

**Request by Lamont-Doherty Earth Observatory
for an Incidental Harassment Authorization
to Allow the Incidental Take of Marine Mammals
during a Marine Geophysical Survey
by the R/V *Marcus G. Langseth*
in the Atlantic Ocean off New Jersey,
Summer 2015**

submitted by

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to

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Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off New Jersey, Summer 2015

SUMMARY

The State University of New Jersey at Rutgers (Rutgers), with funding from the U.S. National Science Foundation (NSF), proposes to conduct a high-energy, 3-D seismic survey on the R/V *Marcus G. Langseth* in the northwest Atlantic Ocean ~25–85 km from the coast of New Jersey in summer 2015. The NSF-owned *Langseth* is operated by Columbia University's Lamont-Doherty Earth Observatory (L-DEO) under an existing Cooperative Agreement. Although the *Langseth* is capable of conducting high energy seismic surveys using up to 36 airguns with a discharge volume of 6600 in³, the proposed seismic survey would only use a small towed subarray of 4 airguns with a total discharge volume of ~700 in³. The seismic survey would take place outside of U.S. state waters within the U.S. Exclusive Economic Zone (EEZ) in water depths ~20–75 m. This request is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371(a)(5).

The survey was originally proposed for implementation in 2014. NSF environmental compliance, including all federal statutory and regulatory obligations, was completed for the survey on 1 July 2014, and the survey commenced. Because of mechanical issues with the vessel, the survey was unable to be completed during the effective periods set forth in the Incidental Harassment Authorization (IHA) and Incidental Take Statement (ITS) issued for the survey. According to the U.S. National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), although the survey has not changed from what was approved in 2014, a new IHA will be required to conduct the same survey during a rescheduled time in 2015.

As the vessel operator, L-DEO, on behalf of itself, NSF, and the research entities, are submitting this IHA application for the proposed activity. In this application, we refer to conclusions of the Final Environmental Assessment (EA), Finding of No Significant Impact (FONSI), IHA, and Biological Opinion issued by NMFS for the New Jersey survey in 2014, and to observations made during the brief survey conducted in 2014. The effects are fully consistent with those set forth in the 2014 NSF Final EA and FONSI, and 2014 NMFS Final EA, FONSI, IHA, and Biological Opinion, and Essential Fish Habitat (EFH) concurrence letter, and which are incorporated by reference in the 2015 NSF Final EA for this activity and herein.

Numerous species of marine mammals inhabit the proposed survey area off the coast of New Jersey. Several of these species are listed as **endangered** under the U.S. Endangered Species Act (ESA): the sperm, North Atlantic right, humpback, sei, fin, and blue whales. Other ESA-listed species that could occur in the area are the **endangered** leatherback, hawksbill, green, and Kemp's ridley turtles and roseate tern, and the **threatened** loggerhead turtle and piping plover. The **endangered** Atlantic sturgeon and shortnose sturgeon could also occur in or near the study area. ESA-listed **candidate species** that could occur in the area are the cusk and dusky shark.

The items required to be addressed pursuant to 50 C.F.R. § 216.104, “Submission of Requests”, are set forth below. They include descriptions of the specific operations to be conducted, the marine mammals occurring in the study area, proposed measures to mitigate against any potential injurious effects on marine mammals, and a plan to monitor any behavioral effects of the operations on those marine mammals.

I. OPERATIONS TO BE CONDUCTED

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

Overview of the Activity

Rutgers proposes to conduct a seismic survey in the Atlantic Ocean, ~25–85 km off the coast of New Jersey. The proposed full-fold 3-D box/survey area is defined by the coordinates at the four corners (including turns and run-in and run-out of each line): 39:38:00°N, 73:44:36°W; 39:43:12°N, 73:41:00°W; 39:25:30°N, 73:06:12°W; and 39:20:06°N, 73:10:06°W (Fig. 1). Water depths in the survey area are ~20–75 m. The seismic survey would be conducted outside of state waters and within the U.S. EEZ, and is scheduled to occur for ~30 days during June–August 2015.

The procedures to be used for the survey on the inner-middle shelf of the New Jersey continental margin would be the same as those proposed for the 2014 survey and would be similar to those used during previous seismic surveys by L-DEO, and would use conventional seismic methodology. The purpose of the proposed research is to collect and analyze data on the arrangement of sediments deposited during times of changing global sea level from roughly 60 million years ago to present. Despite their existence being clearly indicated in sediment cores recovered during IODP Expedition 313, features such as river valleys cut into coastal plain sediments, now buried under a km of younger sediment and flooded by today’s ocean, cannot be resolved in existing 2-D seismic data to the degree required to map shifting shallow-water depositional settings in the vicinity of clinoform rollovers.

To achieve the project’s goals, the lead Principal Investigator (PI), Dr. G. Mountain (Rutgers University), and collaborating PIs, J. Austin and C. Fulthorpe, M. Nedimović, (University of Texas at Austin), propose to use a 3-D seismic reflection survey to map sequences around existing IODP Expedition 313 drill sites and analyze their spatial/temporal evolution. Objectives that would then be met include establishing the impact of known Ice House base-level changes on the stratigraphic record; providing greater understanding of the response of nearshore environments to changes in elevation of global sea level; and determining the amplitudes and timing of global sea-level changes during the mid-Cenozoic. The project objectives remain the same as those described for the 2014 survey.

The survey would involve one source vessel, the R/V *Langseth*, which is owned by NSF and operated on its behalf by Columbia University’s L-DEO, and one support vessel. The *Langseth* would deploy two pairs of subarrays of 4 airguns as an energy source; the subarrays would fire alternately, with a total volume of ~700 in³. The receiving system would be a passive component of the proposed activity and would consist of a system of hydrophones: four 3000-m hydrophone streamers at 75-m spacing, or a combination of one 3000-m hydrophone streamer and a P-Cable hydrophone streamer system. As the airgun array is towed along the survey lines, the hydrophone streamers would receive the returning acoustic signals and transfer the data to the on-board processing system.

A total of ~4900 km of 3-D survey lines, including turns, would be shot in an area 12 x 50 km with a line spacing of 150 m in two 6-m wide race-track patterns (Fig. 1). There would be additional seismic operations in the survey area associated with airgun testing and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional

operations. The same transect lengths and area of survey proposed for 2015 was analyzed for the 2014 survey. Because of mechanical/equipment issues on the survey vessel along with weather issues (including Hurricane Arthur), the full 3-D array of equipment could not be deployed. Given equipment

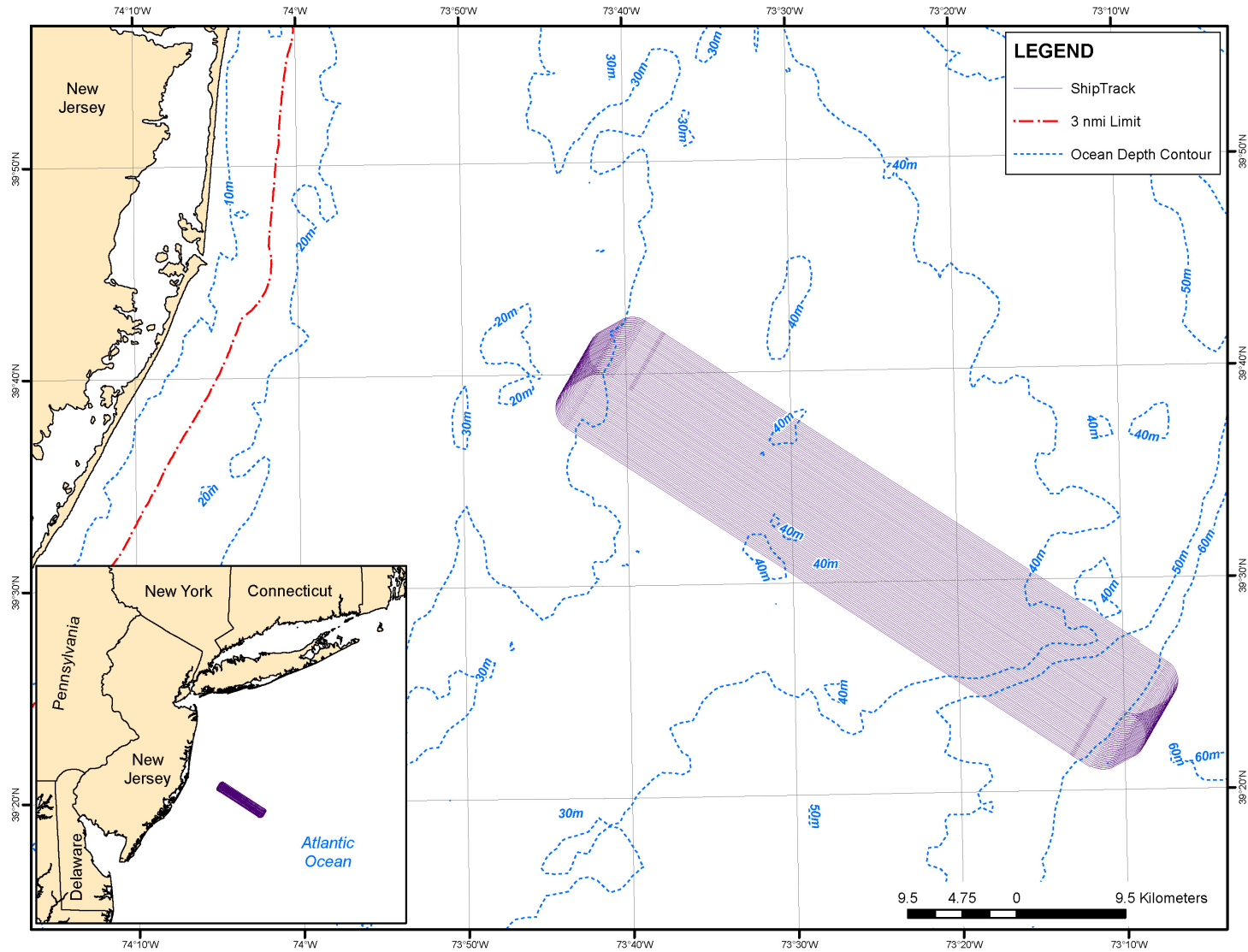


FIGURE 1. Location of the proposed seismic survey in the Atlantic Ocean off the coast of New Jersey during June–August 2015.

limitations, only ~61 h of seismic survey data were collected in 2014, with only ~43 h at full power (700 in³) on survey tracklines. Of the 43 h of data collected, ~22 h were of substandard data quality because of equipment damage from rough seas. However, the existing data did allow confirmation that the smaller 700-in³ source array was suitable for the project, thus eliminating potential use of the larger 1400-in³ array originally proposed in 2014.

In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated from the *Langseth* continuously throughout the survey, but not during transits. All planned geophysical data acquisition activities would be conducted by L-DEO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel with some personnel transfer on/off the *Langseth* by a small vessel.

Source Vessel Specifications

The R/V *Marcus G. Langseth* is described in § 2.2.2.1 of the Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (June 2011) and Record of Decision (June 2012), referred to herein as the PEIS. The vessel speed during seismic operations would be 4.5 kt (~8.3 km/h).

The support vessel would be a multi-purpose offshore utility vessel similar to the *Northstar Commander*, which is 28 m long with a beam of 8 m and a draft of 2.6 m. It is powered by a twin-screw Volvo D125-E, with 450 hp for each screw.

Airgun Description

During the survey, the airgun array to be used would be the full 4-string array with most of the airguns turned off (see § XI for an explanation of the source level selection). The active airguns would be 4 airguns in one string on the port side forming Source 1, and 4 airguns in one string on the starboard side forming Source 2. These identical port and starboard sources would be operated in “flip-flop” mode, firing alternately as the ship progresses along the track, as is common for 3-D seismic data acquisition. Thus, the source volume would not exceed 700 in³ at any time. Whereas the full array is described and illustrated in § 2.2.3.1 of the PEIS, the smaller subarrays proposed for this survey are described further in Appendix A of the Environmental Assessment (EA). The subarrays would be towed at a depth of 4.5m or 6 m. The shot interval would be ~5 s (12.5 m). While the 4.5m depth is preferred, the choice of tow depth would not be made until the survey based on sea and weather conditions. We have assumed the use of the 6-m tow depth for the impacts analysis and take estimate calculations, as that results in the farthest sound propagation. Mitigation zones have been calculated for both tow depths, however (see below and Appendix A of the EA, Table A2), and during operations the relevant mitigation zone would be applied.

Predicted Sound Levels

During the planning phase, mitigation zones for the proposed survey were calculated based on modeling by L-DEO for both the exclusion zone (EZ) and the safety zone; these zones are given in Table 1 and Table A2, Appendix A of the EA. A more detailed description of the modeling process used to develop the mitigation zones can be found in Appendix A of the EA. Received sound levels in deep water have been predicted by L-DEO for the 4-airgun array and the single Bolt 1900LL 40-in³ airgun that would be used during power downs. Scaling factors between those arrays and the 18-airgun, 3300-in³ array, taking into account tow depth differences, were developed and applied to empirical data for the 18-airgun array in shallow water in the Gulf of Mexico from Diebold et al. (2010). Because the choice of

array size and tow depth would not be made until the survey, the use of the 4-airgun array towed at 6 m is assumed in the impacts and take estimate analysis, as that results in the farthest sound propagation. During actual operations, however, the corresponding mitigation zone would be applied for the selected source level.

Table 1 shows the 180-dB EZ and 160-dB “Safety Zone” (distances at which the rms sound levels are expected to be received) for the mitigation airgun and the 4-airgun subarray. The 160- and 180-dB re 1 $\mu\text{Pa}_{\text{rms}}$ distances are the criteria currently specified by NMFS (2000) for cetaceans. The 180-dB distance has also been used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs. Per the Biological Opinion issued in 2014 (Appendix C of the 1 July 2014 Final EA), a 166-dB distance would be used for Level B takes for sea turtles. Per the IHA for this survey issued in 2014 (Appendix D of the 1 July 2014 Final EA), the Exclusion Zone was increased by 3 dB (thus operational mitigation would be at the 177-dB isopleth), which adds ~50% to the power-down/shut-down radius. NSF does not view this overly precautionary approach appropriate, and it is not included here. A recent retrospective analysis of acoustic propagation of *Langseth* sources in a coastal/shelf environment from the Cascadia Margin off Washington suggests that predicted radii (using an approach similar to that used here) for *Langseth* sources were 2–3 times larger than measured in shallow water, so in fact were very conservative (Crone et al. 2014).

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), although at the time of preparation of this Draft Amended EA, the date of release of the final guidelines and how they would be implemented are unknown. As such, this Draft Amended EA has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as described in § XI.

Description of Operations

The survey would involve one source vessel, the *Langseth*, supported by a support vessel. The *Langseth* would deploy two pairs of subarrays of 4 airguns as an energy source; the subarrays would fire alternately, with a total volume of ~700 in³. The receiving system would be a passive component of the proposed activity and would consist of a system of hydrophones: four 3000-m hydrophone streamers at 75-m spacing, or preferentially, a combination of two 3000-m hydrophone streamers and a P-Cable system. As the airgun array is towed along the survey lines, the hydrophone streamers would receive the returning acoustic signals and transfer the data to the on-board processing system.

A total of ~4900 km of 3-D survey lines, including turns, would be shot in an area 12 x 50 km with a line spacing of 150 m in two 6-m wide race-track patterns (Fig. 1). There would be additional seismic operations in the survey area associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional operations.

TABLE 1. Predicted distances in meters to which sound levels ≥ 180 and 160 dB re 1 $\mu\text{Pa}_{\text{rms}}$ would be received during the proposed 3-D survey off New Jersey, using a 4-airgun, 700-in³ subset of 1 string (at 4.5- or 6-m tow depth), and the 40-in³ airgun during power-downs. Radii are based on scaling described in the text of Appendix A of the EA and Figures A2 to A6, and the assumption that received levels on an rms basis are, numerically, 10 dB higher than the SEL values¹.

Source and Volume	Water Depth	Predicted RMS Radii (m)	
		180 dB	160 dB
4-airgun subarray (700 in ³) @ 4.5 m	<100 m	378	5240
4-airgun subarray (700 in ³) @ 6 m	<100 m	439	6100
Single Bolt airgun (40 in ³) @ 6 m	<100 m	73	995

In addition to the operations of the airgun array, a Kongsberg EM 122 multibeam echosounder (MBES) and a Knudsen Chirp 3260 sub-bottom profiler (SBP) will also be operated from the *Langseth* continuously throughout the survey. These sources are described in § 2.2.3.1 of the PEIS.

II. DATES, DURATION, AND REGION OF ACTIVITY

The date(s) and duration of such activity and the specific geographical region where it will occur.

The survey activities would encompass the survey area between in the Atlantic Ocean ~25–85 km off the coast of New Jersey. The proposed full-fold 3-D box/survey area is defined by the coordinates at the four corners (including turns and run-in and run-out of each line): 39:38:00°N, 73:44:36°W; 39:43:12°N, 73:41:00°W; 39:25:30°N, 73:06:12°W; and 39:20:06°N, 73:10:06°W (Fig. 1). Water depths in the survey area are ~30–75 m. The seismic survey would be conducted outside of state waters and within the U.S. EEZ.

The *Langseth* would depart from New York, NY, and spend ~8 h in transit to the proposed survey area. Setup, deployment, and streamer ballasting would take ~3 days. The seismic survey would take 30 days plus 2 contingency days, and the *Langseth* would spend one day for gear retrieval and transit back to New York. The survey would be conducted during summer (June–August) 2015. Operations could be delayed or interrupted because of a variety of factors including equipment malfunctions and weather-related issues, but use of the airguns would not occur outside of the effective IHA period.

III. SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

The species and numbers of marine mammals likely to be found within the activity area

¹ Sound sources are primarily described in sound pressure level (SPL) units. SPL is often referred to as rms or “root mean square” pressure, averaged over the pulse duration. Sound exposure level (SEL) is a measure of the received energy in a pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period.

Thirty-one marine mammal species could occur near the proposed survey area. To avoid redundancy, we have included the required information about the species and (insofar as it is known) numbers of these species in § IV, below.

IV. STATUS, DISTRIBUTION AND SEASONAL DISTRIBUTION OF AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities

Sections III and IV are integrated here to minimize repetition.

Thirty-one cetacean species (6 mysticetes and 25 odontocetes) could occur near the proposed survey site (Table 2). Six of the 31 species are listed under the U.S. Endangered Species Act (ESA) as **Endangered**: the North Atlantic right, humpback, blue, fin, sei, and sperm whales. In fact, only five species were observed during the 13-day cruise in 2014, including one humpback whale, plus one unidentified baleen whale and one unidentified dolphin (Ingram et al. 2014). An additional four cetacean species, although present in the wider western North Atlantic Ocean, likely would not be found near the proposed survey area between ~39–40°N because their ranges generally do not extend as far north (Clymene dolphin, *Stenella clymene*; Fraser's dolphin, *Lagenodelphis hosei*; melon-headed whale, *Peponocephala electra*; and Bryde's whale, *Balaenoptera brydei*). Although the secondary range of the beluga whale (*Delphinapterus leucas*) may range as far south as New Jersey (Jefferson et al. 2008), and there have been at least two sightings off the coast of New Jersey (IOC 2013), this species is not included here as it is unlikely to be encountered during the proposed survey. Similarly, no pinnipeds are included; harp seals (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*) are rare in the proposed survey area, and gray (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) have a more northerly distribution during the summer (DoN 2005) and are therefore not expected to occur there during the survey. No pinnipeds were observed during the 13-day cruise in 2014. Information on grey, harbor, and harp seals was included in the 2014 NMFS EA for this project, and was incorporated into the 2014 NSF EA and the 2015 NSF Draft Amended EA by reference (Appendix E of the 1 July 2014 Final EA).

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine mammals are given in § 3.6.1 and § 3.7.1 of the PEIS. The proposed survey area off New Jersey is near one of the detailed analysis areas (DAAs) in the PEIS. The general distributions of mysticetes and odontocetes in this region of the Atlantic Ocean are discussed in § 3.6.2.1 and § 3.7.2.1 of the PEIS, respectively. Additionally, information on marine mammals in this region is included in § 4.2.2.1 of the Bureau of Ocean Energy Management (BOEM) draft PEIS for Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas (BOEM 2012). The rest of this section deals with more specific species distribution off the coast of New Jersey. For the sake of completeness, an additional six odontocetes that are expected to be rare or extralimital in the proposed survey area were included here but were not included in the PEIS.

The main sources of information used here are the 2010 and Draft 2013 U.S. Atlantic and Gulf of Mexico marine mammal stock assessment reports (SARs: Waring et al. 2010, 2013), the Ocean Biogeographic Information System (OBIS: IOC 2013), and the Cetacean and Turtle Assessment Program (CETAP 1982). The SARs include maps of sightings for most species from NMFS' Northeast and Southeast Fisheries Science Centers (NEFSC and SEFSC) surveys in summer 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. OBIS is a global database of marine species sightings. CETAP covered 424,320 km of trackline on the U.S. outer continental shelf from Cape Hatteras to Nova Scotia. Aerial and shipboard surveys were conducted over a 39-month period from 1 November 1978 to 28 January 1982. The mid-

Atlantic area referred to in the following species accounts included waters south of Georges Bank down to Cape Hatteras, and from the coast out to ~1830 m depth.

TABLE 2. The habitat, occurrence, regional population sizes, and conservation status of marine mammals that could occur in or near the proposed survey area in the Northwest Atlantic Ocean off New Jersey.

Species	Habitat	Occurrence in survey area in summer	Regional/SAR abundance estimates ¹	ESA ²	IUCN ³	CITES ⁴
<i>Mysticetes</i>						
North Atlantic right whale	Coastal and shelf	Rare	455 / 455 ⁵	EN	EN	I
Humpback whale	Mainly coastal, banks	Common	11,600 ⁶ / 823 ⁷	EN	LC	I
Minke whale	Mainly coastal	Rare	138,000 ⁸ / 20,741 ⁹	NL	LC	I
Sei whale	Mainly offshore	Uncommon	10,300 ¹⁰ / 357 ¹¹	EN	EN	I
Fin whale	Slope, pelagic	Uncommon	26,500 ¹² / 3522 ⁵	EN	EN	I
Blue whale	Coastal, shelf, pelagic	Rare	855 ¹³ / 440 ⁵	EN	EN	I
<i>Odontocetes</i>						
Sperm whale	Pelagic	Common	13,190 ¹⁴ / 2288 ¹⁵	EN	VU	I
Pygmy sperm whale	Off shelf	Uncommon	N.A. / 3785 ¹⁶	NL	DD	II
Dwarf sperm whale	Off shelf	Uncommon	N.A. / 3785 ¹⁶	NL	DD	II
Cuvier's beaked whale	Pelagic	Uncommon	N.A. / 6532 ¹⁷	NL	LC	II
Northern bottlenose whale	Pelagic	Rare	N.A. / N.A.	NL	DD	II
True's beaked whale	Pelagic	Rare	N.A. / 7092 ¹⁸	NL	DD	II
Gervais' beaked whale	Pelagic	Rare	N.A. / 7092 ¹⁸	NL	DD	II
Sowerby's beaked whale	Pelagic	Rare	N.A. / 7092 ¹⁸	NL	DD	II
Blainville's beaked whale	Pelagic	Rare	N.A. / 7092 ¹⁸	NL	DD	II
Rough-toothed dolphin	Mainly pelagic	Rare	N.A. / 271 ⁵	NL	LC	II
Bottlenose dolphin	Coastal, offshore	Common	N.A. / 89,080 ¹⁹	NL [^]	LC	II
Pantropical spotted dolphin	Mainly pelagic	Rare	N.A. / 3333 ⁵	NL	LC	II
Atlantic spotted dolphin	Mainly coastal	Common	N.A. / 44,715 ⁵	NL	DD	II
Spinner dolphin	Coastal, pelagic	Rare	N.A. / N.A.	NL	DD	II
Striped dolphin	Off shelf	Uncommon	N.A. / 54,807 ⁵	NL	LC	II
Short-beaked common dolphin	Shelf, pelagic	Common	N.A. / 173,486 ⁵	NL	LC	II
White-beaked dolphin	Shelf <200 m	Rare	10s–100s of 1000s ²⁰ / 2003 ⁵	NL	LC	II
Atlantic white-sided dolphin	Shelf and slope	Uncommon	10s–100s of 1000s ²¹ / 48,819 ⁵	NL	LC	II
Risso's dolphin	Mainly shelf, slope	Common	N.A. / 18,250 ⁵	NL	LC	II
False killer whale	Pelagic	Extralimital	N.A. / N.A.	NL	DD	II
Pygmy killer whale	Mainly pelagic	Rare	N.A. / N.A.	NL	DD	II
Killer whale	Coastal	Rare	N.A. / N.A.	NL*	DD	II
Long-finned pilot whale	Mainly pelagic	Uncommon	780K ²² / 26,535 ⁵	NL [†]	DD	II
Short-finned pilot whale	Mainly pelagic	Uncommon	780K ²² / 21,515 ⁵	NL	DD	II
Harbor porpoise	Coastal	Rare	~500K ²³ / 79,883 ²⁴	NL	LC	II

N.A. = Data not available or species status was not assessed.

¹ SAR (stock assessment report) abundance estimates are from the 2013 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments (Waring et al. 2014) as noted, and regional abundance estimates are for the North Atlantic regions as noted.

² U.S. Endangered Species Act; EN = Endangered, NL = Not listed

³ Codes for IUCN classifications from IUCN Red List of Threatened Species (IUCN 2013): EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient

⁴ Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2013): Appendix I = Threatened with extinction; Appendix II = not necessarily now threatened with extinction but may become so unless trade is closely controlled

⁵ Estimate for the Western North Atlantic Stock (Waring et al. 2014)

⁶ Best estimate for the western North Atlantic in 1992–1993 (IWC 2013)

⁷ Minimum estimate for the Gulf of Maine stock (Waring et al. 2014)

⁸ Best estimate for the North Atlantic in 2002–2007 (IWC 2013)

⁹ Estimate for the Canadian East Coast Stock (Waring et al. 2014)

¹⁰ Estimate for the Northeast Atlantic in 1989 (Cattanach et al. 1993)

¹¹ Estimate for the Nova Scotia Stock (Waring et al. 2014)

¹² Best estimate for the North Atlantic in 2007 (IWC 2013)

¹³ Estimate for the central and northeast Atlantic in 2001 (Pike et al. 2009)

¹⁴ Estimate for the North Atlantic (Whitehead 2002)

¹⁵ Estimate for the North Atlantic Stock (Waring et al. 2014)

¹⁶ Combined estimate for pygmy and dwarf sperm whales, Western North Atlantic Stock (Waring et al. 2014)

¹⁷ Estimate for the Western North Atlantic Stock (Waring et al. 2014)

¹⁸ Combined estimate for *Mesoplodon* spp. Western North Atlantic stocks (Waring et al. 2014)

¹⁹ Combined estimate for the Western North Atlantic Offshore Stock and the Northern Migratory Coastal Stock (Waring et al. 2014)

²⁰ High tens to low hundreds of thousands in the North Atlantic (Reeves et al. 1999a)

²¹ Tens to low hundreds of thousands in the North Atlantic (Reeves et al. 1999b)

²² Estimate for both long- and short-finned pilot whales in the central and eastern North Atlantic in 1989 (IWC 2013)

²³ Estimate for the North Atlantic (Jefferson et al. 2008)

²⁴ Estimate for the Gulf of Maine/Bay of Fundy Stock (Waring et al. 2014)

* Killer whales in the eastern Pacific Ocean, near Washington state, are listed as endangered under the U.S. ESA but not in the Atlantic Ocean.

^ The Western North Atlantic Coastal Morphotype stocks, ranging from NJ to FL, are listed as depleted under the U.S. Marine Mammal Protection Act, as are some other stocks to the south of the proposed survey area.

† Considered a strategic stock.

Mysticetes

North Atlantic Right Whale (*Eubalaena glacialis*)

The North Atlantic right whale is known to occur primarily in the continental shelf waters off the eastern U.S. and Canada, from Florida to Nova Scotia (Winn et al. 1986; Jefferson et al. 2008). There are five well-known habitats in the northwest Atlantic used annually by right whales (Winn et al. 1986; NMFS 2005). These include the winter calving grounds in coastal waters of the southeastern U.S. (Florida/Georgia); spring feeding grounds in the Great South Channel (east of Cape Cod); late winter/spring feeding grounds and nursery grounds in Massachusetts Bay and Cape Cod Bay; summer/fall feeding and nursery grounds in the Bay of Fundy; and summer/fall feeding grounds on the Nova Scotian Shelf. In addition, Jeffreys Ledge, off the coast of northern Massachusetts, New Hampshire, and Maine, could be an important fall feeding area for right whales and an important nursery area during summer, especially in July and August (Weinrich et al. 2000). The first three habitats were designated as Critical Habitat Areas by NMFS (1994).

There is a general seasonal north-south migration of the North Atlantic population between feeding and calving areas, but right whales could be seen anywhere off the Atlantic U.S. throughout the year (Gaskin 1982). The seasonal occurrence of right whales in mid Atlantic waters is mostly between November and April, with peaks in December and April (Winn et al. 1986) when whales transit through the area on their migrations to and from breeding grounds or feeding grounds. The migration route between the Cape Cod summer feeding grounds and the Georgia/Florida winter calving grounds, known as the mid-Atlantic corridor, has not been considered to include “high use” areas, yet the whales clearly move through these waters regularly in all seasons (Reeves and Mitchell 1986; Winn et al. 1986; Kenney et al. 2001; Reeves 2001; Knowlton et al. 2002; Whitt et al. 2013).

North Atlantic right whales are found commonly on the northern feeding grounds off the northeastern U.S. during early spring and summer. The highest abundance in Cape Cod Bay is in February and April (Winn et al. 1986; Hamilton and Mayo 1990) and from April to June in the Great South Channel east of Cape Cod (Winn et al. 1986; Kenney et al. 1995). Throughout the remainder of summer and into fall (June–November), they are most commonly seen farther north on feeding grounds in Canadian waters, with a peak abundance during August, September, and early October (Gaskin 1987). Morano et

al. (2012) and Mussoline et al. (2012) indicated that right whales are present in the southern Gulf of Maine year-round and that they occur there over longer periods than previously thought.

Some whales, including mothers and calves, remain on the feeding grounds through the fall and winter. However, the majority of the right whale population leaves the feeding grounds for unknown wintering habitats and returns when the cow-calf pairs return. The majority of the right whale population is unaccounted for on the southeastern U.S. winter calving ground, and not all reproductively-active females return to the area each year (Kraus et al. 1986; Winn et al. 1986; Kenney et al. 2001). Other wintering areas have been suggested, based upon sparse data or historical whaling logbooks; these include the Gulf of St. Lawrence, Newfoundland and Labrador, coastal waters of New York and between New Jersey and North Carolina, Bermuda, and Mexico (Payne and McVay 1971; Aguilar 1986; Mead 1986; Lien et al. 1989; Knowlton et al. 1992; Cole et al. 2009; Patrician et al. 2009).

Knowlton et al. (2002) provided an extensive and detailed analysis of survey data, satellite tag data, whale strandings, and opportunistic sightings along State waters of the mid-Atlantic migratory corridor², from the border of Georgia/South Carolina to south of New England, including waters in the proposed seismic survey area, spanning the period from 1974 to 2002. The majority of sightings (94%) along the migration corridor were within 56 km of shore, and more than half (64%) were within 18.5 km of shore (Knowlton et al. 2002). Water depth preference was for shallow waters; 80% of all sightings were in depths <27 m, and 93% were in depths <45 m (Knowlton et al. 2002). Most sightings farther than 56 km from shore occurred at the northern end of the corridor, off New York and south of New England. North of Cape Hatteras, most sightings were reported for March–April. Sighting data analyzed by Winn et al. (1986) dating back to 1965 showed that the occurrence of North Atlantic right whales in the mid Atlantic, including the proposed survey area, peaked in April and December (Winn et al. 1986). A review of the mid-Atlantic whale sighting and tracking data archive for the mid Atlantic from 1974 to 2002 showed North Atlantic right whale sightings off the coast of New Jersey throughout the year, except during May–June, August, and November (Beaudin Ring 2002).

The Interactive North Atlantic Right Whale Sighting Map showed 32 sightings in the shelf waters off New Jersey between 2006 and 2012 (NEFSC 2013). Two of these sightings occurred just to the north of the proposed survey site. Three sightings were made in June, and none were made in July. However, two sightings were made during July to the far east of the proposed survey area (NEFSC 2013). There are also at least eight sightings of right whales off New Jersey in the Ocean Biogeographic Information System (OBIS; IOC 2013), which were made during the 1978–1982 Cetacean and Turtle Assessment Program (CETAP) surveys (CETAP 1982).

Palka (2006) reviewed North Atlantic right whale density in the U.S. Navy Northeast Operating Area based on summer abundance surveys conducted during 1998–2004. One of the lowest whale densities (including right whales) was found in the mid-Atlantic stratum, which includes the proposed survey area. However, survey effort for this stratum was also the lowest; only two surveys were conducted. No right whales were sighted.

Whitt et al. (2013) surveyed for right whales off the coast of New Jersey using acoustic and visual techniques from January 2008 to December 2009. Whale calls were detected off New Jersey year-round and four sightings were made: one in November, one in December, one in January just to the west of the

² Multi-year datasets for the analysis were provided by the New England Aquarium (NEAQ), North Atlantic Right Whale Consortium (NARWC), Oregon State University, Coastwise Consulting Inc., Georgia Department of Natural Resources, University of North Carolina Wilmington (UNCW), Continental Shelf Associates, Cetacean and Turtle Assessment Program (CETAP), NOAA, and University of Rhode Island.

survey area, and one cow-calf pair in May. In light of these findings, Whitt et al. (2013) suggested expanding the existing critical habitat to include waters of the mid-Atlantic. NMFS (2010) previously noted that such a revision could be warranted, but no revisions have been made to the critical habitat yet.

Federal and Other Action.—In 2002, NMFS received a petition to revise and expand the designation of critical habitat for the North Atlantic right whale. The revision was declined and the critical habitat designated in 1994 remained in place (NMFS 2005). Another petition for a revision to the critical habitat was received in 2009 that sought to expand the currently designated critical feeding and calving habitat areas and include a migratory corridor as critical habitat (NMFS 2010). NMFS noted that the requested revision may be warranted, but no revisions have been made as of September 2013. The designation of critical habitat does not restrict activities within the area or mandate any specific management action. However, actions authorized, funded, or carried out by Federal agencies that may have an impact on critical habitat must be consulted upon in accordance with Section 7 of the ESA, regardless of the presence of right whales at the time of impacts. Impacts on these areas that could affect primary constituent elements such as prey availability and the quality of nursery areas must be considered when analyzing whether habitat may be adversely modified.

A number of other actions have been taken to protect North Atlantic right whales, including establishing the Right Whale Sighting Advisory System designed to reduce collisions between ships and right whales by alerting mariners to the presence of the whales (see NEFSC 2012); a Mandatory Ship Reporting System implemented by the U.S. Coast Guard in the right whale nursery and feeding areas (USCG 1999, 2001; Ward-Geiger et al. 2005); recommended shipping routes in key right whale aggregation areas (NOAA 2006, 2007, 2013b); regulations to implement seasonal mandatory vessel speed restrictions in specific locations (Seasonal Management Areas) during times when whales are likely present, including ~37 km around points near the Ports of New York/New Jersey (40.495°N, 73.933°W) and Philadelphia and Wilmington (38.874°N, 75.026°W) during 1 November–30 April (NMFS 2008); temporary Dynamic Management Areas in response to actual whale sightings, requiring gear modifications to traps/pots and gillnets in areas north of 40°N with unexpected right whale aggregations (NOAA 2012); and a voluntary seasonal (April 1 to July 31) Area to be Avoided in the Great South Channel off Massachusetts (NOAA 2013b). Furthermore, BOEM proposed that no seismic surveys would be authorized within right whale critical habitat areas in its draft PEIS (BOEM 2012). The proposed survey area is not in any of these areas.

North Atlantic right whales likely would not be encountered during the proposed survey.

Humpback Whale (*Megaptera novaeangliae*)

In the North Atlantic, a Gulf of Maine stock of the humpback whale is recognized off the northeastern U.S. coast as a distinct feeding stock (Palsbøll et al. 2001; Vigness-Raposa et al. 2010). Whales from this stock feed during spring, summer, and fall in areas ranging from Cape Cod to Newfoundland. In the spring, greatest concentrations of humpback whales occur in the western and southern edges of the Gulf of Maine. During summer, the greatest concentrations are found throughout the Gulf of Maine, east of Cape Cod, and near the coast from Long Island to northern Virginia. Similar distribution patterns are seen in the fall, although sightings south of Cape Cod Bay are less frequent than those near the Gulf of Maine. From December to March, there are few occurrences of humpback whales over the continental shelf of the Gulf of Maine, and in Cape Cod and Massachusetts Bay (Clapham et al. 1993; Fig. B-5a in DoN 2005).

GMI (2010) reported 17 sightings of humpback whales during surveys conducted in shallow water (<30 m) on the continental shelf off New Jersey in January 2008–December 2009, with sightings during

every season (including 1 in spring and 4 in summer³). There are over 40 OBIS sighting records of humpback whales for the continental shelf off New Jersey, including sightings near the proposed survey area (IOC 2013). There was one sighting of a humpback whale during the 13-day cruise in 2014.

Common Minke Whale (*Balaenoptera acutorostrata*)

Four populations of the minke whale are recognized in the North Atlantic, including the Canadian East Coast stock that ranges from the eastern U.S. coast to Davis Strait (Waring et al. 2013). Minke whales are common off the U.S. east coast over continental shelf waters, especially off New England during spring and summer (CETAP 1982). Seasonal movements in the Northwest Atlantic are apparent, with animals moving south and offshore from New England waters during the winter (Fig. B-11a in DoN 2005; Waring et al. 2013). There are approximately 30 OBIS sightings of minke whales off New Jersey (IOC 2013), most of which were observed in the spring and summer during CETAP surveys (CETAP 1982).

GMI (2010) reported four sightings of minke whales during surveys conducted in shallow water (<30 m) on the continental shelf off New Jersey in January 2008–December 2009: two during winter and two during spring. Two sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2011 on the shelf break off New Jersey (Waring et al. 2013). Minke whales likely would not be encountered during the proposed survey.

Sei Whale (*Balaenoptera borealis*)

Two stocks of the sei whale are recognized in the North Atlantic: the Labrador Sea Stock and the Nova Scotia Stock; the latter has a distribution that includes continental shelf waters from the northeastern U.S. to areas south of Newfoundland (Waring et al. 2013). The southern portion of the Nova Scotia stock's range includes the Gulf of Maine and Georges Bank during spring and summer (Waring et al. 2013). Peak sightings occur in spring and are concentrated along the eastern edge of Georges Bank into the Northeast Channel and the southwestern edge of Georges Bank (Fig. B-6a in DoN 2005; Waring et al. 2013). Mitchell and Chapman (1977) suggested that this stock moves from spring feeding grounds on or near Georges Bank to the Scotian Shelf in June and July, eastward to Newfoundland and the Grand Banks in late summer, back to the Scotian Shelf in fall, and offshore and south in winter. During summer and fall, most sei whale sightings occur in feeding grounds in the Bay of Fundy and on the Scotian Shelf; sightings south of Cape Cod are rare (Fig. B-6a in DoN 2005).

There are at least three OBIS sightings of sei whales off New Jersey, and several more sightings to the south of the proposed survey area (IOC 2013). Palka (2012) reported one sighting on the shelf break off New Jersey in water depths ranging from 100–2000 m during June–August 2011 surveys. There were no sightings of sei whales during the CETAP surveys (CETAP 1982).

Fin Whale (*Balaenoptera physalus*)

Fin whales are present in U.S. shelf waters during winter, and are sighted more frequently than any other large whale at this time (DoN 2005). They occur year-round in shelf waters of New England and New Jersey (CETAP 1982; Fig. B-8a in DoN 2005). Winter sightings are most concentrated around Georges Bank and in Cape Cod Bay. During spring and summer, most fin whale sightings are north of 40°N, with smaller numbers on the shelf south of there, including off New Jersey (Fig. B-8a in DoN 2005). During fall, almost all fin whales move out of U.S. waters to feeding grounds in the Bay of Fundy and on the Scotian Shelf, remain at Stellwagen Bank and Murray Basin (Fig. B-8a in DoN 2005), or begin a southward migration (Clark 1995).

³ GMI defined spring as 11 April–21 June and summer as 22 June–27 September.

GMI (2010) reported 37 sightings of fin whales during surveys conducted in shallow water (<30 m) on the continental shelf off New Jersey in January 2008–December 2009, with sightings during every season (including 11 in spring and 4 in summer). Acoustic detections were also made during all seasons (GMI 2010). Numerous sightings were also made off New Jersey during NEFSC and SEFSC summer surveys between 1995 and 2011, with two sightings on the shelf and other sightings on the shelf break and beyond (Waring et al. 2013). There are 170 OBIS sightings of fin whales off New Jersey (IOC 2013), most of which were made during the CETAP surveys (CETAP 1982).

Blue Whale (*Balaenoptera musculus*)

In the western North Atlantic, the distribution of the blue whale extends as far north as Davis Strait and Baffin Bay (Sears and Perrin 2009). Little is known about the movements and wintering grounds of the stocks (Mizroch et al. 1984). The acoustic detection of blue whales using the U.S. Navy's Sound Surveillance System (SOSUS) program has tracked blue whales throughout most of the North Atlantic, including deep waters east of the U.S. Atlantic EEZ and subtropical waters north of the West Indies (Clark 1995).

Wenzel et al. (1988) reported the occurrence of three blue whales in the Gulf of Maine in 1986 and 1987, which were the only reports of blue whales in shelf waters from Cape Hatteras to Nova Scotia. Several other sightings for the waters off the east coast of the U.S. were reported by DoN (2005). Wenzel et al. (1988) suggested that it is unlikely that blue whales occur regularly in the shelf waters off the U.S. east coast. Similarly, Waring et al. (2010) suggested that the blue whale is, at best, an occasional visitor in the U.S. Atlantic EEZ.

During CETAP surveys, the only two sightings of blue whales were made south of Nova Scotia (CETAP 1982). There are two offshore sightings of blue whales in the OBIS database to the southeast of New Jersey and several sightings to the north off New England and in the Gulf of Maine (IOC 2013). Blue whales likely would not be encountered during the proposed survey.

Odontocetes

Sperm Whale (*Physeter macrocephalus*)

In the northwest Atlantic, the sperm whale generally occurs in deep water along the continental shelf break from Virginia to Georges Bank, and along the northern edge of the Gulf Stream (Waring et al. 2001). Shelf edge, oceanic waters, seamounts, and canyon shelf edges are also predicted habitats of sperm whales in the Northwest Atlantic (Waring et al. 2001). Off the eastern U.S. coast, they are also known to concentrate in regions with well-developed temperature gradients, such as along the edges of the Gulf Stream and warm core rings, which may aggregate their primary prey, squid (Jaquet 1996).

Sperm whales appear to have a well-defined seasonal cycle in the Northwest Atlantic. In winter, most historical records are in waters east and northeast of Cape Hatteras, with few animals north of 40°N; in spring, they shift the center of their distribution northward to areas east of Delaware and Virginia, but they are widespread throughout the central area of the Mid-Atlantic Bight and southern tip of Georges Bank (Fig. B-10a in DoN 2005; Waring et al. 2013). During summer, they expand their spring distribution to include areas east and north of Georges Bank, the Northeast Channel, and the continental shelf south of New England (inshore of 100 m deep). By fall, sperm whales are most common south of New England on the continental shelf but also along the shelf edge in the Mid-Atlantic Bight (Fig. B-10a in DoN 2005; Waring et al. 2013).

There are several hundred OBIS records of sperm whales in deep waters off New Jersey and New England (IOC 2013), and numerous sightings were reported on and seaward of the shelf break during

CETAP surveys (CETAP 1982) and during summer NEFSC and SEFSC surveys between 1998 and 2011 (Waring et al. 2013).

Pygmy and Dwarf Sperm Whales (*Kogia breviceps* and *K. sima*)

In the northwest Atlantic, both pygmy and dwarf sperm whales are thought to occur as far north as the Canadian east coast, with the pygmy sperm whale ranging as far as southern Labrador; both species prefer deep, offshore waters (Jefferson et al. 2008). Between 2006 and 2010, 127 pygmy and 32 dwarf sperm whale strandings were recorded from Maine to Puerto Rico, mostly off the southeastern U.S. coast; five strandings of pygmy sperm whales were reported for New Jersey (Waring et al. 2013).

There are 14 OBIS sightings of pygmy or dwarf sperm whales in offshore waters off New Jersey (IOC 2013). Several sightings of *Kogia* sp. (either pygmy or dwarf sperm whales) for shelf break waters off New Jersey were also reported during summer NEFSC and SEFSC surveys between 1995 and 2011 (Waring et al. 2013).

Cuvier's Beaked Whale (*Ziphius cavirostris*)

In the northwest Atlantic, Cuvier's beaked whale has stranded and been sighted as far north as the Nova Scotian shelf, and occurs most commonly from Massachusetts to Florida (MacLeod et al. 2006). Most sightings in the northwest Atlantic occur in late spring or summer, particularly along the continental shelf edge in the mid-Atlantic region (CETAP 1982; Waring et al. 2001, 2013). Mapping of combined beaked whale sightings in the northwest Atlantic suggests that beaked whales are rare in winter and fall, uncommon in spring, and abundant in summer in waters north of Virginia, off the shelf break and over the continental slope and areas of high relief, including the waters off New Jersey (Fig. B-13a in DoN 2005).

DoN mapped several sightings of Cuvier's beaked whales during the summer along the shelf break off New Jersey (Fig. B-13a in DoN 2005). One sighting was made off New Jersey during the CETAP surveys (CETAP 1982). Palka (2012) reported one sighting on the shelf break off New Jersey in water depths 100–2000 m during June–August 2011 surveys. There are eight OBIS sighting records of Cuvier's beaked whale in offshore waters off New Jersey (IOC 2013).

Northern Bottlenose Whale (*Hyperoodon ampullatus*)

Northern bottlenose whales are considered extremely uncommon or rare within waters of the U.S. Atlantic EEZ (Reeves et al. 1993; Waring et al. 2010), but there are known sightings off New England and New Jersey (CETAP 1982; McLeod et al. 2006; Waring et al. 2010). Two sightings of three individuals were made during the CETAP surveys; one sighting was made during May to the east of Cape Cod and the second sighting was made on 12 June along the shelf edge east of Cape May, New Jersey (CETAP 1982). Three sightings were made during summer surveys along the southern edge of Georges Bank in 1993 and 1996, and another three sightings were made in water depths 1000–4000 m at ~38–40°N during NEFSC and SEFSC surveys between 1998 and 2006 (Waring et al. 2010). In addition, there is one OBIS sighting off New England in 2005 made by the Canadian Department of Fisheries and Oceans (IOC 2013). DoN (2005) also reported northern bottlenose whale sightings beyond the shelf break off New Jersey during spring and summer. Northern bottlenose whales likely would not be encountered during the proposed survey.

True's Beaked Whale (*Mesoplodon mirus*)

In the Northwest Atlantic, True's beaked whale occurs from Nova Scotia to Florida and the Bahamas (Rice 1998). Carwardine (1995) suggested that this species could be associated with the Gulf Stream. DoN did not report any sightings of True's beaked whale off New Jersey (Fig. B-13a in DoN 2005); however, several sightings of undifferentiated beaked whales were reported for shelf break waters

off New Jersey during summer NEFSC and SEFSC surveys between 1995 and 2011 (Waring et al. 2013). There are no OBIS sightings of True's beaked whale off New Jersey, but there is one stranding record off North Carolina and one record off New England (IOC 2013). There are numerous other stranding records for the east coast of the U.S. (Macleod et al. 2006). True's beaked whales likely would not be encountered during the proposed survey.

Gervais' Beaked Whale (*Mesoplodon europaeus*)

Based on stranding records, Gervais' beaked whale appears to be more common in the western Atlantic than in the eastern Atlantic (Macleod et al. 2006; Jefferson et al. 2008). Off the U.S. east coast, it occurs from Cape Cod Bay, Massachusetts (Moore et al. 2004) to Florida, with a few records in the Gulf of Mexico (Mead 1989). DoN mapped two sightings of Gervais' beaked whale during summer to the south of the proposed survey area and numerous other sightings along the shelf break off the northeast coast of the U.S. (Fig. B-13a in DoN 2005). Palka (2012) reported three sightings in deep offshore waters during June–August 2011 surveys off the northeastern coast of the U.S. There are four OBIS stranding records of Gervais' beaked whale for Virginia, but no records for New Jersey (IOC 2013). Gervais' beaked whales likely would not be encountered during the proposed survey.

Sowerby's Beaked Whale (*Mesoplodon bidens*)

Sowerby's beaked whale occurs in cold temperate waters of the North Atlantic (Mead 1989). In the western North Atlantic, it is found from at least Massachusetts to the Labrador Sea (Mead et al. 2006; Jefferson et al. 2008). Palka (2012) reported one sighting on the shelf break off New Jersey during June–August 2011 surveys. There are also at least five OBIS sighting records in deep waters off New Jersey (IOC 2013). DoN mapped one stranding in New Jersey in fall and one in Delaware in spring, but no sightings off New Jersey (Fig. B-13a in DoN 2005). Sowerby's beaked whales likely would not be encountered during the proposed survey.

Blainville's Beaked Whale (*Mesoplodon densirostris*)

In the western North Atlantic, Blainville's beaked whale is found from Nova Scotia to Florida, the Bahamas, and the Gulf of Mexico (Würsig et al. 2000). There are numerous strandings records along the east coast of the U.S. (Macleod et al. 2006). DoN mapped several sightings of Blainville's beaked whale during summer along the shelf break off the northeastern coast of the U.S. (Fig. B-13a in DoN 2005). There is one OBIS sighting record in offshore waters to the southeast of New Jersey and one in offshore waters off New England (IOC 2013). Blainville's beaked whales likely would not be encountered during the proposed survey.

Rough-toothed Dolphin (*Steno bredanensis*)

The rough-toothed dolphin is distributed worldwide in tropical, subtropical, and warm temperate waters (Miyazaki and Perrin 1994). They are generally seen in deep, oceanic water, although they can occur in shallow coastal waters in some locations (Jefferson et al. 2008). The rough-toothed dolphin rarely ranges north of 40°N (Jefferson et al. 2008).

One sighting of 45 individuals was made south of Georges Bank seaward of the shelf edge during the CETAP surveys (CETAP 1982), and another sighting was made in the same areas during 1986 (Waring et al. 2010). In addition, two sightings were made off New Jersey to the southeast of the proposed survey area during 1979 and 1998 (Waring et al. 2010; IOC 2013). Palka (2012) reported a sighting in deep offshore waters off New Jersey during June–August 2011 surveys. Rough-toothed dolphins likely would not be encountered during the proposed survey.

Common Bottlenose Dolphin (*Tursiops truncatus*)

In the northwest Atlantic, the common bottlenose dolphin occurs from Nova Scotia to Florida, the Gulf of Mexico and the Caribbean, and south to Brazil (Würsig et al. 2000). There are regional and seasonal differences in the distribution of the offshore and coastal forms of bottlenose dolphins off the U.S. east coast. Although strandings of bottlenose dolphins are a regular occurrence along the U.S. east coast, since July 2013, an unusually high number of dead or dying bottlenose dolphins (971 as of 8 December 2013; 1175 as of 16 March 2014; 1283 as of 18 May 2014; and 1546 as of 19 October 2014) have washed up on the mid-Atlantic coast from New York to Florida (NOAA 2014). NOAA declared an unusual mortality event (UME), the tentative cause of which is thought to be cetacean morbillivirus. As of 20 October 2014, 266 of 280 dolphins tested were confirmed positive or suspect positive for morbillivirus. NOAA personnel observed that the affected dolphins occur in nearshore waters, whereas dolphins in offshore waters >50 m deep did not appear to be affected (Environment News Service 2013), but have stated that it is uncertain exactly what populations have been affected (NOAA 2014). In addition to morbillivirus, the bacteria *Brucella* was confirmed in 30 of 95 dolphins tested as of 20 October 2014 (NOAA 2014). The NOAA web site is updated frequently, and it is apparent that the strandings initially had been moving south; in the 4 November update, dolphins had been reported washing up only as far south as South Carolina, and in the 8 December update, strandings were also reported in Georgia and Florida. Recently, the numbers of strandings appear to be decreasing, especially in the northern states; between 17 August and 19 October, there were 2, 3, 4, and 0 strandings in NY, NJ, DE, and MD, respectively.

Evidence of year-round or seasonal residents and migratory groups exist for the coastal form of bottlenose dolphins, with the so-called “northern migratory management unit” occurring north of Cape Hatteras to New Jersey, but only during summer and in waters <25 m deep (Waring et al. 2010). The offshore form appears to be most abundant along the shelf break and is differentiated from the coastal form by occurring in waters typically >40 m deep (Waring et al. 2010). Bottlenose dolphin records in the Northwest Atlantic suggest that they generally can occur year-round from the continental shelf to deeper waters over the abyssal plain, from the Scotian Shelf to North Carolina (Fig. B-14a in DoN 2005).

GMI (2010) reported 319 sightings of bottlenose dolphins during surveys conducted in shallow water (<30 m) on the continental shelf off New Jersey in January 2008–December 2009, with most sightings made during spring and summer. Palka (2012) also reported numerous sightings on the shelf break off New Jersey in water depths ranging from 100–2000 m during June–August 2011 surveys. There are also several hundred OBIS records off New Jersey, including sightings near the proposed survey area on the shelf and along the shelf edge (IOC 2013). There was one sighting of 10 bottlenose dolphins during the 13-day cruise in 2014.

Pantropical Spotted Dolphin (*Stenella attenuata*)

Pantropical spotted dolphins generally occur in deep offshore waters between 40°N and 40°S (Jefferson et al. 2008). There have been a few sightings at the southern edge of Georges Bank (Waring et al. 2010). In addition, there are at least 10 OBIS sighting records for waters off New Jersey that were made during surveys by the Canadian Wildlife Service between 1965 and 1992 (IOC 2013). Pantropical spotted dolphins likely would not be encountered during the proposed survey.

Atlantic Spotted Dolphin (*Stenella frontalis*)

In the western Atlantic, the distribution of the Atlantic spotted dolphin extends from southern New England, south to the Gulf of Mexico, the Caribbean Sea, Venezuela, and Brazil (Leatherwood et al. 1976; Perrin et al. 1994; Rice 1998). During summer, Atlantic spotted dolphins are sighted in shelf waters south of Chesapeake Bay, and near the continental shelf edge, on the slope, and offshore north of

there, including the waters of New Jersey (Fig. B-15a *in* DoN 2005; Waring et al. 2013). Several sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2011 on the shelf break off New Jersey (Waring et al. 2013). There are two OBIS sighting records northeast of the survey area and at least eight records to the southeast of the survey area (IOC 2013). There was one sighting of 12 Atlantic spotted dolphins during the 13-day cruise in 2014.

Spinner Dolphin (*Stenella longirostris*)

The spinner dolphin is pantropical in distribution, with a range nearly identical to that of the pantropical spotted dolphin, including oceanic tropical and sub-tropical waters between 40°N and 40°S (Jefferson et al. 2008). The distribution of spinner dolphins in the Atlantic is poorly known, but they are thought to occur in deep waters along most of the U.S. coast; sightings off the northeast U.S. coast have occurred exclusively in offshore waters >2000 m (Waring et al. 2010). Several sightings were mapped by DoN (Fig. B-16 *in* DoN 2005) for offshore waters to the far east of New Jersey. There are also seven OBIS sighting records off the eastern U.S. but no records near the proposed survey area or in shallow water (IOC 2013). Spinner dolphins likely would not be encountered during the proposed survey.

Striped Dolphin (*Stenella coeruleoalba*)

In the western North Atlantic, the striped dolphin occurs from Nova Scotia to the Gulf of Mexico and south to Brazil (Würsig et al. 2000). Off the northeastern U.S. coast, striped dolphins occur along the continental shelf edge and over the continental slope from Cape Hatteras to the southern edge of Georges Bank (Waring et al. 2013). In all seasons, striped dolphin sightings have been centered along the 1000-m depth contour, and sightings have been associated with the north edge of the Gulf Stream and warm core rings (Waring et al. 2013). Their occurrence off the northeastern U.S. coast seems to be highest in the summer and lowest during the fall (Fig. B-17a *in* DoN 2005).

There are approximately 100 OBIS sighting records of striped dolphins for the waters off New Jersey to the east of the proposed survey area, mainly along the shelf break (IOC 2013). Numerous sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2011 off the shelf break (Waring et al. 2013).

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin occurs from Cape Hatteras to Georges Bank during mid January–May, moves onto Georges Bank and the Scotian Shelf during mid summer and fall, and has been observed in large aggregations on Georges Bank in fall (Selzer and Payne 1988; Waring et al. 2013). Sightings off New Jersey have been made during all seasons (Fig. B-19a *in* DoN 2005). GMI (2010) reported 32 sightings of short-beaked common dolphins during surveys conducted in shallow water (<30 m) on the continental shelf off New Jersey in January 2008–December 2009, with sightings during fall and winter. There are over 100 OBIS sighting records near the proposed survey area off New Jersey, with most sightings near the shelf edge, but there are also several sightings in shelf waters (IOC 2013). There were 4 sightings of a total of 45 short-beaked common dolphins during the 13-day cruise in 2014.

White-beaked Dolphin (*Lagenorhynchus albirostris*)

The white-beaked dolphin is widely distributed in cold temperature and subarctic North Atlantic waters (Reeves et al. 1999a), and mainly occurs over the continental shelf, especially along the shelf edge (Carwardine 1995). It occurs in immediate offshore waters of the east coast of the North America, from Labrador to Massachusetts (Rice 1998). Off the northeastern U.S. coast, white-beaked dolphins are mainly found in the western Gulf of Maine and around Cape Cod (CETAP 1982; Fig. B-20a *in* DoN 2005; Waring et al. 2010). There are two OBIS sighting records to the east of the proposed survey area

off New Jersey, and one to the south off North Carolina (IOC 2013). White-beaked dolphins likely would not be encountered during the proposed survey.

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

The Atlantic white-sided dolphin occurs in cold temperate to subpolar waters of the North Atlantic in deep continental shelf and slope waters (Jefferson et al. 2008). In the western North Atlantic, it ranges from Labrador and southern Greenland to ~38°N (Jefferson et al. 2008). There are seasonal shifts in Atlantic white-sided dolphin distribution off the northeastern U.S. coast, with low numbers in winter from Georges Basin to Jeffrey's Ledge and very high numbers in spring in the Gulf of Maine. In summer, Atlantic white-sided dolphins are mainly distributed northward from south of Cape Cod with the highest numbers from Cape Cod north to the lower Bay of Fundy; sightings off New Jersey appear to be sparse (Fig. B-21a in DoN 2005). There are over 20 OBIS sighting records in the shelf waters off New Jersey, including near the proposed survey area (IOC 2013).

Risso's Dolphin (*Grampus griseus*)

The highest densities of Risso's dolphin occur in mid latitudes ranging from 30° to 45°, and primarily in outer continental shelf and slope waters (Jefferson et al. 2013). Off the northeast U.S. coast during spring, summer, and autumn, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras to Georges Bank, but they range into oceanic waters during the winter (Waring et al. 2013). Mapping of Risso's dolphin sightings off the U.S. east coast suggests that they could occur year-round from the Scotian Shelf to the coast of the southeastern U.S. in waters extending from the continental shelf to the continental rise (DoN 2005). Off New Jersey, the greatest number of sightings occur near the continental slope during summer (Fig. B-22a in DoN 2005).

There are at least 170 OBIS records near the proposed survey area off New Jersey, including shelf waters and at the shelf edge (IOC 2013). Numerous sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2011 for the shelf break off New Jersey (Waring et al. 2013). There was one sighting of a Risso's dolphin during the 13-day cruise in 2014.

Pygmy Killer Whale (*Feresa attenuata*)

The pygmy killer whale is pantropical/subtropical, generally occurring between 40°N and 35°S (Jefferson et al. 2008). There is no abundance estimate for the pygmy killer whale off the U.S. east coast because it is rarely sighted during surveys (Waring et al. 2010). One group of six pygmy killer whales was sighted off Cape Hatteras in waters >1500 m deep during a NMFS vessel survey in 1992 (Hansen et al. 1994 in Waring et al. 2010). There are an additional three OBIS sighting records to the southeast of the proposed survey area (Palka et al. 1991 in IOC 2013). Pygmy killer whales likely would not be encountered during the proposed survey.

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found worldwide in tropical and temperate waters generally between 50°N and 50°S (Odell and McClune 1999). It is widely distributed, but not abundant anywhere (Carwardine 1995). In the western Atlantic, it occurs from Maryland to Argentina (Rice 1998). Very few false killer whales were sighted off the U.S. northeast coast in the numerous surveys mapped by DoN (2005). There are 13 OBIS sighting records for the waters off the eastern U.S., but none are near the proposed survey area (IOC 2013). False killer whales likely would not be encountered during the proposed survey.

Killer Whale (*Orcinus orca*)

In the western North Atlantic, killer whales occur from the polar ice pack to Florida and the Gulf of Mexico (Würsig et al. 2000). Based on historical sightings and whaling records, killer whales apparently were most often found along the shelf break and offshore in the northwest Atlantic (Katona et al. 1988). They are considered uncommon or rare in waters of the U.S. Atlantic EEZ (Katona et al. 1988). Killer whales represented <0.1 % of all cetacean sightings (12 of 11,156 sightings) in CETAP surveys during 1978–1981 (CETAP 1982). Four of the 12 sightings made during the CETAP surveys were made offshore from New Jersey. Off New England, killer whales are more common in summer than in any other season, occurring nearshore and off the shelf break (Fig. B-24 in DoN 2005). There are 39 OBIS sighting records for the waters off the eastern U.S., but none off New Jersey (IOC 2013). Killer whales likely would not be encountered during the proposed survey.

Long- and Short-finned Pilot Whales (*Globicephala melas* and *G. macrorhynchus*)

There are two species of pilot whale, both of which could occur in the survey area. The long-finned pilot whale (*G. melas*) is distributed antitropically, whereas the short-finned pilot whale (*G. macrorhynchus*) is found in tropical, subtropical, and warm temperate waters (Olson 2009). In the northwest Atlantic, pilot whales often occupy areas of high relief or submerged banks and associated with the Gulf Stream edge or thermal fronts along the continental shelf edge (Waring et al. 1992). The ranges of the two species overlap in the shelf/shelf-edge and slope waters of the northeastern U.S. between New Jersey and Cape Hatteras, with long-finned pilot whales occurring to the north (Bernard and Reilly 1999). During winter and early spring, long-finned pilot whales are distributed along the continental shelf edge off the northeast U.S. coast and in Cape Cod Bay, and in summer and fall they also occur on Georges Bank, in the Gulf of Maine, and north into Canadian waters (Fig. B-25a in DoN 2005).

There are at least 200 OBIS sighting records for pilot whales for the waters off New Jersey, including sightings over the shelf; these sightings include *Globicephala* sp. and *G. melas* (IOC 2013). Numerous sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2007 for the shelf break off New Jersey (Waring et al. 2013).

Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise inhabits cool temperate to subarctic waters of the Northern Hemisphere (Jefferson et al. 2008). There are likely four populations in the western North Atlantic: Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland (Gaskin 1984, 1992). Individuals found off the eastern U.S. coast likely would be almost exclusively from the Gulf of Maine/Bay of Fundy stock.

Harbor porpoises concentrate in the northern Gulf of Maine and southern Bay of Fundy during July–September, with a few sightings ranging as far south as Georges Bank and one off Virginia (Waring et al. 2013). In summer, sightings mapped from numerous sources extended only as far south as off northern Long Island, New York (Fig. B-26a in DoN 2005). During October–December and April–June, harbor porpoises are dispersed and range from New Jersey to Maine, although there are lower densities at the northern and southern extremes (DoN 2005; Waring et al. 2013). Most would be found over the continental shelf, but some are also encountered over deep waters (Westgate et al. 1998). During January–March, harbor porpoises concentrate farther south, from New Jersey to North Carolina, with lower densities occurring from New York to New Brunswick (DoN 2005; Waring et al. 2013).

GMI (2010) reported 51 sightings of harbour porpoise during surveys conducted in shallow water (<30 m) on the continental shelf off New Jersey in January 2008–December 2009, with sightings during fall and winter. There are 10 OBIS sighting records for the waters off New Jersey during March–June,

most of which are from the CETAP surveys (CETAP 1982; IOC 2013). Harbor porpoises likely would not be encountered during the proposed survey.

V. TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

L-DEO requests an IHA pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) for incidental take by harassment during its planned seismic survey in the Atlantic Ocean off the coast of New Jersey during June–July 2014.

The operations outlined in § I have the potential to take marine mammals by harassment. Sounds will be generated by the airguns used during the survey, by echosounders, and by general vessel operations. “Takes” by harassment will potentially result when marine mammals near the activities are exposed to the pulsed sounds generated by the airguns or echosounders. The effects will depend on the species of marine mammal, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see § VII). Disturbance reactions are likely amongst some of the marine mammals near the tracklines of the source vessel. No take by serious injury is anticipated, given the nature of the planned operations and the mitigation measures that are planned (see § XI, MITIGATION MEASURES). No lethal takes are expected.

VI. NUMBERS OF MARINE MAMMALS THAT COULD BE TAKEN

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [section V], and the number of times such takings by each type of taking are likely to occur.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

VII. ANTICIPATED IMPACT ON SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammal.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

- First we summarize the potential impacts on marine mammals of airgun operations, and refer to recent literature that has become available since the PEIS was released in 2011, as called for in § VII. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.
- Then we summarize the potential impacts of operations by the echosounders and refer to recent literature that has become available since the PEIS was released in 2011. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.
- Finally, we estimate the numbers of marine mammals that could be affected by the proposed survey in the Atlantic Ocean off New Jersey during June–July 2014. This section includes a description of the rationale for the estimates of the potential numbers of harassment “takes” during the planned survey, as called for in § VI. Acoustic modeling was conducted by L-DEO,

determined to be acceptable by NMFS to use in the calculation of estimated takes under the MMPA (e.g., NMFS 2013b,c), including for the 2014 survey. Analysis conducted for the proposed 2015 survey remains the same as described in the 2014 NSF Final EA for the 2014 survey, except for the smaller size of the airgun array.

Summary of Potential Effects of Airgun Sounds

As noted in the PEIS (§ 3.4.4.3, § 3.6.4.3, and § 3.7.4.3), the effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Permanent hearing impairment (PTS), in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall et al. 2007; Le Prell 2012). Rather, the onset of TTS has been considered an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility. Recent research has shown that sound exposure can cause cochlear neural degeneration, even when threshold shifts and hair cell damage are reversible (Liberman 2013). These findings have raised some doubts as to whether TTS should continue to be considered a non-injurious effect. Although the possibility cannot be entirely excluded, it is unlikely that the project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term.

Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers (e.g., Nieuwkirk et al. 2012). Several studies have shown that marine mammals at distances 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 that 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 mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales are quite variable.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (e.g., Gedamke 2011; Guerra et al. 2011, 2013), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. Guerra et al. (2013) reported that ambient noise levels between seismic pulses were elevated because of reverberation at ranges of 50 km from the seismic source. Based on measurements in deep water of the Southern Ocean, Gedamke (2011) estimated that the slight elevation of background levels during intervals between pulses reduced blue and fin whale communication space by as much as 36–51% when a seismic survey was operating 450–2800 km away. Based on preliminary modeling, Wittekind et al. (2013) reported that airgun sounds could reduce the communication range of blue and fin whales 2000 km from the seismic source. Klinck et al.

(2012) also found reverberation effects between airgun pulses. Nieukirk et al. (2012) and Blackwell et al. (2013) noted the potential for masking effects from seismic surveys on large whales.

Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses (e.g., Nieukirk et al. 2012). Cerchio et al. (2014) suggested that the breeding display of humpback whales off Angola could be disrupted by seismic sounds, as singing activity declined with increasing received levels. In addition, some cetaceans are known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behavior in response to airgun sounds (e.g., Di Iorio and Clark 2010; Castellote et al. 2012; Blackwell et al. 2013). The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small odontocetes that have been studied directly (e.g., MacGillivray et al. 2014). 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. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Based on NMFS (2001, p. 9293), NRC (2005), and Southall et al. (2007), we believe that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or “taking”. By potentially significant, we mean, ‘in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations’.

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; Ellison et al. 2012). 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 (e.g., New et al. 2013). 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). 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 marine 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 would be affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals could be disturbed to some biologically important degree by a seismic program are based primarily on behavioral observations of a few species. Detailed studies have been done on humpbacks, gray whales, bowheads, and sperm whales. Less detailed data are 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. 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. 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. They simply avoided the sound source by displacing their

migration route to varying degrees, but within the natural boundaries of the migration corridors (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995).

Responses of *humpback whales* to seismic surveys have been studied during migration, on summer feeding grounds, and on Angolan winter breeding grounds; there has also been discussion of effects on the Brazilian wintering grounds. Off Western Australia, avoidance reactions began at 5–8 km from the array, and those reactions kept most pods ~3–4 km from the operating seismic boat; there was localized displacement during migration of 4–5 km by traveling pods and 7–12 km by more sensitive resting pods of cow-calf pairs (McCauley et al. 1998, 2000). However, some individual humpback whales, especially males, approached within distances of 100–400 m. Studies examining the behavioral responses of humpback whales to airguns are currently underway off eastern Australia (Cato et al. 2011, 2012, 2013).

In the Northwest Atlantic, sighting rates were significantly greater during non-seismic periods compared with periods when a full array was operating, and humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods (Moulton and Holst 2010). On their summer feeding grounds in southeast Alaska, there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μ Pa on an approximate rms basis (Malme et al. 1985). It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel et al. 2004), but data from subsequent years, indicated that there was no observable direct correlation between strandings and seismic surveys (IWC 2007).

There are no data on reactions of *right whales* to seismic surveys. However, Rolland et al. (2012) suggested that ship noise causes increased stress in right whales; they showed that baseline levels of stress-related fecal hormone metabolites decreased in North Atlantic right whales with a 6-dB decrease in underwater noise from vessels. Wright et al. (2011) also reported that sound could be a potential source of stress for marine mammals.

Results from *bowhead whales* show that their responsiveness can be quite variable depending on their activity (migrating vs. feeding). Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 20–30 km from a medium-sized airgun source (Miller et al. 1999; Richardson et al. 1999). However, more recent research on bowhead whales corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources (e.g., Miller et al. 2005). Nonetheless, Robertson et al. (2013) showed that bowheads on their summer feeding grounds showed subtle but statistically significant changes in surfacing–respiration–dive cycles during exposure to seismic sounds, including shorter surfacing intervals, shorter dives, and decreased number of blows per surface interval.

Bowhead whale calls detected in the presence and absence of airgun sounds have been studied extensively in the Beaufort Sea. Bowheads continue to produce calls of the usual types when exposed to airgun sounds on their summering grounds, although numbers of calls detected are significantly lower in the presence than in the absence of airgun pulses; Blackwell et al. (2013) reported that calling rates in 2007 declined significantly where received SPLs from airgun sounds were 116–129 dB re 1 μ Pa. Thus, bowhead whales in the Beaufort Sea apparently decrease their calling rates in response to seismic operations, although movement out of the area could also contribute to the lower call detection rate (Blackwell et al. 2013).

A multivariate analysis of factors affecting the distribution of calling bowhead whales during their fall migration in 2009 noted that the southern edge of the distribution of calling whales was significantly closer to shore with increasing levels of airgun sound from a seismic survey a few hundred kilometers to the east of the study area (i.e., behind the westward-migrating whales; McDonald et al. 2010, 2011). It

was not known whether this statistical effect represented a stronger tendency for quieting of the whales farther offshore in deeper water upon exposure to airgun sound, or an actual inshore displacement of whales.

Reactions of migrating and feeding (but not wintering) *gray whales* to seismic surveys have been studied. Off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μ Pa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB re 1 μ Pa_{rms} (Malme et al. 1986, 1988). 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 (e.g., Gailey et al. 2007; Johnson et al. 2007; Yazvenko et al. 2007a,b).

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensounded by airgun pulses; sightings by observers on seismic vessels off the U.K. 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, although there was localized avoidance (Stone and Tasker 2006). Singing fin whales in the Mediterranean moved away from an operating airgun array, and their song notes had lower bandwidths during periods with versus without airgun sounds (Castellote et al. 2012).

During seismic surveys in the Northwest Atlantic, baleen whales as a group showed localized avoidance of the operating array (Moulton and Holst 2010). Sighting rates were significantly lower during seismic operations compared with non-seismic periods. Baleen whales were seen on average 200 m farther from the vessel during airgun activities vs. non-seismic periods, and these whales more often swam away from the vessel when seismic operations were underway compared with periods when no airguns were operating (Moulton and Holst 2010). Blue whales were seen significantly farther from the vessel during single airgun operations, ramp up, and all other airgun operations compared with non-seismic periods (Moulton and Holst 2010). Similarly, fin whales were seen at significantly farther distances during ramp up than during periods without airgun operations; there was also a trend for fin whales to be sighted farther from the vessel during other airgun operations, but the difference was not significant (Moulton and Holst 2010). Minke whales were seen significantly farther from the vessel during periods with than without seismic operations (Moulton and Holst 2010). Minke whales were also more likely to swim away and less likely to approach during seismic operations compared to periods when airguns were not operating (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. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year, and 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.

Toothed Whales.—Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal 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., Stone and Tasker 2006; Moulton and Holst 2010; Barry et al. 2012). In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance.

During seismic surveys in the Northwest Atlantic, delphinids as a group showed some localized avoidance of the operating array (Moulton and Holst 2010). The mean initial detection distance was significantly farther (by ~200 m) during seismic operations compared with periods when the seismic source was not active; however, there was no significant difference between sighting rates (Moulton and Holst 2010). The same results were evident when only long-finned pilot whales were considered.

Preliminary findings of a monitoring study of *narwhals* (*Monodon monoceros*) in Melville Bay, Greenland (summer and fall 2012) showed no short-term effects of seismic survey activity on narwhal distribution, abundance, migration timing, and feeding habits (Heide-Jørgensen et al. 2013a). In addition, there were no reported effects on narwhal hunting. These findings do not seemingly support a suggestion by Heide-Jørgensen et al. (2013b) that seismic surveys in Baffin Bay may have delayed the migration timing of narwhals, thereby increasing the risk of narwhals to ice entrapment.

The *beluga*, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels (e.g., Miller et al. 2005). Captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviors (e.g., Finneran et al. 2000, 2002, 2005).

Most studies of *sperm whales* exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses; in most cases the whales do not show strong avoidance (e.g., Stone and Tasker 2006; Moulton and Holst 2010), but foraging behavior can be altered upon exposure to airgun sound (e.g., Miller et al. 2009). There are almost no specific data on the behavioral reactions of *beaked whales* to seismic surveys. Most beaked whales tend to avoid approaching vessels of other types (e.g., Würsig et al. 1998) and/or change their behavior in response to sounds from vessels (e.g., Pirota et al. 2012). 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 (e.g., Simard et al. 2005). 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.

The limited available data suggest that *harbor porpoises* show stronger avoidance of seismic operations than do Dall's porpoises. Thompson et al. (2013) reported decreased densities and reduced acoustic detections of harbor porpoise in response to a seismic survey in Moray Firth, Scotland, at ranges of 5–10 km (SPLs of 165–172 dB re 1 μ Pa, SELs of 145–151 dB μ Pa² · s); however, animals returned to the area within a few hours. The apparent tendency for greater responsiveness in the harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson et al. 1995; Southall et al. 2007).

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and some other odontocetes. A ≥ 170 dB disturbance criterion (rather than ≥ 160 dB) is considered appropriate for delphinids, which tend to be less responsive than the more responsive cetaceans.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds

exposed to strong sounds. However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions.

Additional data are needed to determine the received sound levels at which small odontocetes would start to incur TTS upon exposure to repeated, low-frequency pulses of airgun sound with variable received levels. To determine how close an airgun array would need to approach in order to elicit TTS, one would (as a minimum) need to allow for the sequence of distances at which airgun pulses would occur, and for the dependence of received SEL on distance in the region of the seismic operation (e.g., Breitzke and Bohlen 2010; Laws 2012). At the present state of knowledge, it is also necessary to assume that the effect is directly related to total received energy, although there is recent evidence that auditory effects in a given animal are not a simple function of received acoustic energy. Frequency, duration of the exposure and occurrence of gaps within the exposure can also influence the auditory effect (Finneran and Schlundt 2010, 2011; Finneran et al. 2010a,b; Finneran 2012; Ketten 2012; Finneran and Schlundt 2011, 2013; Kastelein et al. 2013a).

The assumption that, in marine mammals, the occurrence and magnitude of TTS is a function of cumulative acoustic energy (SEL) is probably an oversimplification (Finneran 2012). Popov et al. (2011) examined the effects of fatiguing noise on the hearing threshold of Yangtze finless porpoises when exposed to frequencies of 32–128 kHz at 140–160 dB re 1 μ Pa for 1–30 min. They found that an exposure of higher level and shorter duration produced a higher TTS than an exposure of equal SEL but of lower level and longer duration. Kastelein et al. (2012a,b; 2013b) also reported that the equal-energy model is not valid for predicting TTS in harbor porpoises or harbor seals.

Recent data have shown that the SEL required for TTS onset to occur increases with intermittent exposures, with some auditory recovery during silent periods between signals (Finneran et al. 2010b; Finneran and Schlundt 2011). Schlundt et al. (2013) reported that the potential for seismic surveys using airguns to cause auditory effects on dolphins could be lower than previously thought. Based on behavioral tests, Finneran et al. (2011) and Schlundt et al. (2013) reported no measurable TTS in bottlenose dolphins after exposure to 10 impulses from a seismic airgun with a cumulative SEL of ~ 195 dB re 1 μ Pa² · s; results from auditory evoked potential measurements were more variable (Schlundt et al. 2013).

Recent studies have also shown that the SEL necessary to elicit TTS can depend substantially on frequency, with susceptibility to TTS increasing with increasing frequency above 3 kHz (Finneran and Schlundt 2010, 2011; Finneran 2012). When beluga whales were exposed to fatiguing noise with sound levels of 165 dB re 1 μ Pa for durations of 1–30 min at frequencies of 11.2–90 kHz, the highest TTS with the longest recovery time was produced by the lower frequencies (11.2 and 22.5 kHz); TTS effects also gradually increased with prolonged exposure time (Popov et al. 2013a). Popov et al. (2013b) also reported that TTS produced by exposure to a fatiguing noise was larger during the first session (or naïve subject state) with a beluga whale than TTS that resulted from the same sound in subsequent sessions (experienced subject state). Therefore, Supin et al. (2013) reported that SEL may not be a valid metric for examining fatiguing sounds on beluga whales. Similarly, Nachtigall and Supin (2013) reported that false killer whales are able to change their hearing sensation levels when exposed to loud sounds, such as warning signals or echolocation sounds.

It is inappropriate to assume that onset of TTS occurs at similar received levels in all cetaceans (*cf.* Southall et al. 2007). Some cetaceans could incur TTS at lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin. Based on the best available information, Southall et al. (2007) recommended a TTS threshold for exposure to single or multiple pulses of 183 dB re 1 μ Pa² · s.

Tougaard et al. (2013) proposed a TTS criterion of 165 dB re 1 $\mu\text{Pa}^2 \cdot \text{s}$ for porpoises based on data from two recent studies. Gedamke et al. (2011), based on preliminary simulation modeling that attempted to allow for various uncertainties in assumptions and variability around population means, suggested that some baleen whales whose closest point of approach to a seismic vessel is 1 km or more could experience TTS.

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al. 1995, p. 372ff; Gedamke et al. 2011). In terrestrial animals, exposure to sounds sufficiently strong to elicit a large TTS induces physiological and structural changes in the inner ear, and at some high level of sound exposure, these phenomena become non-recoverable (Le Prell 2012). At this level of sound exposure, TTS grades into PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS (e.g., Kastak and Reichmuth 2007; Kastak et al. 2008).

Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds with received levels ≥ 180 dB and 190 dB re 1 $\mu\text{Pa}_{\text{rms}}$, respectively (NMFS 2000). These criteria have been used in establishing the exclusion (=shut-down) zones planned for the proposed seismic survey. However, those criteria were established before there was any information about minimum received levels of sounds necessary to cause auditory impairment in marine mammals.

Recommendations for science-based noise exposure criteria for marine mammals, frequency-weighting procedures, and related matters were published by Southall et al. (2007). Those recommendations were never formally adopted by NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys, although some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations. In December 2013, NOAA made available for public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), taking at least some of the Southall et al. recommendations into account. The new acoustic guidance and procedures could account for the now-available scientific data on marine mammal TTS, the expected offset between the TTS and PTS thresholds, differences in the acoustic frequencies to which different marine mammal groups are sensitive (e.g., M-weighting or generalized frequency weightings for various groups of marine mammals, allowing for their functional bandwidths), and other relevant factors. At the time of preparation of this Draft EA, the date of release of the final guidelines and how they would be implemented are unknown.

Nowacek et al. (2013) concluded that current scientific data indicate that seismic airguns have a low probability of directly harming marine life, except at close range. Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see § XI and § XIII). Also, many marine mammals and (to a limited degree) sea turtles show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects could also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and

other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong transient sounds.

There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. However, Gray and Van Waerebeek (2011) have suggested a cause-effect relationship between a seismic survey off Liberia in 2009 and the erratic movement, postural instability, and akinesia in a pantropical spotted dolphin based on spatially and temporally close association with the airgun array. Additionally, a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings (e.g., Castellote and Llorens 2013).

Non-auditory effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are especially unlikely to incur non-auditory physical effects. The brief duration of exposure of any given mammal, the deep water in the study area, and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals to sounds strong enough to induce non-auditory physical effects.

Possible Effects of Other Acoustic Sources

The Kongsberg EM 122 MBES and Knudsen Chirp 3260 SBP would be operated from the source vessel during the proposed survey. Information about this equipment was provided in § 2.2.3.1 of the PEIS. A review of the anticipated potential effects (or lack thereof) of MBESs, SBPs, and pingers on marine mammals and sea turtles appears in § 3.4.4.3, § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.

There has been some recent attention given to the effects of MBES on marine mammals, as a result of a report issued in September 2013 by an IWC independent scientific review panel linking the operation of a MBES to a mass stranding of melon-headed whales (*Peponocephala electra*; Southall et al. 2013) off Madagascar. During May–June 2008, ~100 melon-headed whales entered and stranded in the Loza Lagoon system in northwest Madagascar at the same time that a 12-kHz MBES survey was being conducted ~65 km away off the coast. In conducting a retrospective review of available information on the event, an independent scientific review panel concluded that the Kongsberg EM 120 MBES was the most plausible behavioral trigger for the animals initially entering the lagoon system and eventually stranding. The independent scientific review panel, however, identified that an unequivocal conclusion on causality of the event was not possible because of the lack of information about the event and a number of potentially contributing factors. Additionally, the independent review panel report indicated that this incident was likely the result of a complicated confluence of environmental, social, and other factors that have a very low probability of occurring again in the future, but recommended that the potential be considered in environmental planning. It should be noted that this event is the first known marine mammal mass stranding closely associated with the operation of a MBES. Leading scientific experts knowledgeable about MBES have expressed concerns about the independent scientific review panel analyses and findings (Bernstein 2013).

There is no available information on marine mammal behavioral response to MBES sounds (Southall et al. 2013) or sea turtle responses to MBES systems. Much of the literature on marine mammal response to sonars relates to the types of sonars used in naval operations, including Low-Frequency Active (LFA) sonars (e.g., Miller et al. 2012; Sivle et al. 2012) and Mid-Frequency Active (MFA) sonars (e.g., Tyack et al. 2011; Melcón et al. 2012; Miller et al. 2012; DeRuiter et al. 2013a,b; Goldbogen et al. 2013). However, the MBES sounds are quite different from naval sonars. Ping duration of the MBES is

very short relative to naval sonars. Also, at any given location, an individual marine mammal would be in the beam of the MBES for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; naval sonars often use near-horizontally-directed sound. In addition, naval sonars have higher duty cycles. These factors would all reduce the sound energy received from the MBES relative to that from naval sonars.

Risch et al. (2012) found a reduction in humpback whale song in the Stellwagen Bank National Marine Sanctuary during Ocean Acoustic Waveguide Remote Sensing (OAWRS) activities that were carried out approximately 200 km away. The OAWRS used three frequency-modulated (FM) pulses centered at frequencies of 415, 734, and 949 Hz with received levels in the sanctuary 88–110 dB re 1 μ Pa. Deng et al (2014) measured the spectral properties of pulses transmitted by three 200-kHz echo sounders, and found that they generated weaker sounds at frequencies below the center frequency (90–130 kHz). These sounds are within the hearing range of some marine mammals, and the authors suggested that they could be strong enough to elicit behavioural responses within close proximity to the sources, although they would be well below potentially harmful levels.

Despite the aforementioned information that has recently become available, this Draft EA is in agreement with the assessment presented in § 3.6.4.3 and § 3.7.4.3 of the PEIS that operation of multibeam echosounders (MBES), sub-bottom profilers (SBP), and pingers is not likely to impact mysticetes or odontocetes (1) given the lower acoustic exposures relative to airguns and (2) because the intermittent and narrow, downward-directed nature of the acoustic sources would result in no more than one or two brief ping exposures of any individual animal, given the movement and speed of the vessel.

Numbers of Marine Mammals that could be “Taken by Harassment”

All anticipated takes would be “takes by harassment”, involving temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. (However, as noted earlier, there is no specific information demonstrating that injurious “takes” would occur even in the absence of the planned mitigation measures.) In the sections below, we describe methods to estimate the number of potential exposures to various received sound levels and present estimates of the numbers of marine mammals that could be affected during the proposed seismic program. The estimates are based on a consideration of the number of marine mammals that could be disturbed appreciably by operations with the airgun array to be used during ~4900 km of seismic surveys in the Atlantic Ocean off New Jersey. The sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

It is assumed that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the MBES, SBP, and ADCP would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES, SBP, and ADCP, given their characteristics (e.g., narrow downward-directed beam) and other considerations described in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS. Such reactions are not considered to constitute “taking” (NMFS 2001). Therefore, no additional allowance is included for animals that could be affected by sound sources other than airguns.

Basis for Estimating “Take by Harassment”

The estimates are based on a consideration of the number of marine mammals that could be within the area around the operating airgun array where the received levels (RLs) of sound >160 dB re 1 μ Pa_{rms} are predicted to occur (see Table 1). The estimated numbers are based on the densities (numbers per unit area) of marine mammals expected to occur in the area in the absence of a seismic survey. To the extent that

marine mammals tend to move away from seismic sources before the sound level reaches the criterion level and tend not to approach an operating airgun array, these estimates are likely to overestimate the numbers actually exposed to the specified level of sounds. The overestimation is expected to be particularly large when dealing with the higher sound-level criteria, e.g., 180 dB re 1 $\mu\text{Pa}_{\text{rms}}$, as animals are more likely to move away before RL reaches 180 dB than they are to move away before it reaches (for example) 160 dB re 1 $\mu\text{Pa}_{\text{rms}}$. Likewise, they are less likely to approach within the ≥ 180 dB re 1 $\mu\text{Pa}_{\text{rms}}$ radius than they are to approach within the considerably larger ≥ 160 dB radius.

We used densities calculated from the U.S. Navy's "OPAREA Density Estimates" (NODE) database (DoN 2007). The cetacean density estimates are based on the NMFS-NEFSC aerial surveys conducted between 1998 and 2004; all surveys from New Jersey to Maine were conducted in summer (June–August). Density estimates were derived 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 survey data were not collected. For some species, there were not enough sightings to be able to produce a density surface, so densities were estimated using traditional line-transect analysis. The models and analyses have been incorporated into a web-based Geographic Information System (GIS) developed by Duke University's Department of Defense Strategic Environmental Research and Development Program (SERDP) team in close collaboration with the NMFS SERDP team (Read et al. 2009). We used the GIS to obtain densities in a polygon the size of the survey area for the 19 cetacean species in the model. The GIS provides minimum, mean, and maximum estimates for four seasons, and we have used the mean estimates for summer. Mean densities were used because the minimum and maximum estimates are for points within the polygon, whereas the mean estimate is for the entire polygon.

The estimated numbers of individuals potentially exposed presented below are based on the 160-dB re 1 $\mu\text{Pa}_{\text{rms}}$ criterion for all cetaceans. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently to be considered "taken by harassment". Table 3 shows the density estimates calculated as described above and the estimates of the number of different individual marine mammals that potentially could be exposed to ≥ 160 dB re 1 $\mu\text{Pa}_{\text{rms}}$ during the seismic survey if no animals moved away from the survey vessel. The *Requested Take Authorization* is given in the far right column of Table 3. For species for which densities were not available but for which there were sighting records near the survey area, we have included a *Requested Take Authorization* for the mean group size for the species from Palka (2012).

It should be noted that the following estimates of exposures to various sound levels assume that the proposed survey would be completed; in fact, the ensonified areas calculated using the planned number of line-kilometers **have been increased by 25%** to accommodate turns, lines that may need to be repeated, equipment testing, etc. As is typical during offshore ship surveys, inclement weather and equipment malfunctions are likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated exclusion zones would result in the shut down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 $\mu\text{Pa}_{\text{rms}}$ sounds are precautionary and probably overestimate the actual numbers of marine mammals that could be involved. These estimates assume that there would be no weather, equipment, or mitigation delays, which is highly unlikely. For the 2014 survey, NMFS added an additional 25% to the estimated take to account for the turnover of marine mammals in the survey area. NSF has traditionally not included this factor into take calculations and therefore has not included it here.

TABLE 3. Densities and estimates of the possible numbers of individuals that could be exposed to ≥ 160 dB re 1 $\mu\text{Pa}_{\text{rms}}$ during the proposed seismic survey in the northwest Atlantic off New Jersey during June–August 2015. The proposed sound source consists of a 4-airgun subarray with a total discharge volume of ~ 700 in³. Species in italics are listed under the ESA as endangered. The column of numbers in boldface shows the numbers of Level B "takes" for which authorization is requested.

Species	Reported Density (#/1000 km ²) Read et al. (2009) ¹	Correction Factor ²	Estimated Density (#/1000 km ²)	Ensonified Area (km ²)	Calculated Take ³	% of Regional Pop'n ⁴	Requested Level B Take Authorization
Mysticetes							
<i>North Atlantic right whale</i>	0		0	2037	0	0	0
<i>Humpback whale</i>	0		0	2037	0	0.01	1⁵
Minke whale	0		0	2037	0	0	0
<i>Sei whale</i>	0.161		0.161	2037	0	0.01	1⁵
<i>Fin whale</i>	0.002		0.002	2037	0	<0.01	1⁵
<i>Blue whale</i>	0		0	2037	0	0	0
Odontocetes							
<i>Sperm whale</i>	7.06		7.06	2037	14	0.11	14
Pygmy/dwarf sperm whale	0.001		0.001	2037	0	0.05	2⁵
Beaked whales ⁶	0.124		0.124	2037	0	0.02	3⁵
Rough-toothed dolphin	0		0	2037	0	0	0
Bottlenose dolphin	111.3		111.3	2037	227	0.26	227
Pantropical spotted dolphin	0		0	2037	0	0	0
Atlantic spotted dolphin	36.11		36.11	2037	74	0.16	74
Spinner dolphin ⁷	0		0	2037	0	0	0
Striped dolphin	0		0	2037	0	0.08	46⁵
Short-beaked common dolphin	0		0	2037	0	0.01	18⁵
White-beaked dolphin ⁷	0		0	2037	0	0	0
Atlantic white-sided dolphin	0		0	2037	0	0.03	15⁵
Risso's dolphin	13.60		13.60	2037	28	0.15	28
Pygmy killer whale ⁷	0		0	2037	0	N/A	0
False killer whale ⁷	0		0	2037	0	N/A	0
Killer whale ⁷	0		0	2037	0	N/A	0
Pilot whale	0.184		0.184	2037	0	<0.01	9⁵
Harbor porpoise	0		0	2037	0	0	0

¹ Densities are the mean values for the survey area, calculated from the SERDP model of Read et al. (2009).

² No correction factors were applied for these calculations.

³ Calculated take is estimated density (reported density x correction factor) multiplied by the 160-dB ensonified area (including the 25% contingency).

⁴ Requested takes are expressed as percentages of the larger regional populations, where available, for species that are at least partly pelagic; where not available (most odontocetes—see Table 2), Draft 2013 SAR population estimates were used; N/A means not available.

⁵ Requested take authorization was increased to group size from Palka (2012) for species for which densities were zero but that have been sighted near the proposed survey area.

⁶ May include Cuvier's, True's, Gervais', Sowerby's, or Blainville's beaked whales, or the northern bottlenose whale

⁷ Atlantic waters are not included in the SERDP model of Read et al. (2009).

Consideration should be given to the hypothesis that delphinids are less responsive to airgun sounds than are mysticetes, as referenced in both the PEIS and "Summary of Potential Airgun Effects" of this document. The 160-dB (rms) criterion currently applied by NMFS, on which the following estimates are based, was developed based primarily on data from gray and bowhead whales. The estimates of "takes by harassment" of delphinids given below are thus considered precautionary. NMFS is currently drafting new acoustic guidance and procedures for marine mammals; new criteria for behavioral harassment may be based on dose-response-type curves or risk functions. Available data suggest that the current use of a

160-dB criterion may be improved upon, as behavioral response may not occur for some percentage of odontocetes and mysticetes exposed to received levels >160 dB, whereas other individuals or groups may respond in a manner considered as taken to sound levels <160 dB (NMFS 2013a). It has become evident that the context of an exposure of a marine mammal to sound can affect the animal's initial response to the sound (NMFS 2013a).

Potential Number of Marine Mammals Exposed

The number of different individuals that could be exposed to airgun sounds with received levels ≥ 160 dB re $1 \mu\text{Pa}_{\text{rms}}$ on one or more occasions can be estimated by considering the total marine area that would be within the 160-dB radius around the operating seismic source on at least one occasion, along with the expected density of animals in the area. The number of possible exposures (including repeated exposures of the same individuals) can be estimated by considering the total marine area that would be within the 160-dB radius around the operating airguns, including areas of overlap. During the proposed survey, the transect lines are closely spaced relative to the 160-dB distance. Thus, the area including overlap is 35.5 times the area excluding overlap, so a marine mammal that stayed in the survey area during the entire survey could be exposed ~ 36 times, on average. However, it is unlikely that a particular animal would stay in the area during the entire survey. The numbers of different individuals potentially exposed to ≥ 160 dB re $1 \mu\text{Pa}_{\text{rms}}$ were calculated by multiplying the expected species density times the anticipated area to be ensonified to that level during airgun operations excluding overlap. The area expected to be ensonified was determined by entering the planned survey lines into a MapInfo GIS, using the GIS to identify the relevant areas by “drawing” the applicable 160-dB buffer (see Table 1) around each seismic line, and then calculating the total area within the buffers.

Applying the approach described above, $\sim 1630 \text{ km}^2$ ($\sim 2037 \text{ km}^2$ including the 25% contingency) would be within the 160-dB isopleth on one or more occasions during the proposed survey. Because this approach does not allow for turnover in the mammal populations in the area during the course of the survey, the actual number of individuals exposed may be underestimated, although the conservative (i.e., probably overestimated) line-kilometer distances used to calculate the area may offset this. Also, the approach assumes that no cetaceans would move away or toward the trackline as the *Langseth* approaches in response to increasing sound levels before the levels reach 160 dB. Another way of interpreting the estimates that follow is that they represent the number of individuals that are expected (in the absence of a seismic program) to occur in the waters that would be exposed to ≥ 160 dB re $1 \mu\text{Pa}_{\text{rms}}$.

The estimate of the number of individual cetaceans that could be exposed to seismic sounds with received levels ≥ 160 dB re $1 \mu\text{Pa}_{\text{rms}}$ during the proposed survey is 343 (Table 3). That total includes 14 cetaceans listed as *Endangered* under the ESA, all sperm whales (0.11% of the regional population). Most (96%) of the cetaceans potentially exposed are delphinids; the bottlenose dolphin, Atlantic spotted dolphin, and Risso's dolphin are estimated to be the most common delphinid species in the area, with estimates of 227 (0.26% of the regional population), 74 (0.16%), and 28 (0.15%) exposed to ≥ 160 dB re $1 \mu\text{Pa}_{\text{rms}}$, respectively.

Conclusions

The proposed seismic survey will involve towing an airgun array that introduces pulsed sounds into the ocean, along with simultaneous operation of a MBES and a SBP. The survey will employ a 4-airgun subarray, with a total discharge volume of 700 in^3 . Routine vessel operations, other than the proposed airgun operations, are conventionally assumed not to affect marine mammals sufficiently to constitute “taking”. No “taking” of marine mammals is expected in association with echosounder operations given the considerations discussed in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.

Cetaceans.—In § 3.6.7 and 3.7.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures may result in a small number of Level B behavioral effects in some mysticete and odontocete species in the North Atlantic QAA; that Level A effects were highly unlikely; and that operations were unlikely to adversely affect ESA-listed species.

In this IHA Application, estimates of the numbers of marine mammals that could be exposed to strong airgun sounds during the proposed program have been presented, together with the requested “take authorization”. The estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are very low percentages of the regional population sizes (Table 3). The estimates are likely overestimates the actual number of animals that would be exposed to and would react to the seismic sounds. The reasons for that conclusion are outlined above. The relatively short-term exposures are unlikely to result in any long-term negative consequences for the individuals or their populations.

VIII. ANTICIPATED IMPACT ON SUBSISTENCE

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

There is no subsistence hunting near the proposed survey area, so the proposed activities will not have any impact on the availability of the species or stocks for subsistence users.

IX. ANTICIPATED IMPACT ON HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The proposed seismic survey would not result in any permanent impact on habitats used by marine mammals or to the food sources they use. The main impact issue associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in § VII, above. This section briefly reviews the conclusions of the PEIS about effects of airguns on fish and invertebrates.

Effects of seismic sound on marine invertebrates (crustaceans and cephalopods), marine fish, and their fisheries are discussed in § 3.2.4 and § 3.3.4 and Appendix D of the PEIS. The PEIS concluded that there could be changes in behavior and other non-lethal, short-term, temporary impacts, and injurious or mortal impacts on a small number of individuals within a few meters of a high-energy acoustic source, but that there would be no significant impacts of NSF-funded marine seismic research on populations.

X. ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, because operations will be limited in duration. However, a small minority of the marine mammals that are present near the proposed activity may be temporarily displaced as much as a few kilometers by the planned activity.

XI. MITIGATION MEASURES

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Marine mammals and sea turtles are known to occur in the proposed study area. To minimize the likelihood that impacts will occur to the species and stocks, airgun operations will be conducted in accordance with the MMPA and the ESA, including obtaining permission for incidental harassment or incidental ‘take’ of marine mammals and other endangered species. The proposed activities will take place in the U.S. EEZ.

The following subsections provide more detailed information about the mitigation measures that are an integral part of the planned activities. The procedures described here are based on protocols used during previous L-DEO seismic research cruises as approved by NMFS, and on best practices recommended in Richardson et al (1995), Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

Planning Phase

As discussed in § 2.4.1.1 of the PEIS, mitigation of potential impacts from the proposed activities begins during the planning phase of the proposed activities. Several factors were considered during the planning phase of the proposed activities, including

1. Energy Source—Part of the considerations for the proposed survey was to evaluate whether the research objectives could be met with a smaller energy source than the full, 36-airgun, 6600-in³ *Langseth* array, and it was decided that the scientific objectives could be met using an energy source comprising 4 airguns (total volume 700 in³ volume), and towed at a depth of ~4.5 or 6 m. Two such subarrays of either 4 airguns would be used alternately (flip-flop mode); one would be towed on the port side, the other one on the starboard side. Thus, the source volume would not exceed 700 in³ at any time. Because the choice of subarray size and tow depth would not be made until the survey because of weather and sea conditions, we have assumed in the impacts analysis and take estimate calculations the use of the 6-m tow depth, as that would result in the farthest sound propagation.
2. Survey Timing—The PIs worked with L-DEO and NSF to identify potential times to carry out the survey taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals, sea turtles, and seabirds), weather conditions, equipment, and optimal timing for other proposed seismic surveys using the *Langseth*. Some marine mammal species are expected to occur in the area year-round, so altering the timing of the proposed project likely would result in no net benefits for those species. Some migratory species are expected to be farther north at the time of the survey, so the survey timing is beneficial for those species.
3. Mitigation Zones—During the planning phase, mitigation zones for the proposed survey were calculated based on modeling by L-DEO for both the exclusion zone (EZ) and the safety zone; these zones are given in Table 1 and Table A2, Appendix A of the EA. A more detailed description of the modeling process used to develop the mitigation zones can be found in Appendix A of the EA. Received sound levels in deep water have been predicted by L-DEO for the 4-airgun subarray and the single Bolt 1900LL 40-in³ airgun that would be used during

power downs. Scaling factors between those arrays and the 18-airgun, 3300-in³ array, taking into account tow depth differences, were developed and applied to empirical data for the 18-airgun array in shallow water in the Gulf of Mexico from Diebold et al. (2010). Because the choice of array size and tow depth would not be made until the survey because of weather and sea conditions, the use of the 6-m tow depth is assumed in the impacts and take estimate analysis, as that results in the farthest sound propagation. During actual operations, however, the corresponding mitigation zone would be applied for the selected source level.

Table 1 shows the 180-dB EZ and 160-dB “Safety Zone” (distances at which the rms sound levels are expected to be received) for the mitigation airgun and the 4-airgun subarray. The 160 and 180-dB re 1 $\mu\text{Pa}_{\text{rms}}$ distances are the criteria currently specified by NMFS (2000) for cetaceans. The 180-dB distance has also been used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs. Per the Biological Opinion issued in 2014 (Appendix C of the 1 July 2014 Final EA), a 166-dB distance would be used for Level B takes for sea turtles. Per the IHA for this survey issued in 2014 (Appendix D of the 1 July 2014 Final EA), the Exclusion Zone was increased by 3 dB (thus operational mitigation would be at the 177-dB isopleth), which adds ~50% to the power-down/shut-down radius. NSF does not view this overly precautionary approach appropriate, and it is not included here. A recent retrospective analysis of acoustic propagation of *Langseth* sources in a coastal/shelf environment from the Cascadia Margin off Washington suggests that predicted radii (using an approach similar to that used here) for *Langseth* sources were 2–3 times larger than measured in shallow water, so in fact were very conservative (Crone et al. 2014).

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), although at the time of preparation of this Draft Amended EA, the date of release of the final guidelines and how they would be implemented are unknown. As such, this Draft Amended EA has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as noted below.

Mitigation During Operations

Mitigation measures that will be adopted during the proposed survey include (1) power-down procedures, (2) shut-down procedures, (3) ramp-up procedures, and (4) special procedures for situations or species of particular concern.

Power-down Procedures

A power down involves decreasing the number of airguns in use such that the radius of the 180-dB (or 190-dB) zone is decreased to the extent that marine mammals or turtles are no longer in or about to enter the EZ. During a power down, one airgun will be operated. The continued operation of one airgun is intended to alert marine mammals and turtles to the presence of the seismic vessel in the area. In contrast, a shut down occurs when all airgun activity is suspended.

If a marine mammal or turtle is detected outside the EZ but is likely to enter the EZ, the airguns will be powered down before the animal is within the EZ. Likewise, if a mammal or turtle is already within the EZ when first detected, the airguns will be powered down immediately. During a power down of the airgun array, the 40-in³ airgun will be operated. If a marine mammal or turtle is detected within or near the smaller EZ around that single airgun (Table 1), it will be shut down (see next subsection).

Following a power down, airgun activity will not resume until the marine mammal or turtle has cleared the safety zone. The animal will be considered to have cleared the safety zone if

- it is visually observed to have left the EZ, or
- it has not been seen within the zone for 15 min in the case of small odontocetes, or
- it has not been seen within the zone for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales, or
- the vessel has moved outside the EZ for turtles, e.g., if a turtle is sighted close to the vessel and the ship speed is 8.3 km/h, it would take the vessel ~3 min to leave the turtle behind.

During airgun operations following a shut down whose duration has exceeded the time limits specified above, the airgun array would be ramped up gradually. Ramp-up procedures are described below. During past *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity. Furthermore, under these circumstances, ramp-up procedures may unnecessarily extend the length of the survey time needed to collect seismic data. LDEO and NSF have concluded in consultation with NMFS that ramp up is not necessary after an extended power down. This assessment therefore does not include this practice as part of the monitoring and mitigation plan.

Shut-down Procedures

The operating airgun(s) will be shut down if a marine mammal or turtle is seen within or approaching the EZ for the single airgun. Shut downs will be implemented (1) if an animal enters the EZ of the single airgun after a power down has been initiated, or (2) if an animal is initially seen within the EZ of the single airgun when more than one airgun (typically the full array) is operating. Airgun activity will not resume until the marine mammal or turtle has cleared the safety zone, or until the PSO is confident that the animal has left the vicinity of the vessel. Criteria for judging that the animal has cleared the safety zone will be as described in the preceding subsection.

Ramp-up Procedures

A ramp-up procedure will be followed when the airgun array begins operating after a specified period without airgun operations. It is proposed that, for the present survey, this period would be ~8 min. Similar periods (~8–10 min) were used during previous L-DEO surveys. Ramp up will not occur if a marine mammal or sea turtle has not cleared the safety zone as described earlier.

Ramp up will begin with the smallest airgun in the array (40 in³). Airguns will be added in a sequence such that the source level of the array will increase in steps not exceeding 6 dB per 5-min period. During ramp up, the PSOs will monitor the EZ, and if marine mammals or turtles are sighted, a power down or shut down will be implemented as though the full array were operational.

If the complete EZ has not been visible for at least 30 min prior to the start of operations in either daylight or nighttime, ramp up would not commence unless at least one airgun (40 in³ or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the airgun array will not be ramped up from a complete shut down at night or in thick fog, because the outer part of the safety zone for that array will not be visible during those conditions. If one airgun has operated during a power-down period, ramp up to full power will be permissible at night or in poor visibility, on the assumption that marine mammals and turtles will be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. Ramp up of the airguns will not be initiated if a sea turtle or marine mammal is sighted within or near the applicable EZs during the day or night.

As noted above under “Power-down Procedures”, during past R/V *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return

to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity.

Special Procedures for Situations or Species of Concern

It is unlikely that a North Atlantic right whale would be encountered, but if so, the airguns will be shut down immediately if one is sighted at any distance from the vessel because of its rarity and conservation status. Also, it is unlikely that concentrations of humpback, fin, sperm, blue, or sei whales or dolphins would be encountered, but if so, they will be avoided.

XII. PLAN OF COOPERATION

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

- (i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;
- (ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;
- (iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and
- (iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

Not applicable. The proposed activity will take place in the Atlantic Ocean, and no activities will take place in or near a traditional Arctic subsistence hunting area.

XIII. MONITORING AND REPORTING PLAN

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding...

L-DEO proposes to sponsor marine mammal monitoring during the present project, in order to implement the proposed mitigation measures that require real-time monitoring, and to satisfy the anticipated monitoring requirements of the IHA.

L-DEO's proposed Monitoring Plan is described below. L-DEO understands that this Monitoring Plan will be subject to review by NMFS, and that refinements may be required.

The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. L-DEO is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

PSO observations will take place during daytime airgun operations and nighttime start ups of the airguns. Airgun operations will be suspended when marine mammals or turtles are observed within, or about to enter, designated exclusion zones [see § XI above] where there is concern about potential effects on hearing or other physical effects. PSOs will also watch for marine mammals and turtles near the seismic vessel for at least 30 min prior to the planned start of airgun operations. Observations will also be made during daytime periods when the *Langseth* is underway without seismic operations, such as during transits.

During seismic operations, at least four visual PSOs will be based aboard the *Langseth*. PSOs will be appointed by L-DEO with NMFS concurrence. During the majority of seismic operations, two PSOs will monitor for marine mammals and sea turtles around the seismic vessel. Use of two simultaneous observers will increase the effectiveness of detecting animals around the source vessel. However, during meal times, only one PSO may be on duty. PSO(s) will be on duty in shifts of duration no longer than 4 h. Other crew will also be instructed to assist in detecting marine mammals and turtles and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew will be given additional instruction regarding how to do so.

The *Langseth* is a suitable platform for marine mammal and turtle observations. When stationed on the observation platform, the eye level will be ~21.5 m above sea level, and the observer will have a good view around the entire vessel. During daytime, the PSO(s) will 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 (NVDs) will be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), when required. Laser rangefinding binoculars (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. Those are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly; that is done primarily with the reticles in the binoculars.

Passive Acoustic Monitoring

Passive acoustic monitoring (PAM) will take place to complement the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustical monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The acoustic monitoring will 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. It will be monitored in real time so that the visual observers can be advised when cetaceans are detected.

The PAM system consists of hardware (i.e., hydrophones) and software. The “wet end” of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. The tow cable is 250 m long, and the hydrophones are fitted in the last 10 m of cable. A depth gauge is attached to the free end of the cable, and the cable is typically towed at depths <20 m. The array will be deployed from a winch located on the back deck. A deck cable will connect the tow cable to the electronics unit in the main computer lab where the acoustic station, signal conditioning, and processing system will be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the Pamguard software. The system can detect marine mammal vocalizations at frequencies up to 250 kHz.

One acoustic PSO or PSAO (in addition to the 4 visual PSOs) will be on board. The towed hydrophones will ideally be monitored 24 h per day while at the seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating.

However, PAM may not be possible if damage occurs to the array or back-up systems during operations. One PSO will monitor the acoustic detection system at any one time, 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 PSAO monitoring the acoustical data will be on shift for 1–6 h at a time. All observers are expected to rotate through the PAM position, although the most experienced with acoustics will be on PAM duty more frequently.

When a vocalization is detected while visual observations are in progress, the PSAO will contact the visual PSO immediately, to alert him/her to the presence of cetaceans (if they have not already been seen), and to allow a power down or shut down to be initiated, if required. The information regarding the call will be entered 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. The acoustic detection can also be recorded for further analysis.

PSO Data and Documentation

PSOs will record data to estimate the numbers of marine mammals and turtles exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data will be used 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 or sea turtle is within or near the EZ.

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

1. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace.
2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

The data listed under (2) will also be recorded at the start and end of each observation watch, and during a watch whenever there is a change in one or more of the variables.

All observations and power downs or shut downs will be recorded in a standardized format. Data will be entered into an electronic database. The accuracy of the data entry will be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of data to be prepared 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 shut down).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS.
3. Data on the occurrence, distribution, and activities of marine mammals and turtles in the area where the seismic study is conducted.
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 and turtles seen at times with and without seismic activity.

A report will be submitted to NMFS and NSF within 90 days after the end of the cruise. The report will describe the operations that were conducted and sightings of marine mammals and turtles near the operations. The report will provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report will summarize the dates and locations of seismic operations, and all marine mammal and turtle sightings (dates, times, locations, activities, associated seismic survey activities). The report will also include estimates of the number and nature of exposures that could result in “takes” of marine mammals by harassment or in other ways.

XIV. COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL TAKE

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

L-DEO and NSF would coordinate with applicable U.S. agencies (e.g., NMFS), and will comply with their requirements.

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