pelagic	Rare.
Pygmy killer whale (*Feresa attenuate*).	Western North Atlantic	MMPA–NC, ESA–NL	[11] 1,108	Pelagic	Rare.
Killer whale (*Orcinus orca*)	Western North Atlantic	MMPA–NC, ESA–NL	[12] 28	Coastal	Rare.
Long-finned pilot whale (*Globicephala melas*).	Western North Atlantic	MMPA–NC, ESA–NL	26,535	Pelagic	Common.
Short-finned pilot whale (*G. macrorhynchus*).	Western North Atlantic	MMPA–NC, ESA–NL	21,515	Pelagic	Common.
Harbor porpoise (*Phocoena phocoena*).	Gulf of Maine/Bay of Fundy.	MMPA–NC, ESA–NL	79,883	Coastal	Rare.

[1] MMPA: D = Depleted, S = Strategic, NC = Not Classified.

[2] ESA: EN = Endangered, T = Threatened, DL = Delisted, NL = Not listed.

[3] 2013 NMFS Stock Assessment Report (Waring *et al.,* 2014) unless otherwise noted. NA = Not Available.

[4] Minimum population estimate based on photo identification studies in the Gulf of St. Lawrence (Waring *et al.,* 2010).

[5] There is no stock designation for this species in the Atlantic. Abundance estimate derived from the ETP stock = 11,163 (Wade and Gerodette, 1993); Hawaii stock = 327 (Barlow, 2006); and Northern Gulf of Mexico stock = 33 (Waring *et al.,* 2012).

[6] There is no abundance information for this species in the Atlantic. Abundance estimate derived from the Northern Gulf of Mexico Stock = 11,441 (Waring *et al.,* 2012).

[7] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 6,086 (CV=0.93) (Mullin and Fulling, 2003).

[8] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 726 (CV=0.70) for the Gulf of Mexico stock (Mullin and Fulling, 2004).

[9] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 2,283 (CV=0.76) for the Gulf of Mexico stock (Mullin, 2007).

[10] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 177 (CV=0.56) for the Gulf of Mexico stock (Mullin, 2007).

[11] There is no abundance information for this species in the Atlantic. Abundance estimate derived from the Northern Gulf of Mexico stock = 152 (Mullin, 2007) and the Hawaii stock = 956 (Barlow, 2006).

[12] There is no abundance information for this species in the Atlantic. Abundance estimate derived from the Northern Gulf of Mexico stock = 28 (Waring *et al.,* 2012).

NMFS refers the public to Lamont-Doherty's application, the Foundation's EA (see **ADDRESSES**), and the 2013 NMFS Marine Mammal Stock Assessment Report available online at: *http://www.nmfs.noaa.gov/pr/sars/pdf/ao2013_draft.pdf* 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 the types of stressors associated with the specified activity (e.g., seismic airgun operations, vessel movement) impact marine mammals (via observations or scientific studies). This section may include a discussion of known effects that do not rise to the level of an MMPA take (for example, with acoustics, we may include a discussion of studies of animals exhibiting no reaction to sound or exhibiting barely perceptible avoidance behaviors). This discussion may also include reactions that we consider to rise to the level of a take.

We intend 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. The ''Estimated Take by Incidental Harassment'' section later in this document will include a quantitative analysis of the number of individuals that we expect Lamont-Doherty to take during this activity. The ''Negligible Impact Analysis'' section will include the analysis of how this specific activity would impact marine mammals. We will consider the content of the following sections: (1) Estimated Take by Incidental Harassment; (3) Proposed Mitigation; and (4) Anticipated Effects on Marine Mammal Habitat, to draw conclusions regarding the likely impacts of this activity on the reproductive success or survivorship of individuals—and from that consideration—the likely impacts of this activity on the affected marine mammal populations or stocks.

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 30 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.

As mentioned previously in this document, 24 marine mammal species (7 mysticetes and 17 odontocetes) would likely occur in the proposed action area. Table 2 presents the classification of these species into their respective functional hearing group. We consider a species' functional hearing group when we analyze the effects of exposure to sound on marine mammals.

TABLE 2—CLASSIFICATION OF MARINE MAMMALS THAT COULD POTENTIALLY OCCUR IN THE PROPOSED ACTIVITY AREA IN SEPTEMBER THROUGH OCTOBER, 2014 BY FUNCTIONAL HEARING GROUP (SOUTHALL *et. al.,* 2007)

Low frequency hearing range	North Atlantic right, humpback, Bryde's, minke, sei, fin, and blue whale.
Mid-frequency hearing range	Sperm whale, Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, True's beaked whale, false killer whale, pygmy killer whale, killer whale, rough-toothed dolphin, bottlenose dolphin, pantropical spotted dolphin, Atlantic spotted dolphin, striped dolphin, Clymene dolphin, short-beaked common dolphin, Risso's dolphin, long-finned pilot whale, short-finned pilot whale.
High frequency hearing range	Harbor porpoise

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 for Dall's porpoises).

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/hour) for humpback and sperm whales according to the airgun array's operational status (i.e., active versus silent).

Masking

The term masking refers to the inability of a subject to recognize the occurrence of an acoustic stimulus as a result of the interference of another acoustic stimulus (Clark *et al.,* 2009). Masking, or auditory interference, generally occurs when sounds in the environment are louder than, and of a similar frequency as, auditory signals an animal is trying to receive. Masking 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.

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). Introduced underwater sound may, through masking, 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).

We expect that the masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds will be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic airgun pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in some situations, reverberation occurs for much or the entire interval between pulses (e.g., Simard *et al.,* 2005; Clark and Gagnon, 2006) which could mask calls. Some baleen and toothed whales continue calling in the presence of seismic pulses, and that 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). However, 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, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles *et al.,* 1994). However, more recent studies have found that they 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). Several studies have 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 odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking.

Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior through shifting call frequencies, increasing call volume, and increasing vocalization rates. For example in one study, blue whales increased call rates when exposed to noise from seismic surveys in the St. Lawrence Estuary (Di Iorio and Clark, 2010). The North Atlantic right whales exposed to high shipping noise increased call frequency (Parks *et al.,* 2007), while some humpback whales respond 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). 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. Structured signals, such as the echolocation click sequences of small toothed whales, may be readily detected 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. Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. 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). These behavioral reactions are often shown as: 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 the water from haul-outs or rookeries). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder, 2007; Weilgart, 2007).

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. Some of these significant behavioral modifications include:

- Change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);
- Habitat abandonment due to loss of desirable acoustic environment; and
- Cessation of feeding or social interaction.

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). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of industrial sound. In most cases, this approach likely overestimates the numbers of marine mammals that could potentially be affected in some biologically-important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically-important degree by a seismic program are based primarily on behavioral observations of a few species. Scientists have conducted detailed studies on humpback, gray, bowhead (*Balaena mysticetus*), and sperm whales. There are less detailed data available for some other species of baleen whales and small toothed whales, but for many species there are no data on responses to marine seismic surveys.

Baleen Whales—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable (reviewed in Richardson *et al.,* 1995). Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away from the area. In the cases of migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals (Richardson *et al.,* 1995). They avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Studies of gray, bowhead, and humpback whales have shown that seismic pulses with received levels of 160 to 170 dB re: 1 µPa seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed (Malme *et al.,* 1986, 1988; Richardson *et al.,* 1995). In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from four to 15 km (2.5 to 9.3 mi) from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other strong behavioral reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and studies summarized in the Foundation's EA have shown that some species of baleen whales, notably bowhead and humpback whales, at times show strong avoidance at received levels lower than 160–170 dB re: 1 µPa.

Researchers have studied the responses of humpback whales to seismic surveys during migration, feeding during the summer months, breeding while offshore from Angola, and wintering offshore from Brazil. McCauley *et al.* (1998, 2000a) 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 (p-p). 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.* 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).

A few studies have documented reactions of migrating and feeding (but not wintering) gray whales 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).

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 sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting vs. 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). 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.

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). Baleen whales as a group were also seen significantly farther from the vessel during seismic compared with non-seismic periods, and they were more often seen to be swimming away from the operating seismic vessel (Moulton and Holst, 2010). Blue and minke whales were initially sighted significantly farther from the vessel during seismic operations compared to non-seismic periods; the same trend was observed for fin whales (Moulton and Holst, 2010). Minke whales were most often observed to be swimming away from the vessel when seismic operations were underway (Moulton and Holst, 2010).

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, 2013). The western Pacific gray whale (*Eschrichtius robustus*) population did not appear affected by a seismic survey in its feeding ground during a previous year (Johnson *et al.,* 2007). 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, 2013). 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.

Toothed Whales—There is little systematic information available about reactions of toothed whales to noise pulses. There are few studies on toothed whales similar to the more extensive baleen whale/seismic pulse work summarized earlier in this notice. However, there are recent systematic studies on sperm whales (e.g., Gordon *et al.,* 2006; Madsen *et al.,* 2006; Winsor and Mate, 2006; Jochens *et al.,* 2008; Miller *et al.,* 2009). 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).

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, small toothed whales more often tend to head away, or to maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (e.g., 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 and beluga whales (*Delphinapterus leucas)* 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 before exhibiting aversive behaviors.

Results for porpoises depend on species. The limited available data suggest that harbor porpoises show stronger avoidance of seismic operations than do Dall's porpoises (Stone, 2003; MacLean and Koski, 2005; Bain and Williams, 2006; Stone and Tasker, 2006). Dall's porpoises seem relatively tolerant of airgun operations (MacLean and Koski, 2005; Bain and Williams, 2006), although they too have been observed to avoid large arrays of operating airguns (Calambokidis and Osmek, 1998; Bain and Williams, 2006). This apparent difference in responsiveness of these two porpoise species is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson *et al.,* 1995; Southall *et al.,* 2007).

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 that foraging behavior was altered upon exposure to airgun sound (Jochens *et al.,* 2008; Miller *et al.,* 2009; Tyack, 2009).

There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. However, some northern bottlenose whales remained in the general area and continued 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). 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 that foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels. In any event, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel, although this has not been documented explicitly. In fact, Moulton and Holst (2010) reported 15 sightings of beaked whales during seismic studies in the northwest Atlantic; seven of those sightings were made at times when at least one airgun was operating. There was little evidence to indicate that beaked whale behavior was affected by airgun operations; sighting rates and distances were similar during seismic and non-seismic periods (Moulton and Holst, 2010).

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 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 hundreds of meters, and many seals remained within 100–200 m (328–656 ft) of the trackline as the operating airgun array passed by. 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).

Researchers have studied temporary threshold shift in certain captive odontocetes and pinnipeds exposed to strong sounds (reviewed in Southall *et al.,* 2007). However, there has been no specific documentation of temporary threshold shift let alone permanent hearing damage, (i.e., permanent threshold shift, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions).

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). Although in the case of the seismic survey, animals are not expected to be exposed to levels high enough or durations long enough to result in PTS.

PTS is considered 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 nonhuman animals. 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).

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 we 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. Marine mammals generally avoid the immediate area around operating seismic vessels.

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 homeostasis. 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 classical ''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 hypothalmus-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 are quickly replenished once the stress is alleviated. 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, energy resources must be diverted 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 which is 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, we assume 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), we also assume 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 are especially 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).

Potential Effects of Other Acoustic Devices

Multibeam Echosounder

Lamont-Doherty would operate the Kongsberg EM 122 multibeam echosounder from the source vessel during the planned study. 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 deep) or four (less than 1,000 m 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.

We have 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 lead to the eventual entrapment and mortality of the whales within the Loza Lagoon system (e.g., the survey vessel transiting in a north-south direction on the shelf break parallel to the shore may have trapped the animals between the sound source and the shore driving them towards the Loza Lagoon). They concluded that for odontocete cetaceans that hear well in the 10–50 kHz range, where ambient noise is typically quite low, high-power active sonars operating in this range may be more easily audible and have potential effects over larger areas than low frequency systems that have more typically been considered in terms of anthropogenic noise impacts (Southall, *et al.,* 2013). However, the risk may be very low given the extensive use of these systems worldwide on a daily basis and the lack of direct evidence of such responses previously 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 silencing and dispersal by sperm whales (Watkins *et al.,* 1985), 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 (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 that have been associated with the operation of naval sonar, there is concern that mid-frequency sonar sounds can cause serious impacts to marine mammals (see above). However, the echosounder proposed for use by the *Langseth* is quite different than sonar used for navy 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.

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 in order to 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.

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.''

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 an animal just below the surface could be cut by a vessel's propeller. 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).

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 large size for the array carries the risk of entanglement for marine mammals. Wildlife, especially slow moving individuals, such as large whales, have a low probability of entanglement due to slow speed of the survey vessel and onboard monitoring efforts. Lamont-Doherty has no recorded cases of entanglement of marine mammals during their conduct of over 10 years of seismic surveys (NSF, 2011).

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 the Seafloor

The seismometers would occupy approximately 450 square meters (4,843.7 square miles) of seafloor habitat and may disturb benthic invertebrates. However, due to the natural sinking of the anchors from their own weight into the seafloor and natural sedimentation processes, these impacts would be localized and short-term. We do not expect any long-term habitat impacts.

Anticipated Effects on Fish

We consider 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 that by exposure to seismic survey sounds. Peer-reviewed scientific literature has presented few data on this subject. We are 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 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 in the former case and less than 2 m 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 second 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, some equivocally, 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. They concluded that mortality rates caused by exposure to seismic surveys are so low, as compared to natural mortality rates, that the impact of seismic surveying on recruitment to a fish stock must be regarded as insignificant.

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 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). We 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 the 2011 PEIS (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 & 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, we do 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 take authorization under section 101(a)(5)(D) of the MMPA, we 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 Foundation and Observatory-funded seismic research cruises as approved by us and detailed in the Foundation's 2011 PEIS and 2014 EA;

(2) Previous incidental harassment authorizations applications and authorizations that we have 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.

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

(1) Expanded shutdown procedures for North Atlantic right whales;
(2) Expanded exclusion zones in shallow water based on lower thresholds;
(3) Requirements on the directionality of the survey's tracklines.

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. Protected species 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 180-dB exclusion zone (with buffer).

During seismic operations, at least four protected species observers would be aboard the *Langseth.* Lamont-Doherty would appoint the observers with our 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 × 50

Fujinon), Big-eye binoculars (25 × 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.

When the observers see marine mammals within or about to enter the designated exclusion zone, the *Langseth* would immediately power down or shutdown the airguns. 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 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 they predicted the received sound levels (180 dB with buffer, 180 dB, and 160 dB) from the airgun arrays and a single airgun.

Table 3—Modeled Distances to Which Sound Levels Greater Than or Equal to 160 and 177 dB re: 1 μPa Could Be Received During the Proposed Survey in the Atlantic Ocean, September Through October, 2014.

Source and volume (in^3)	Tow depth (m)	Water depth (m)	Predicted RMS distances[1] (m)		
			180 dB with buffer	180 dB	160 dB
Single bolt airgun (40 in^3)	6 or 9	< 100	121	86	938
		100–1,000	100	100	582
		> 1,000	100	100	388
18-Airgun array (3,300 in^3)	6	< 100	1,630[2]	1,097[2]	15,280[2]
		100–1,000	675[3]	675[3]	5,640[3]
		> 1,000	450	450	3,760
36-Airgun array (6,600 in^3)	9	< 100	2,880[4]	2,060[4]	22,600[4]
		100–1,000	1,391	1,391	8,670
		> 1,000	927	927	5,780

[1] Predicted distances based on Table 1 of the Foundation's application. The Foundation calculated the 180-dB zone with 3-dB buffer based on our proposed recommendation to expand the 180-dB exclusion zones in shallow water.
[2] Predicted distances based on empirically-derived measurements in the Gulf of Mexico for an 18-airgun array.
[3] Intermediate Depth: Predicted distances based on model results with a correction factor (1.5) between deep and intermediate water depths.
[4] Predicted distances based on empirically-derived measurements in the Gulf of Mexico with scaling factor applied to account for differences in tow depth.

The 180-dB level shutdown criteria are applicable to cetaceans as specified by NMFS (2000). Lamont-Doherty used these levels to establish their original exclusion zones. For this survey, we will require Lamont-Doherty to enlarge the radius of 180-dB exclusion zones for each airgun array configuration in shallow water by a factor of 3-dB, which results in an exclusion zone that is 25 percent larger.

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).

Power Down Procedures—A power down involves decreasing the number of airguns in use such that the radius of the 180-dB exclusion zone (with buffer) 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 exclusion zone (with buffer) 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 exclusion zone (with buffer) (see Table 3). 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).

We estimate that the *Langseth* would transit outside the original 180-dB exclusion zone after an 8-minute wait period. This period is based on the 180-dB exclusion zone for the airgun subarray towed at a depth of 12 m (39.4

ft) in relation to 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.

Considering the conservation status for north Atlantic right whales, the *Langseth* crew would shut down the airgun(s) immediately in the unlikely event that observers detect this species, regardless of the distance from the vessel. The *Langseth* would only begin ramp-up would only if observers have not seen the north Atlantic right whale for 30 minutes.

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 stepwise 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, the Observatory 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 shutdown 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 a marine mammal is sighted within or near the applicable exclusion zones.

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 onto the transect. 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.

Directionality of Survey Tracklines

In order to avoid the potential entrapment of marine mammals within inshore areas, we proposed to require Lamont-Doherty to plan to conduct the seismic surveys (especially when near land) from the coast (inshore) and proceed towards the sea (offshore).

Mitigation Conclusions

We have 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 us 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 considered by us, we have 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 ITA 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. We 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 us 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., we need 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., we need 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 sponsor marine mammal monitoring during the present project to supplement the mitigation measures that require real-time monitoring, and to satisfy the monitoring requirements of the Authorization. Lamont-Doherty understands that we would review the monitoring plan and may require refinements to the plan.

Lamont-Doherty planned the monitoring work as a self-contained project independent of any other related monitoring projects that may occur in the same regions at the same time. Further, Lamont-Doherty is prepared to discuss coordination of its monitoring program with any other related work that might be conducted by other groups working insofar as it is practical for them.

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 acoustical 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 acoustic 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, which is 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 four visual observers. 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 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.

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.

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 the Foundation within 90 days after the end of the cruise. The report would describe the operations conducted and sightings of marine mammals and turtles 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 could result in "takes" of marine mammals by harassment or in other ways.

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), the Observatory shall immediately cease the specified activities and immediately report the take to the Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *ITP.Cody@noaa.gov* and the Southeast Regional Stranding Coordinator at (305) 361–4586. 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 Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *ITP.Cody@noaa.gov* and the Southeast Regional Stranding Coordinator at (305) 361–4586. The report must include the same information identified in the paragraph above this section. Activities may continue while we review the circumstances of the incident. We 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 Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *ITP.Cody@noaa.gov* and the Southeast Regional Stranding Coordinator at (305) 361–4586, within 24 hours of the discovery. Activities may continue while NMFS reviews the circumstances of the incident. Lamont-Doherty would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to us.

Estimated Take by Incidental Harassment

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].

Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the airgun sub-arrays may have the potential to result in the behavioral disturbance of some marine mammals. Thus, we propose to authorize take by Level B 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.

TABLE 2—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).

Our practice has been to apply the 160 dB re: 1 μPa received level threshold for underwater impulse sound levels to determine whether take by Level B harassment occurs. Southall *et al.* (2007) provides a severity scale for ranking observed behavioral responses of both free-ranging marine mammals and laboratory subjects to various types of anthropogenic sound (see Table 4 in Southall *et al.* [2007]). The 180-dB level shutdown criteria are applicable to cetaceans as specified by NMFS (2000). Lamont-Doherty used these levels to establish their original exclusion zones. For this survey, we will require Lamont-Doherty to enlarge the radius of 180-dB exclusion zones for each airgun array configuration in shallow water by a factor of 3-dB, which results in an exclusion zone that is 25 percent larger.

The probability of vessel and marine mammal interactions (i.e., ship strike) occurring during the proposed survey is unlikely due to the *Langseth's* slow operational speed, which is typically 4.6 kts (8.5 km/h; 5.3 mph). Outside of seismic operations, the Langseth's cruising speed would be approximately 11.5 mph (18.5 km/h; 10 kts) which is generally below the speed at which studies have noted reported increases of marine mammal injury or death (Laist et al., 2001). In addition, the *Langseth* has a number of other advantages for avoiding ship strikes as compared to most commercial merchant vessels, including the following: The *Langseth's* bridge offers good visibility to visually monitor for marine mammal presence; observers posted during operations scan the ocean for marine mammals and must report visual alerts of marine mammal presence to crew; and the observers receive extensive training that covers the fundamentals of visual observing for marine mammals and information about marine mammals and their identification at sea. Thus, we do not anticipate that take, by vessel strike, would result from the movement of the vessel.

Lamont-Doherty did not estimate any additional take allowance for animals that could be affected by sound sources other than the airgun. NMFS does not expect that the sound levels produced by the echosounder, sub-bottom profiler, and ADCP would exceed by the sound levels produced by the airguns during concurrent operations of the sound sources. Because of the beam pattern and directionality of these sources, combined with their lower source levels, it is not likely that these sources would take marine mammals independently from the takes that Lamont-Doherty has estimated to result from airgun operations. At this time, we propose not to authorize additional takes for these sources for the action. We are currently evaluating the broader use of these types of sources to determine under what specific circumstances coverage for incidental take would or would not be advisable. We are working on guidance that would outline a consistent recommended approach for applicants to address the potential impacts of these types of sources.

We considered the probability for entanglement of marine mammals to be low because of the vessel speed and the monitoring efforts onboard the survey vessel. Lamont-Doherty has no recorded cases of entanglement of marine mammals during their conduct of over 10 years of seismic surveys. Therefore, we do not believe it is necessary to authorize additional takes for entanglement at this time.

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

The following sections describe Lamont-Doherty's methods to estimate take by incidental harassment. Lamont-Doherty based their estimates on the number of marine mammals that could be harassed by seismic operations with the airgun array during approximately 6,350 km (3,946 mi) of transect lines in the Atlantic Ocean.

Ensonified Area Calculations: In order to estimate the potential number of marine mammals exposed to airgun sounds, Lamont-Doherty considers the total marine area within the 160-dB radius around the operating airguns. This ensonified area includes areas of overlapping transect lines. They determine the ensonified area by entering the planned survey lines into a MapInfo GIS, using the software to identify the relevant areas by ''drawing'' the applicable 160-dB buffer (see Table 3) around each seismic line, and then calculating the total area within the buffers.

For this survey, Lamont-Doherty assumes that the *Langseth* will not need to repeat some tracklines, accommodate the turning of the vessel, address equipment malfunctions, or conduct equipment testing to complete the survey. They propose not to increase the proposed number of line-kilometers for the seismic operations by 25 percent to account for these contingency operations. The revised total ensonified area is approximately 41,170 km^2 (15,896 mi^2) a 36.4 percent reduction in the total ensonified area that Lamont-Doherty proposed in their application.

Exposure Estimates: Lamont-Doherty calculates the numbers of different individuals potentially exposed to approximately 160 dB re: 1 μPa by multiplying the expected species density estimates (number/km^2) for that area in the absence of a seismic program times the estimated area of ensonification (i.e., 41,170 km^2; 15,896 mi^2).

Table 3 of their application presents their original estimates of the number of different individual marine mammals that could potentially experience exposures greater than or equal to 160 dB re: 1 μPa during the seismic survey if no animals moved away from the survey vessel. Lamont-Doherty used the Strategic Environmental Research and Development Program's (SERDP) spatial decision support system (SDSS) Marine Animal Model Mapper tool (Read *et al.* 2009) to calculate cetacean densities within the survey area based on the U.S. Navy's ''OPAREA Density Estimates'' (NODE) model (DoN, 2007). The NODE model derives density estimates using density surface modeling of the existing line-transect data, which uses sea surface temperature, chlorophyll *a,* depth, longitude, and latitude to allow extrapolation to areas/seasons where marine mammal survey data collection did not occur. Lamont-Doherty used the SERDP SDSS tool to obtain mean densities in a polygon the size of the seismic survey area for the cetacean species during the fall (September through November).

For the proposed Authorization, we have reviewed Lamont-Doherty's take estimates presented in Table 3 of their application and have revised take calculations for some species based upon the best available density information from SERDP SDSS and other sources noted in the footnote section for Table 3. These include takes for North Atlantic right, fin, blue, Bryde's, and sei whales; and the Southern Migratory Coastal, Southern North Carolina Estuarine System, and Northern North Carolina Estuarine System stocks of bottlenose dolphins. Table 5 presents the revised estimates of the possible numbers of marine mammals exposed to sound levels greater than or equal to 160 dB re: 1 μPa during the proposed seismic survey.

Table 4—Densities and Estimates of the Possible Numbers of Marine Mammals Exposed to Sound Levels Greater Than or Equal to 160 dB re: 1 μPa During the Proposed Seismic Survey in the Atlantic Ocean, September Through October 2014

Species	Density estimate [1] (#/1000 sq km)	Modeled number of individuals exposed to sound levels ≥160 dB [2]	Proposed take authorization	Percent of species or stock [3]	Population trend [4]
North Atlantic right whale	Entire area—0.1 [5]	0	[5] 5	1.10	Increasing.
Humpback whale	0.73, 0.56, 1.06	38	38	4.62	Increasing.
Minke whale	0.03, 0.02, 0.04	1	1	0.005	No data.
Sei whale	Entire area—0.489 [5]	0	[5] 21	5.88	No data.
Fin whale	Entire area—0.26 [5]	1	[5] 11	0.31	No data.
Blue whale	Entire area—0.036 [5]	0	[5] 2	0.45	No data.
Bryde's whale	Entire area—0.429 [5]	0	[5] 18	0.16	No data.
Sperm whale	0.03, 0.68, 3.23	91	91	5.71	No data.
Dwarf sperm whale	0.64, 0.49, 0.93	33	33	0.87	No data.
Pygmy sperm whale	0.64, 0.49, 0.93	33	33	0.87	No data.
Cuvier's beaked whale	0.01, 0.14, 0.58	17	17	0.24	No data.
Blainville's beaked whale	0.01, 0.14, 0.58	17	17	0.24	No data.
Gervais' beaked whale	0.01, 0.14, 0.58	17	17	0.24	No data.
True's beaked whale	0.01, 0.14, 0.58	17	17	0.24	No data.
Rough-toothed dolphin	0.30, 0.23, 0.44	16	16	5.90	No data.
Bottlenose dolphin (Offshore)	70.4, 331, 49.4	3,383	3,383	4.36	No data.
Bottlenose dolphin (SMC)	70.4, 0, 0	685	685	7.05	No data.
Bottlenose dolphin (SNCES)	70.4, 0, 0	[6] 1	1	0.53	No data.
Bottlenose dolphin (NNCES)	70.4, 0, 0	[6] 1	1	0.11	No data.
Pantropical spotted dolphin	14, 10.7, 20.4	737	737	22.11	No data.
Atlantic spotted dolphin	216.5, 99.7, 77.4	4,632	4,632	10.36	No data.

TABLE 4—DENSITIES AND ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO SOUND LEVELS GREATER THAN OR EQUAL TO 160 dB RE: 1 μPa DURING THE PROPOSED SEISMIC SURVEY IN THE ATLANTIC OCEAN, SEPTEMBER THROUGH OCTOBER 2014—Continued

Species	Density estimate [1] (#/1000 sq km)	Modeled number of individuals exposed to sound levels ≥160 dB [2]	Proposed take authorization	Percent of species or stock [3]	Population trend [4]
Spinner dolphin	0, 0, 0	0	0	0	No data.
Striped dolphin	0, 0.4, 3.53	98	98	0.18	No data.
Clymene dolphin	6.7, 5.12, 9.73	352	352	5.78	No data.
Short-beaked common dolphin	5.8, 138.7, 26.4	1,343	1,343	0.77	No data.
Atlantic white-sided dolphin	0, 0, 0	0	0	0	No data.
Fraser's dolphin	0, 0, 0	0	0	0	No data.
Risso's dolphin	1.18, 4.28, 2.15	88	88	0.48	No data.
Melon-headed whale	0, 0, 0	0	0	0	No data.
False killer whale	0, 0, 0	0	0	0	No data.
Pygmy killer whale	0, 0, 0	0	0	0	No data.
Killer whale	0, 0, 0	0	0	0	No data.
Long-finned pilot whale	3.74, 58.9, 19.1	799	799	3.01	No data.
Short-finned pilot whale	3.74, 58.9, 19.1	799	799	3.71	No data.
Harbor porpoise	0, 0, 0	0	0	0	No data.

[1] Except where noted, densities are the mean values for the shallow (<100 m), intermediate (100–1,000 m), and deep (≤1,000 m) water stratum in the survey area calculated from the SERDP SDSS NODES summer model (Read *et al.,* 2009) as presented in Table 3 of Lamont-Doherty's application.

[2] Modeled take in this table corresponds to the total modeled take over all depth ranges shown in Table 3 of Lamont-Doherty's application. See Table 3 of their application for their original take estimates by shallow, intermediate, and deep strata. See the addendum to their application for revised take estimates based on modifications to the tracklines to reduce the total ensonified area by 36.4 percent (i.e., 41,170 km^2; 15,896 mi^2).

[3] Table 1 in this notice lists the stock species abundance estimates used in calculating the percentage of species/stock.

[4] Population trend information from Waring *et al.,* 2013. No data = Insufficient data to determine population trend.

[5] Density data derived from the Navy's NMSDD. Increases for group size based on pers. com. with Dr. Caroline Good (2014) and Mr. McLellan (2014) on large whale presence offshore NC.

[6] Modeled estimate includes the area that is less than 3 km from shore ensonified to greater than or equal to 160 dB (10 km^2 total).

Encouraging and Coordinating Research

Lamont-Doherty would coordinate the planned marine mammal monitoring program associated with the seismic survey in the Atlantic Ocean with applicable U.S. agencies.

Analysis and Preliminary Determinations

Negligible Impact

As explained previously, we have defined the term ''negligible impact'' to mean ''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 Level B harassment 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, and the number of estimated mortalities, effects on habitat, and the status of the species.

In making a negligible impact determination, we consider:

- The number of anticipated injuries, serious injuries, or mortalities;
- The number, nature, and intensity, and duration of Level B 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 take.

For reasons stated previously in this document and based on the following factors, Lamont-Doherty's specified activities are not likely to cause long-term behavioral disturbance, permanent threshold shift, or other non-auditory injury, serious injury, or death. They include:

- The anticipated impacts of Lamont-Doherty's survey activities on marine mammals are temporary behavioral changes due to avoidance of the area.
- The likelihood that marine mammals approaching the survey area will likely be traveling through or opportunistically foraging within the vicinity. Marine mammals transiting within the vicinity of survey operations will be transient as no breeding, calving, pupping, or nursing areas, or haul-outs, overlap with the survey area.
- The low likelihood that North Atlantic right whales would be exposed to sound levels greater than or equal to 160 dB re: 1 μPa due to the requirement that the Langseth crew must shutdown the airgun(s) immediately if observers detect this species, at any distance from the vessel.
- The likelihood that, given sufficient notice through relatively slow ship speed, we expect marine mammals to move away from a noise source that is annoying prior to its becoming potentially injurious;
- 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;

- Our 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 the potential impacts to marine mammal habitat minimal;
- The relatively low potential for temporary or permanent hearing impairment and the likelihood that Lamont-Doherty would avoid this impact through the incorporation of the required monitoring and mitigation measures (including power-downs and shutdowns); and
- The likelihood that marine mammal detection ability by trained visual observers is high at close proximity to the vessel.

NMFS does not anticipate that any injuries, serious injuries, or mortalities would occur as a result of the Observatory's proposed activities, and NMFS does not propose to authorize injury, serious injury, or mortality at this time. We anticipate only behavioral disturbance to occur primarily in the form of avoidance behavior to the sound source during the conduct of the survey activities. Further, the additional mitigation measure requiring Lamont-Doherty to increase the size of the Level A harassment exclusion zones in shallow water will effect the least practicable impact marine mammals.

Table 5 in this document outlines the number of requested Level B harassment takes that we anticipate as a result of these activities. NMFS anticipates that 24 marine mammal species (7 mysticetes and 17 odontocetes) would likely occur in the proposed action area. Of the marine mammal species under our jurisdiction that are known to occur or likely to occur in the study area, six of these species are listed as endangered under the ESA and depleted under the MMPA, including: The North Atlantic, blue, fin, humpback, sei, and sperm whales.

Due to the nature, degree, and context of Level B (behavioral) harassment anticipated and described (see ''Potential Effects on Marine Mammals'' section in this notice), we do not expect the activity to impact rates of recruitment or survival for any affected species or stock. In addition, the seismic surveys would not take place in areas of significance for marine mammal feeding, resting, breeding, or calving and would not adversely impact marine mammal habitat, including the identified habitats for North Atlantic right whales and their calves.

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 we anticipate that the seismic operations would occur on consecutive days, the estimated duration of the survey would last no more than 30 days. Specifically, the airgun array moves continuously over 10s of kilometers daily, as do the animals, making it unlikely that the same animals would be continuously exposed over multiple consecutive days. Additionally, the seismic survey would increase sound levels in the marine environment in a relatively small area surrounding the vessel (compared to the range of the animals), which is constantly travelling over distances, and some animals may only be exposed to and harassed by sound for less than a day.

In summary, we expect marine mammals to avoid the survey area, thereby reducing the risk of exposure and impacts. We do not anticipate disruption to reproductive behavior and there is no anticipated effect on annual rates of recruitment or survival of affected marine mammals. Based on this notice's analysis of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that Lamont-Doherty's proposed seismic survey would have a negligible impact on the affected marine mammal species or stocks.

Small Numbers

As mentioned previously, we estimate that Lamont-Doherty's activities could potentially affect, by Level B harassment only, 24 species of marine mammals under our jurisdiction. For each species, these estimates constitute small numbers relative to the population size. We have provided the population estimates for the marine mammal species that may be taken by Level B harassment in Table 5 in this notice. Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the mitigation and monitoring measures, we find that Lamont-Doherty's proposed activity would take small numbers of marine mammals relative to the populations of 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 that may occur in the proposed survey area, several are listed as endangered under the Endangered Species Act, including the blue, fin, humpback, north Atlantic right, sei, and sperm whales. Under section 7 of the ESA, the Foundation 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 Foundation will conclude the consultation prior to a determination on the issuance of the Authorization.

National Environmental Policy Act (NEPA)

The Foundation has prepared a draft EA titled ''Draft Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off Cape Hatteras, September–October 2014'' which we have posted on our Web site concurrently with the publication of this notice. We will independently evaluate the Foundation's draft EA and determine whether or not to adopt it or prepare a separate NEPA analysis and incorporate relevant portions of the Foundation's draft EA by reference. We will review all comments submitted in response to this notice to complete the NEPA process prior to making a final decision on the 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 Atlantic Ocean offshore Cape Hatteras, NC September 15, 2014 through October 31, 2014, provided they incorporate the previously mentioned 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 Atlantic Ocean offshore Cape Hatteras, NC September through October, 2014.

1. Effective Dates

This Authorization is valid from September 15 through October 31, 2014.

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 Atlantic Ocean bounded by the following coordinates: in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, NC between approximately 32–37° N and approximately 71.5–77° W, as specified in Lamont-Doherty's application and the National Science Foundation's EA.

3. Species Authorized and Level of Takes

a. This authorization limits the incidental taking of marine mammals, by Level B harassment only, to the species listed in Table 5 of this notice in the area described in Condition 2(a):

i. During the seismic activities, if the Holder of this Authorization encounters any marine mammal species that are not listed in Condition 3 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. This Authorization prohibits the taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3 or the taking of any kind of any other species of marine mammal. Thus, it may result in the modification, suspension or revocation of this Authorization.

c. This Authorization limits the methods authorized for taking by Level B harassment to the following acoustic sources without an amendment to this Authorization:

i. an airgun array with a total capacity of 6,600 in^3 (or smaller);
ii. a multi-beam echosounder;
iii. a sub-bottom profiler; and
iv. an acoustic Doppler current profiler.

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 *Jolie.Harrison@noaa.gov* and *ITP.Cody@noaa.gov.*

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 civil twilight-dawn to civil 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 (7×50 Fujinon), and big-eye binoculars (25×150).

Exclusion Zones

b. Establish a 180-dB exclusion zone (with buffer) before starting the airgun subarray (6,600 in^3 or smaller); and a 180-dB exclusion zone (with buffer) for the single airgun (40 in^3). Observers will use the predicted radius distance for the 180-dB exclusion zone (with buffer).

Visual Monitoring at the Start of Airgun Operations

c. Monitor the entire extent of the 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 (with buffer) 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 (with buffer).

ii. If for any reason the visual observer cannot see the full 180-dB exclusion zone (with buffer) 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, 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, 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.

Ramp-Up Procedures

g. Implement a ''ramp-up'' procedure when starting the airguns at the beginning of seismic operations or anytime 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.

n. If a North Atlantic right whale (*Eubalaena glacialis*) is visually sighted, the airgun array will be shut-down regardless of the distance of the animal(s) to the sound source. The array will not resume firing until 30 minutes after the last documented whale visual sighting.

Resuming Airgun Operations After a Shutdown

o. Following a shutdown, if the observer has visually confirmed that the animal has departed the 180-dB exclusion zone (with buffer) within a period of less than or equal to 8 minutes after the shutdown, then the *Langseth* may resume airgun operations at full power.

p. Else, if the observer has not seen the animal depart the 180-dB exclusion zone (with buffer), 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

q. 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.

r. 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.

s. To the maximum extent practicable, the Holder of this Authorization should schedule seismic operations (*i.e.,* shooting the airguns) during daylight hours.

t. To the maximum extent practicable, plan to conduct seismic surveys (especially when near land) from the coast (inshore) and proceed towards the sea (offshore) in order to avoid trapping marine mammals in shallow water.

Mitigation Airgun

u. 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.

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 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) to the seismic activity at received levels greater than or equal to 160 dB re: 1 μPa and/or 180 dB re 1 μPa 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; 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), the Observatory shall immediately cease the specified activities and immediately report the take to the Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *ITP.Cody@noaa.gov* and the Southeast Regional Stranding Coordinator at (305) 361–4586. 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 Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *ITP.Cody@noaa.gov* and the Southeast Regional Stranding Coordinator at (305) 361–4586. The report must include the same information identified in the paragraph above this section. Activities may continue while we review the circumstances of the incident. We 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 Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *ITP.Cody@noaa.gov* and the Southeast Regional Stranding Coordinator at (305) 361–4586, 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

The Observatory 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

We request comments on our analysis and the draft authorization 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 Incidental Harassment Authorization.

Dated: July 25, 2014.

Donna S. Wieting,

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

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