Final Amended Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off New Jersey, Summer 2015

Prepared for

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26 May 2015

LGL Report TA8349-3

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ABSTRACT

The State University of New Jersey at Rutgers (Rutgers), with funding from the U.S. National Science Foundation (NSF), proposes to reschedule a previously approved high-energy, three dimensional (3-D) seismic survey on the Research Vessel (R/V) *Marcus G. Langseth* (*Langseth*) in the northwest Atlantic Ocean ~33–92 km from the coast of New Jersey (27–87 km from New Jersey state waters) to occur in the summer of 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 in^3, the proposed seismic survey would only use a small towed subarray of 4 airguns with a total discharge volume of ~700 in^3, which is the smaller powered of two source levels planned and used during the 2014 survey. 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.

NSF, as the funding agency, has a mission to "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…". The proposed rescheduled seismic survey would collect data in support of a research proposal that was reviewed under the NSF merit review process and identified as an NSF program priority. A two-year continuing grant, contingent upon obtaining appropriate authorizations and completion of the NSF environmental review process, was awarded on 15 January 2014 and funds for both years have been released. The survey would provide data necessary to study the arrangement of sediments deposited during times of changing global sea level from roughly 60 million years ago to present and enable follow-on studies to identify the magnitude, time, and impact of major changes in sea level.

The survey was originally proposed and approved for implementation in 2014. NSF's environmental compliance process, including meeting 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 research objectives and survey had not changed from what was approved in 2014, a new IHA was required to conduct the same survey during a rescheduled time in 2015. A Draft Amended Environmental Assessment (EA) was prepared on behalf of NSF pursuant to the National Environmental Policy Act (NEPA) to address any environmental impacts associated with the rescheduled time for the survey, and in support of other necessary regulatory processes, including the IHA process. The Draft Amended EA was available for a 52-day public comment period. The Draft Amended EA was used as a basis for preparing this Final Amended EA. Comments received on the Draft Amended EA during the public comment period and consultations with regulating agencies were taken into consideration when preparing this Final Amended EA.

As operator of the *Langseth,* L-DEO, on behalf of itself, NSF, and Rutgers University, requested an IHA from NMFS to authorize the incidental, i.e., not intentional, harassment of small numbers of marine mammals should that occur during the proposed rescheduled seismic survey. The analysis in the Draft Amended EA supported the IHA application process and provided information on marine species not addressed by the IHA application, including seabirds and sea turtles that are listed under the U.S. Endangered Species Act (ESA), including candidate species. As analysis on endangered/threatened species was included, the Draft Amended EA was used to support ESA Section 7 consultations with NMFS and U.S. Fish and Wildlife Service (USFWS). The Draft Amended EA was also used in support of consultation with NMFS Greater Atlantic Regional Fisheries Office for Essential Fish Habitat (EFH) under the Magnuson-Stevens Act and preparation of Consistency Determinations (CDs) pursuant to the Coastal Zone Management Act (CZMA). Alternatives addressed in the Final Amended EA consist of a corresponding program at a different time with issuance of an associated IHA and the no action alternative, with no IHA and no seismic survey. This Final Amended EA tiers to the Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement 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 PEIS. It also tiers to the "Final Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off New Jersey, July–Mid August 2014" (2014 Final EA), which was prepared for the 2014 survey. The proposed survey area off the coast of New Jersey is near one of the detailed analysis areas (DAAs) in the PEIS; however, this Final Amended EA and the 2014 Final EA were prepared because a different energy source level and configuration would be used for the proposed survey, and the proposed survey covers only shelf waters whereas the DAA was on the shelf and slope. Additionally, this Final Amended EA addresses the differences from and updates to the 2014 Final EA.

Various species of marine mammals inhabit the proposed survey area off the coast of New Jersey during certain times of the year. Several of these species are listed as ***endangered*** under the 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.

Potential impacts of the proposed rescheduled seismic survey on the environment would be primarily a result of the operation of the airgun array. A multibeam echosounder (MBES) and sub-bottom profiler (SBP) would also be operated. Impacts would be associated with underwater noise, which could result in avoidance behavior by some marine mammals, sea turtles, seabirds, and fish, and other forms of disturbance. An integral part of the planned survey is a monitoring and mitigation program designed to minimize potential impacts of the proposed activity on marine animals present during the proposed research, and to document as much as possible the nature and extent of any effects. Injurious impacts to marine mammals, sea turtles, and seabirds have not been proven to occur near airgun arrays, and are not likely to be caused by the other types of sound sources proposed to be used. However, despite the relatively low levels of sound emitted by the subarray of airguns, a precautionary approach would still be taken. The planned monitoring and mitigation measures would reduce the possibility of any effects.

As was the case with the approved 2014 survey, protection measures designed to mitigate the potential environmental impacts to marine mammals and sea turtles would include the following: ramp ups; typically two, but a minimum of one dedicated observer maintaining a visual watch during all daytime airgun operations; two observers 30 min before and during ramp ups during the day and at night; no start ups during poor visibility or at night unless at least the mitigation airgun has been operating; passive acoustic monitoring (PAM) via towed hydrophones during both day and night to complement visual monitoring (unless operational issues prevent it or the system and back-up system are both damaged during operations); and power downs (or if necessary shut downs) when marine mammals or sea turtles are detected in or about to enter designated exclusion zones. Per the IHA, during operations, a one 1-min shot interval would be used for the mitigation source, and source shutdown would occur if concentrations of large whales were encountered. NSF, Rutgers, L-DEO, and its contractors are committed to applying these measures in order to minimize potential effects on marine mammals and sea turtles and other environmental impacts.

With the planned monitoring and mitigation measures, unavoidable impacts to each species of marine mammal and sea turtle that could be encountered would be expected to be limited to short-term, localized changes in behavior and distribution near the seismic vessel. At most, effects on marine mammals may be interpreted as falling within the U.S. Marine Mammal Protection Act (MMPA) definition of "Level B Harassment" for those species managed by NMFS. No long-term or significant effects would be expected on individual marine mammals, sea turtles, seabirds, fish, the populations to which they belong, or their habitats.

LIST OF ACRONYMS

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ALWTRP	Atlantic Large Whale Take Reduction Plan
AMVER	Automated Mutual-Assistance Vessel Rescue
BOEM	Bureau of Ocean Energy Management
CEQ	Council of Environmental Quality
CETAP	Cetacean and Turtle Assessment Program
CITES	Convention on International Trade in Endangered Species
CZMA	Coastal Zone Management Act
DAA	Detailed Analysis Area
dB	decibel
DoN	Department of the Navy
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	(U.S.) Endangered Species Act
EZ	Exclusion Zone
FAO	Food and Agriculture Organization of the United Nations
FM	Frequency Modulated
GIS	Geographic Information System
h	hour
hp	horsepower
HRTRP	Harbor Porpoise Take Reduction Plan
Hz	Hertz
IHA	Incidental Harassment Authorization (under MMPA)
in	inch
IOC	Intergovernmental Oceanographic Commission of UNESCO
IODP	Integrated Ocean Drilling Program
IUCN	International Union for the Conservation of Nature
kHz	kilohertz
km	kilometer
kt	knot
L-DEO	Lamont-Doherty Earth Observatory
LFA	Low-frequency Active (sonar)
m	meter
min	minute
MBES	Multibeam Echosounder
MFA	Mid-frequency Active (sonar)
MMPA	(U.S.) Marine Mammal Protection Act
ms	millisecond
NEPA	(U.S.) National Environmental Policy Act
NJ	New Jersey
NEFSC	Northeast Fisheries Science Center
NMFS	(U.S.) National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NRC	(U.S.) National Research Council
NSF	National Science Foundation
OBIS	Ocean Biogeographic Information System
OCM	(NOAA) Office for Coastal Management
OCS	Outer Continental Shelf
OEIS	Overseas Environmental Impact Statement
OAWRS	Ocean Acoustic Waveguide Remote Sensing
p or pk	peak
PEIS	Programmatic Environmental Impact Statement
PI	Principal Investigator
PTS	Permanent Threshold Shift
PSO	Protected Species Observer
RL	Received level
rms	root-mean-square
R/V	research vessel
s	second
SAR	U.S. Marine Mammal Stock Assessment Report
SBP	Sub-bottom Profiler
SCUBA	Self-contained underwater breathing apparatus
SEFSC	Southeast Fisheries Science Center
TTS	Temporary Threshold Shift
SEL	Sound Exposure Level
SPL	Sound Pressure Level
UME	Unusual mortality event
UNEP	United Nations Environment Programme
U.S.	United States of America
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
USN	U.S. Navy
µPa	microPascal
vs.	versus
WCMC	World Conservation Monitoring Centre

I. PURPOSE AND NEED

The purpose of this Final Amended Environmental Assessment (EA) is to provide the information needed to assess the potential environmental impacts associated with the rescheduling of a previously approved marine geophysical survey that would use a 4-airgun subarray during the proposed seismic survey off the coast of New Jersey. The survey was originally proposed for implementation in July–mid August 2014. NSF's environmental compliance process, including meeting all federal legal and regulatory obligations, was completed for the project 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 of the Incidental Harassment Authorization (IHA) and Incidental Take Statement (ITS) issued for the survey. According to NMFS, a new IHA Application was required to reschedule the survey in 2015.

This Final Amended EA was prepared pursuant to the National Environmental Policy Act (NEPA), and tiers to the Programmatic Environmental Impact Statement (PEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (NSF and USGS 2011) and Record of Decision (NSF 2012), referred to herein as the PEIS. It also tiers to the "Final Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off New Jersey, July–Mid August 2014" (2014 Final EA), which was prepared for the 2014 survey. The proposed rescheduled survey area off the coast of New Jersey is near one of the detailed analysis areas (DAAs) presented in the PEIS; however, a different energy source level and configuration would be used for the proposed rescheduled survey, which covers only shelf waters, whereas the DAA was on the shelf and slope. This Final Amended EA was prepared to consider the survey proposed for 2015, provide updates, and address differences in the analysis prepared for the 2014 survey and the PEIS DAA. The Final Amended EA provides details of the proposed action at the site-specific level and addresses potential impacts of the proposed rescheduled seismic survey on marine mammals, as well as other species of concern in the area, including sea turtles, seabirds, fish, and invertebrates. This Final Amended EA was based on analysis prepared in a Draft Amended EA. The Draft Amended EA was used in support of an application for an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS), Section 7 consultations under the Endangered Species Act (ESA), and preparation of Consistency Determinations (CDs) under the Coastal Zone Management Act (CZMA). The IHA allows for non-intentional, non-injurious "take by harassment" of small numbers of marine mammals[1] during the proposed rescheduled seismic survey directed by Rutgers in the Atlantic Ocean off New Jersey. The Draft Amended EA was used in support of consultation with NMFS Greater Atlantic Regional Fisheries Office for Essential Fish Habitat (EFH) under the Magnuson-Stevens Act. The Draft Amended EA was made available for a 52-day public comment period. Public comments received and discussions during consultations with regulatory agencies were taken into consideration when preparing this Final Amended EA.

Mission of NSF

NSF was established by Congress under the National Science Foundation Act of 1950 (Public Law 810507, as amended) and is the only federal agency dedicated to the support of fundamental research and

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[1] To be eligible for an IHA under the U.S. Marine Mammal Protection Act (MMPA), the proposed "taking" (with mitigation measures in place) must not cause serious physical injury or death of marine mammals, must have negligible impacts on the species and stocks, must "take" no more than small numbers of those species or stocks, and must not have an unmitigable adverse impact on the availability of the species or stocks for legitimate subsistence uses.

education in all scientific and engineering disciplines. Further details on the mission of NSF are described in § 1.2 of the PEIS.

Purpose of and Need for the Proposed Action

As noted in the PEIS, § 1.3, NSF, based on its mission, has a continuing need to fund seismic surveys that enable scientists to collect data essential to understanding complex Earth processes recorded in sediments on and beneath the ocean floor. NSF fulfills this need through funding research such as seismic surveys. The proposed collaborative research objectives and efforts associated with the proposed rescheduled survey remain unchanged from those planned in 2014. The purpose of the proposed action is to collect data across existing Integrated Ocean Drilling Program (IODP) Expedition 313 drill sites on the inner-middle shelf of the New Jersey continental margin to reveal the arrangement of sediments deposited during times of changing global sea level from roughly 60 million years ago to the present. 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 identified and traced with existing two-dimensional (2-D) seismic data, despite their existence being clearly indicated in sediment cores recovered during IODP Expedition 313. These and other erosional and depositional features would be imaged using three-dimensional (3-D) seismic data and would enable follow-on studies to identify the magnitude, time, and impact of major changes in sea level. The proposed rescheduled seismic survey would collect data in support of a research proposal (Appendix B) that has been reviewed under the NSF merit review process and identified as an NSF program priority to meet NSF's critical need to foster an understanding of Earth processes.

Background of NSF-funded Marine Seismic Research

The background of NSF-funded marine seismic research is described in § 1.5 of the PEIS.

Statutory and Regulatory Setting

The statutory and regulatory setting of this Final Amended EA is described in § 1.8 of the PEIS, including the

- National Environmental Protection Act (NEPA);
- Marine Mammal Protection Act (MMPA);
- Endangered Species Act (ESA);
- Magnuson-Stevens Act for Essential Fish Habitat (EFH); and
- Coastal Zone Management Act (CZMA).

II. Alternatives Including Proposed Action

In this Final Amended EA, three alternatives are evaluated: (1) the proposed rescheduled seismic survey and issuance of an associated IHA, (2) a corresponding seismic survey at an alternative time, along with issuance of an associated IHA, and (3) a no action alternative. Additionally, two alternatives were considered but were eliminated from further analysis. A summary table of the proposed action, alternatives, and alternatives eliminated from further analysis is provided at the end of this section.

Proposed Action

The project objectives and context, activities, and mitigation measures for Rutgers' proposed rescheduled seismic survey are described in the following subsections. The proposed action remains the same as those described for the 2014 survey, except where noted.

(1) Project Objectives and Context

Rutgers proposes to conduct a 3-D seismic survey using Columbia University's Lamont-Doherty Earth Observatory (L-DEO) operated Research Vessel (R/V) *Marcus G. Langseth* (*Langseth*) on the inner-middle shelf of the New Jersey continental margin (Fig. 1). As noted previously, the goal 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 Drs. J. Austin, C. Fulthorpe, and 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.

(2) Proposed Activity

(a) Location of the Activity

The proposed 3-D box/survey area is located in the Atlantic Ocean, ~33–92 km off the coast of New Jersey and 27–87 km from New Jersey state waters (Fig. 1). This area is defined by the coordinates at the four corners (including turns and run-in and run-out of each line) in degrees and decimal minutes: 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.

Water depths across the survey area are ~20–75 m. The proposed rescheduled seismic survey would be conducted outside of state waters and within the U.S. EEZ during ~30 days between June and August 2015. Although the proposed survey area is near the NW Atlantic DAA described in the PEIS, it does not include intermediate- and deep-water depths. The survey location would be the same as that for the 2014 survey.

(b) Description of the Activity

The procedures to be used for the proposed rescheduled survey would be the same as those proposed for the 2014 survey and similar to those used during previous NSF-funded seismic surveys and would use conventional seismic methodology. The proposed rescheduled survey would involve one source vessel, the *Langseth,* which is owned by NSF and operated on its behalf by Columbia University's L-DEO through a Cooperative Agreement entered into in 2012, 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 in^3. 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 one 3000-m hydrophone streamer and a Geometrics 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.

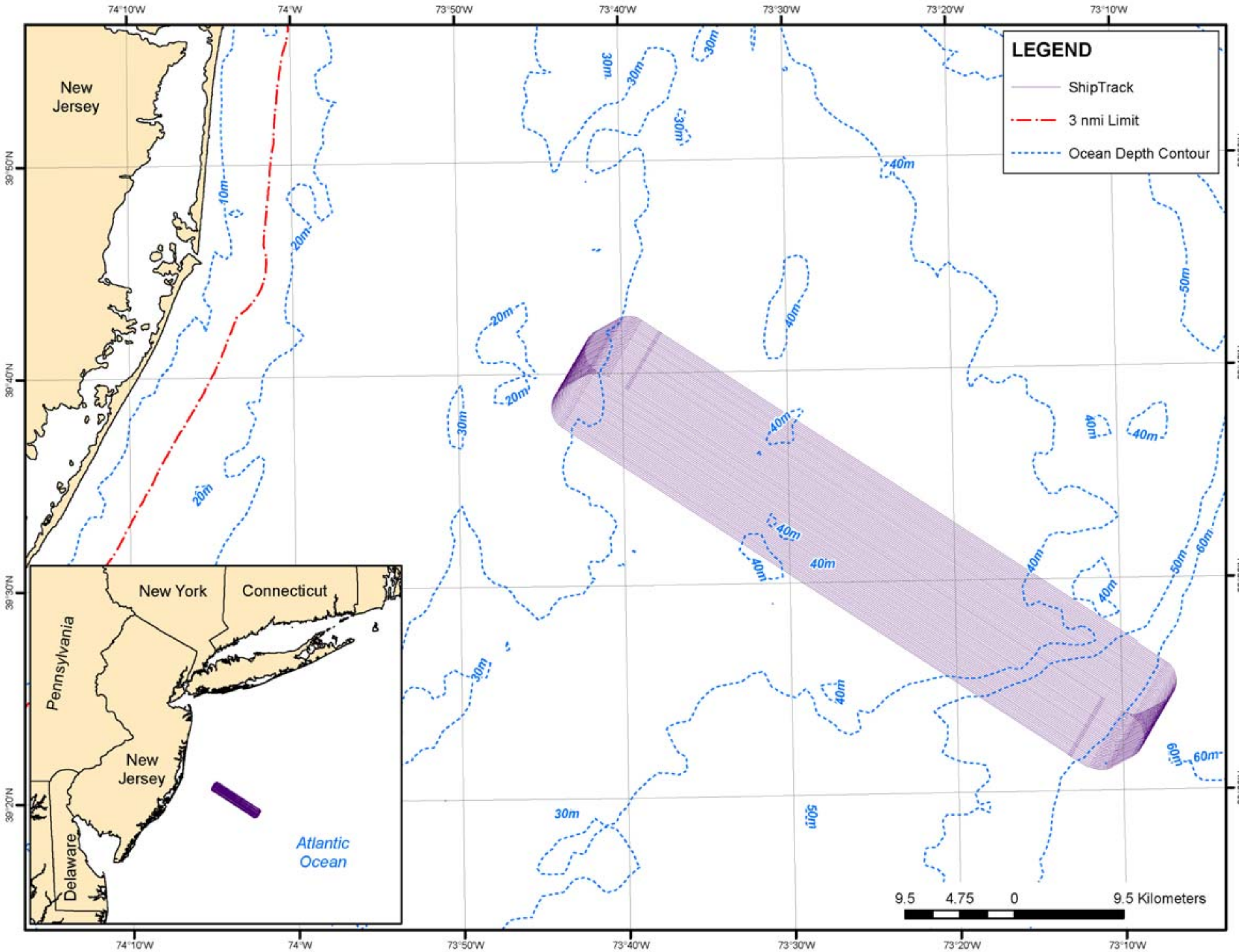

FIGURE 1. Location of the proposed seismic survey in the Atlantic Ocean off the coast of New Jersey.

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 § IV(3)], 25% has been added for those additional operations. The survey parameters noted here support the proposed research goals and therefore differ from the NW Atlantic DAA survey parameters presented in the PEIS. 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 in 2014. Given equipment limitations, only ~61 h of seismic survey data were collected in 2014, with only ~43 h at full power (700 in^3) 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-in^3 source array was suitable for the project, therefore eliminating potential use of the larger 1400-in^3 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 be operated from the *Langseth* continuously throughout the survey, but not during transits. All planned geophysical data acquisition activities would be conducted 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.

(c) Schedule

The *Langseth* would depart from New York 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.

(d) Vessel Specifications

The *Langseth* is described in § 2.2.2.1 of 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.

(e) Airgun Description

During the proposed rescheduled survey, the airgun array to be used would be the full 4-string array with most of the airguns turned off (see § II 3(a) 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. Therefore, the source volume would not exceed 700 in^3 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. The subarrays would be towed at a depth of 4.5 or 6 m. The shot interval would be ~5-6 s (~12.5 m). Because the choice of the precise tow depth would not be made until the survey because of sea and weather conditions, we have assumed the use of 6 m for the impacts analysis and take estimate calculations, as that results in the farthest sound propagation. Mitigation zones have been calculated for the source level and tow depths, (see below and Appendix A, Table A2), and during operations the relevant mitigation zone would be applied.

During the attempted survey in 2014, the 700-in^3 airgun array was determined to be sufficient to image the geological targets of research interest. Therefore, the 1400-in^3 array proposed as an operational possibility in the 1 July 2014 Final EA was eliminated from the analysis in the Draft Amended EA and this Final Amended EA.

(f) Additional Acoustical Data Acquisition Systems

Along with the airgun operations, two additional acoustical data acquisition systems would be operated during the survey, but not during transits: an MBES and a SBP. The ocean floor would be mapped with the Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. These sources are described in § 2.2.3.1 of the PEIS.

(3) Monitoring and Mitigation Measures

Standard monitoring and mitigation measures for seismic surveys are described in § 2.4.4.1 of the PEIS and are described to occur in two phases: pre-cruise planning and during operations. The following sections describe the efforts during both stages for the proposed actions.

(a) Planning Phase

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

1. Energy Source—Part of the considerations for the proposed rescheduled survey was to evaluate whether the research objectives could be met with a smaller energy source than the full, 36-airgun, 6600-in^3 *Langseth* array, and it was decided that the scientific objectives could be met using an energy source comprising 4 airguns (total volume 700 in^3 volume) towed at a depth of ~4.5 or 6 m. Two such subarrays of 4 airguns would be used alternately (flip-flop mode); one would be towed on the port side, the other on the starboard side. Therefore, the source volume would not exceed 700 in^3 at any time. We have assumed in the impacts analysis and take estimate calculations the use of the 4-airgun array towed at 6 m as that would result in the farthest sound propagation. Based on the research goals and current knowledge of environmental conditions in the survey area based on the 2014 activity, the 1400-in^3 source level proposed for possible use in 2014 is no longer viewed necessary and has not been included in this analysis. For the DAA off the coast of New Jersey included in the PEIS, the energy source level analyzed was a pair of 45/105-in^3 Generator-Injector (GI) guns, but this source level was not viewed as adequate for meeting the research goals of the proposed survey.
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, personnel, 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 rescheduled 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 Appendix Table A2. A more detailed description of the modeling process used to develop the mitigation zones can be found in Appendix A. Received sound levels in deep water have been predicted by L-DEO for the 4-airgun array and the single Bolt 1900LL 40-in^3 airgun that would be used during power downs. Scaling factors between those arrays and the 18-airgun, 3300-in^3 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). The use of the 4-airgun array towed at 6 m is assumed in the impacts and take estimate analysis as that would result in the farthest sound propagation. During actual operations, however, the corresponding mitigation zone would be applied for the selected source level. The 1 July 2014 Final EA included mitigation zones and take calculations for a 1400-in^3 array, however, that source level has been determined to be unnecessary and is not included in this analysis.

Table 1 shows the 180-decibel (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 μPa_{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. Pursuant to the Biological Opinion (BO) issued in 2014 and that issued in 2015 (Appendix C), a 166-dB distance would be used for Level B takes for sea turtles. Per the IHA for the survey issued in 2014 (Appendix D of the 1 July 2014 Final EA), the EZ was increased by 3 dB (therefore operational mitigation would be at the 177-dB isopleth), which added ~50% to the power-down/shut-down radius, but the IHA issued in 2015 (Appendix D) did not increase the EZ. NSF is in agreement with the EZ approach taken in the 2015 IHA and does not view the overly precautionary approach of increasing the EZ taken in the 2014 IHA as appropriate; therefore, 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 (modeled) 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). Similarly, preliminary analysis by Crone (2015, pers. comm.) of data collected during the 2014 survey off New Jersey confirmed that *in situ* measurements and estimates of the 160- and 180-dB distances collected by the *Langseth* hydrophone streamer were significantly smaller than the predicted operational mitigation radii.

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, the National Oceanic and Atmospheric Administration (NOAA) published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), although at the time of preparation of this Final Amended EA, the date of release of the final guidelines and how they would be implemented are unknown. As such, this Final 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 and prescribed by the IHA.

TABLE 1. Predicted distances to which sound levels ≥180 and 160 dB re 1 μPa$_{rms}$ would be received during the proposed 3-D survey off New Jersey, using a 4-airgun, 700-in^3 subset of 1 string at 4.5- or 6-m tow depth and the 40-in^3 airgun. Radii are based on scaling described in the text of Appendix A and Figures A2 to A6, and the assumption that received levels on an rms basis are, numerically, 10 dB higher than the SEL values.[2]

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

(b) Operational Phase

Marine species, including marine mammals and sea turtles, are known to occur in the proposed survey area. However, the number of individual animals expected to be approached closely during the proposed activity would be relatively small in relation to regional population sizes. To minimize the likelihood that potential impacts could occur to the species and stocks, monitoring and mitigation measures proposed during the operational phase of the proposed activity, which are consistent with the PEIS and past IHA requirements, include

1. monitoring by protected species observers (PSOs) for marine mammals, sea turtles, seabirds, and fish;
2. passive acoustic monitoring (PAM);
3. PSO data and documentation;
4. mitigation during operations (speed or course alteration; power-down, shut-down, and ramp-up procedures; and special mitigation measures for rare species, species concentrations, and sensitive habitats).

The proposed operational mitigation measures are standard for all high-energy seismic surveys, per the PEIS, and, therefore, are not discussed further here. Special mitigation measures were considered for this proposed survey. Although it is very unlikely that a North Atlantic right whale would be encountered, the airgun array would be shut down if one is sighted at any distance from the vessel because of the species' rarity and conservation status. It is also unlikely that concentrations of large whales of any species would be encountered, but if so, they would be avoided, or the airgun array would be powered down. The latter is a new mitigation measure specified in the 2015 IHA, as is defining "concentrations" as groups of 6 or more individuals that do not appear to be traveling, and using a 1-min shot interval for the mitigation airgun. NSF, L-DEO and Rutgers would be committed to implementing the requirements set forth in the IHA and ITS.

[2] 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 over a 1-s period.

With the proposed monitoring and mitigation provisions, potential effects on most if not all individuals would be expected to be limited to minor behavioral disturbances. Those potential effects would be expected to have negligible impacts both on individual marine mammals and on the associated species and stocks. Ultimately, survey operations would be conducted in accordance with all applicable U.S. federal regulations and IHA requirements.

Alternative 1: Alternative Survey Timing

An alternative to issuing the IHA for the period requested and to conducting the project then would be to conduct the project at an alternative time, such as late spring or early fall (avoiding the North Atlantic right whale migration season) implementing the same monitoring and mitigation measures as under the Proposed Action, and requesting an IHA to be issued for that alternative time. An evaluation of the effects of this Alternative Action is given in § IV.

Alternative 2: No Action Alternative

An alternative to conducting the proposed activity is the "No Action" alternative, i.e., do not request that an IHA be issued and do not allow the proposed rescheduled research operations to be conducted. If the research is not conducted, the "No Action" alternative would result in no disturbance to marine mammals because of the absence of the proposed activity. Although the No-Action Alternative is not considered a reasonable alternative because it does not meet the purpose and need for the Proposed Action, per Council of Environmental Quality (CEQ) regulations it is included and carried forward for analysis in § IV.

Alternatives Considered but Eliminated from Further Analysis

(1) Alternative E1: Alternative Location

The New Jersey continental margin has for decades been recognized as among the best siliciclastic passive margins for elucidating the timing and amplitude of eustatic change during the "Ice House" period of Earth history, when glacioeustatic changes shaped continental margin sediment sections around the world. There is a fundamental need to constrain the complex forcing functions tying evolution and preservation of the margin stratigraphic record to base-level changes. This could be accomplished by following the transect strategy adopted by the international scientific ocean drilling community. This strategy involves integration of drilling results with seismic imaging. In keeping with this strategy, the proposed rescheduled seismic survey would acquire a 3-D seismic volume encompassing the three existing IODP Expedition 313 (Exp313) drill sites on the inner-middle shelf of the New Jersey margin. Exp313, the latest chapter in the multi-decade Mid-Atlantic Transect, represents the scientific community's best opportunity to link excellently sampled and logged late Paleogene-Neogene prograding clinoforms to state-of-the-art 3-D images. Exp313 borehole data would provide lithostratigraphy, geochronology, and paleobathymetry. 3-D seismic imaging would put these sampled records in a spatially accurate, stratigraphically meaningful context. Such imagery would allow researchers to map sequences around Exp313 sites with a resolution and confidence previously unattainable, and to analyze their spatio-temporal evolution.

No other scientific ocean drilling boreholes are available on the New Jersey shelf or elsewhere that provide such high sediment recoveries and high-quality well logs as those of Exp313. The need to tie the proposed 3-D survey to Exp313 drill sites means that it is not possible to conduct the survey in a different area. Also, positioning a 3-D volume requires broad coverage by pre-existing 2-D seismic data. Such data, collected over more than two decades, are readily available on the New Jersey shelf. Furthermore, the proposed research underwent the NSF merit review process, and the science, including the site location, was determined to be meritorious.

(2) Alternative E2: Use of Alternative Technologies

As described in § 2.6 of the PEIS, alternative technologies to the use of airguns were investigated to conduct high-energy seismic surveys. At the present time, these technologies are still not feasible, commercially viable, or appropriate to meet the Purpose and Need. Additional details about these technologies are given in the Final USGS EA (RPS 2014a).

Table 2 provides a summary of the proposed action, alternatives, and alternatives eliminated from further analysis.

TABLE 2. Summary of Proposed Action, Alternatives Considered, and Alternatives Eliminated.

Proposed Action	Description
Proposed Action: Conduct a marine geophysical survey in the Atlantic Ocean off New Jersey	Under the Proposed Action, a 3-D seismic reflection survey would take place in the Atlantic Ocean off New Jersey during the summer of 2015. When considering transit; equipment deployment, maintenance, and retrieval; weather; marine mammal activity; and other contingencies, the proposed activity would be expected to be completed in ~36 days. The standard monitoring and mitigation measures identified in the NSF PEIS would apply and are described in further detail in this document (§ II [3]), along with the requirements identified by the federal regulating agencies. All necessary permits and authorizations, including an IHA, were requested and received from regulatory bodies in 2014 and again in 2015.
Alternatives	Description
Alternative 1: Alternative Survey Timing	Under this Alternative, the survey operations would be conducted at a different time of the year, such as late spring or early fall. The standard monitoring and mitigation measures identified in the NSF PEIS would apply. These measures are described in further detail in this document (§ II [3]) and would apply to survey activity conducted during an alternative survey time period, along with any additional requirements identified by federal regulating agencies as a result of the proposed change. All necessary permits and authorizations, including an IHA, would be requested from the regulatory bodies.
Alternative 2: No Action	Under this Alternative, no proposed activity would be conducted and seismic data would not be collected. No permits and authorizations, including an IHA, would be requested from regulatory bodies, as the Proposed Action would not be conducted.
Alternatives Eliminated from Further Analysis	Description
Alternative E1: Alternative Location	The survey location has been specifically identified because of the data available for that location, including borehole data from three IODP Expedition 313 drill sites that would provide lithostratigraphy, geochronology, and paleobathymetry, and broad coverage by pre-existing 2-D seismic data. The proposed 3-D seismic imaging would put these sampled records in a spatially accurate, stratigraphically meaningful context. Such imagery would allow researchers to map sequences around the drill sites with a resolution and confidence previously unattainable, and to analyze their spatio-temporal evolution. Furthermore, the proposed science underwent the NSF merit review process, and the science, including the site location, was determined to be meritorious. Therefore, conducting the proposed survey at a different location was eliminated from further consideration.
Alternative E2: Alternative Survey Techniques	Under this Alternative, alternative survey techniques would be used, such as marine vibroseis, which could potentially reduce impacts on the marine environment. Alternative technologies were evaluated in the PEIS, § 2.6. At the present time, however, these technologies are still not feasible, commercially viable, or appropriate to meet the Purpose and Need. NSF currently owns the *Langseth*, and its primary capability is to conduct seismic surveys; no other viable technologies are available to NSF. Therefore, this Alternative was eliminated from further consideration.

III. AFFECTED ENVIRONMENT

As described in the PEIS, Chapter 3, the description of the affected environment focuses only on those resources potentially subject to impacts. Accordingly, the discussion of the affected environment (and associated analyses) has focused mainly on those related to marine biological resources, as the proposed short-term activity has the potential to impact marine biological resources within the proposed Project area. These resources are identified in Section III, and the potential impacts to these resources are discussed in Section IV. Initial review and analysis of the proposed Project activity determined that the following resource areas did not require further analysis in this Final Amended EA:

- *Air Quality/Greenhouse Gases*—Project vessel emissions would result from the proposed activity; however, these short-term emissions would not result in any exceedance of federal Clean Air standards. Emissions would be expected to have a negligible impact on the air quality within the survey area;
- *Land Use*—All proposed activities would be in the marine environment. Therefore, no changes to current land uses or activities in the Project area would result from the proposed Project;
- *Safety and Hazardous Materials and Management*—No hazardous materials would be generated or used during proposed activities. All Project-related wastes would be disposed of in accordance with federal and international requirements;
- *Geological Resources (Topography, Geology and Soil)*—The proposed Project would result in no displacement of soil and seafloor sediments. The proposed activity would not adversely affect geologic resources as no impacts would occur;
- *Water Resources*—No discharges to the marine environment are proposed within the Project area that would adversely affect marine water quality. Therefore, there would be no impacts to water resources resulting from the proposed Project activity;
- *Terrestrial Biological Resources*—All proposed Project activities would occur in the marine environment and would not impact terrestrial biological resources;
- *Socioeconomic and Environmental Justice*—Implementation of the proposed Project would not affect, beneficially or adversely, socioeconomic resources, environmental justice, or the protection of children. No changes in the population or additional need for housing or schools would occur. Because of the location of the proposed activity and distance from shore, human activities in the area around the survey vessel would be limited to SCUBA diving, commercial and recreational fishing activities and other vessel traffic. Because of the nature and location of the proposed activity, no impacts would be expected on marine-related local businesses such as coastal restaurants, hotels, and bait and tackle shops. Fishing, SCUBA diving, vessel traffic, and potential impacts are described in further detail in §§ III and IV. Additionally, there is a marine mammal watching industry in New Jersey. Because of the distance from shore to the proposed survey site, it is unlikely that marine mammal watching boat tours would coincide with the proposed survey site or be impacted by the proposed activity. Most activities are conducted within ~20 km of the coast, with the majority occurring closer inshore. Some boat tours occur well south (~100 km) of the proposed survey area around Cape May and in Delaware Bay. Some dolphin watching cruises take place off Atlantic City fairly close to shore. Tours typically are ~1.5–3 h long. Although marine mammals around the seismic survey may avoid the vessel during operations, this behavior would be of short duration and temporary. Given the distance from shore to the proposed activity, the likely distance from any of the few marine mammal

watching activities, and the short and temporary duration of any potential impacts to marine mammals, it would be unlikely that the marine mammal watching industry would be affected by the proposed activity, and, therefore, this issue is not analyzed further in this assessment. Furthermore, no whale watching vessels were encountered by the *Langseth* during the ~13 days the vessel was in the survey area in 2014. No other socioeconomic impacts would be expected as a result of the proposed activity;

- *Visual Resources*—No visual resources would be expected to be negatively impacted as the area of operation is significantly outside of the land and coastal view shed; and
- *Cultural Resources*—With the following possible exceptions, there are no known cultural resources in the proposed Project area. One shipwreck, a known dive site, is in or near the survey area (see Fig. 2 in § III): the *Lillian* (Galiano 2009; Fisherman's Headquarters 2014; NOAA 2014a). Shipwrecks are discussed further in § IV. Airgun sounds would have no effects on solid structures; no significant impacts on shipwrecks would be expected (§ IV). No impacts to cultural resources would be expected.

Physical Environment and Oceanography

The water off the U.S. east coast consists of three water masses: coastal or shelf waters, slope waters, and the Gulf Stream. Coastal waters off Canada, which originate mostly in the Labrador Sea, move southward over the continental shelf until they reach Cape Hatteras, North Carolina, where they are entrained between the Gulf Stream and slope waters. North of Cape Hatteras, an elongated cyclonic gyre of slope water that forms because of the southwest flow of coastal water and the northward flowing Gulf Stream is present most of the year and shifts seasonally relative to the position of the north edge of the Gulf Stream. Slope water eventually merges with the Gulf Stream water. The Gulf Stream flows through the Straits of Florida and then parallel to the continental margin, becoming stronger as it moves northward. It turns seaward near Cape Hatteras and moves northeast into the open ocean.

The shelf waters off New Jersey are part of the Mid-Atlantic Bight, which includes shelf waters from Cape Hatteras to southern Cape Cod. The shelf is dominated by a sandy to muddy-sandy bottom (Steimle and Zetlin 2000; USGS 2000 *in* DoN 2005). The shelf off New Jersey slopes gently and uniformly seaward to the shelf-slope transition 120–150 km offshore in water depths 120–160 m (Carey et al. 1998 *in* GMI 2010). The shelf edge off New Jersey is incised by the Hudson Canyon to the north and the Wilmington Canyon to the south. Several smaller canyons also occur along the shelf edge. The Hudson Canyon is the largest canyon off the east coast of the U.S. The proposed survey area is entirely on the shelf.

The shelf waters off New Jersey become stratified in the spring as the water warms, and are fully stratified throughout the summer, i.e., warmer, fresher water accumulates at the surface and denser, colder, more saline waters occur near the seafloor. The stratification breaks down in fall because of mixing by wind and surface cooling (Castelao et al. 2008). Summer upwelling occurs off New Jersey, where nutrient-rich cold water is brought closer to the surface and stimulates primary production (Glenn et al. 2004; NEFSC 2013a). The primary production of the northeast U.S. continental shelf is 1536 mg C/m^2/day (Sea Around Us 2013). The salinity of shelf water usually increases with depth and is generally lower than the salinity of water masses farther offshore primarily because of the low-salinity input from rivers and estuaries.

There are numerous artificial reefs in shelf waters off New Jersey, including materials such as decommissioned ships, barges, and reef balls or hollow concrete domes (Steimle and Zetlin 2000; Figley 2005); these reefs can provide nursery habitat, protection, and foraging sites to marine organisms. Since 1984, more than 3500 of these artificial patch reefs have been constructed off New Jersey (Figley 2005).

Protected Areas

Several federal Marine Protected Areas (MPAs) or sanctuaries have been established ~500 km north of the proposed survey area, primarily with the intention of preserving cetacean habitat (Hoyt 2005; CetaceanHabitat 2013). These include the Cape Cod Bay Northern Right Whale Critical Habitat Area, the Great South Channel Northern Right Whale Critical Habitat Area east of Cape Cod, the Gerry E Studds Stellwagen Bank National Marine Sanctuary in the Gulf of Maine, and Jeffrey's Ledge, a proposed extension to the Stellwagen Bank National Marine Sanctuary. The Monitor National Marine Sanctuary is located to the southeast of Cape Hatteras, North Carolina. There are also five state Ocean Sanctuaries in Massachusetts waters including Cape Cod, Cape Cod Bay, Cape and Islands, North Shore, and South Essex Ocean Sanctuaries (Mass.Gov 2013). These sanctuaries include most Massachusetts state waters except for the area east of Boston. In addition, three Canadian protected areas also occur in the Northwest Atlantic for cetacean habitat protection, including the Bay of Fundy Right Whale Conservation Area, Roseway Basin Right Whale Conservation Area, and Gully Marine Protected Area off the Scotian Shelf. The proposed survey is not located within or near any federal, state, or international MPA or sanctuary.

The Harbor Porpoise Take Reduction Plan (HPTRP) is intended to reduce the interactions between harbor porpoises and commercial gillnets in four management areas: waters off New Jersey, Mudhole North, Mudhole South, and Southern Mid Atlantic (NOAA 2010b). The HPTRP is not relevant to this EA because harbor porpoises are not expected to occur in the survey area.

Marine Mammals

Thirty-one cetacean species (6 mysticetes and 25 odontocetes) could occur near the proposed survey site (Table 3). 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, all when seismic sources were inactive, including one humpback whale, plus one unidentified baleen whale and one unidentified dolphin (RPS 2014b). 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), therefore are not expected to occur there during the survey. No pinnipeds were observed during the 13-day cruise in 2014. As pinnipeds would not be expected to be encountered or taken during the survey, takes were not assessed here or requested in the IHA application. Information on grey, harbor, and harp seals was included in the 2014 and 2015 NMFS EAs for this project, and is incorporated into this Final Amended EA by reference as if fully set forth herein (Appendix E). NMFS did authorize a small number of takes of pinnipeds in the IHA, and their analysis in support of issuing takes of pinnipeds is incorporated into this Final Amended 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 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,

TABLE 3. 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]
Mysticetes						
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
Odontocetes						
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.

respectively. Additionally, information on marine mammals in this region is included in § 4.2.2.1 of the Bureau of Ocean Energy Management (BOEM) Final PEIS for Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas (BOEM 2014). 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 are included here, but were not included in the PEIS.

The main sources of information used here are the 2010 and 2013 U.S. Atlantic and Gulf of Mexico marine mammal stock assessment reports (SARs: Waring et al. 2010, 2014), 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. The Department of the Navy (DoN) marine resource assessment for the Northeast Operating Areas (DoN 2005) contains maps of species sightings from numerous sources.

(1) 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 north-eastern 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 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 corridor[3], 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 >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 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 from 1974 to 2002 showed right whale sightings off the coast of New Jersey throughout the year, except during May–June, August, and November (Beaudin Ring 2002).

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[3] Multi-year datasets for the analysis were provided by the New England Aquarium, North Atlantic Right Whale Consortium, Oregon State University, Coastwise Consulting Inc., Georgia Department of Natural Resources, University of North Carolina Wilmington, Continental Shelf Associates, CETAP, NOAA, and University of Rhode Island.

The Interactive North Atlantic Right Whale Sighting Map showed 32 sightings in the shelf waters off New Jersey between 2006 and 2012 (NEFSC 2013b). 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 2013b). 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 NE 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 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; on 20 February 2015, NMFS (2015) proposed to expand the northeastern foraging critical habitat to cover the entire area between the Canada-U.S. EEZ line and Cape Cod, out to ~200-m depth, and the southeastern calving critical habitat to cover coastal waters from Cape Fear, North Carolina, to just north of Cape Canaveral, Florida, but not to include the migratory corridor. 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 or SMAs) during times when whales are likely present, including ~37 km around points near the Ports of New York/New Jersey (40.495ºN, 73.933ºW) and Philadelphia and Wilmington (38.874ºN, 75.026ºW) during 1 November–30 April (NMFS 2008); temporary Dynamic Management Areas (DMAs) 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 2012a); and a voluntary seasonal (April 1 to July 31) Area to be Avoided in the

Great South Channel off Massachusetts (NOAA 2013b). Furthermore, in its Final PEIS (BOEM 2014), BOEM proposed that no seismic surveys would be authorized within right whale critical habitat from 15 November to April 15, nor within the Mid-Atlantic and Southeast U.S. SMAs from 1 November to 30 April. Additionally, seismic surveys would not be allowed in active DMAs. The proposed survey area is not in any of these areas.

North Atlantic right whales likely would not be encountered during the proposed rescheduled 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 summer[4]). There are >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 rescheduled 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

[4] GMI defined spring as 11 April–21 June and summer as 22 June–27 September.

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 40ºN, 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).

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). 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 rescheduled survey.

(2) 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 40ºN; 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. (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 ~38–40ºN 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 rescheduled 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 rescheduled 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 rescheduled 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 rescheduled 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 rescheduled 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 rescheduled 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; 1546 as of 19 October 2014; and 1660 as of 15 April 2015) have washed up on the mid-Atlantic coast from New York to Florida (NOAA 2015a). NOAA declared an unusual mortality event (UME), the tentative cause of which is thought to be cetacean morbillivirus. As of 22 December 2014, 270 of 291 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 2015a). In addition to morbillivirus, the bacteria *Brucella* was confirmed in 37 of 144 dolphins tested as of 22 December 2014 (NOAA 2015a). The NOAA web site is updated frequently, and it is apparent that the strandings initially had been moving south; in the 4 November 2013 update, dolphins had been reported washing up only as far south as South Carolina, and in the 8 December 2013 update, strandings were also reported in Georgia and Florida. Since mid 2014, the UME appears to have ended in the northern states: in the 8 months between 17 August 2014 and 15 April 2015, there were 1, 4, 2, and 1 strandings in NY, NJ, DE, and MD, respectively, as compared to pre-UME (2007–2012) annual strandings of 6, 15, 10, and 5 in NY, NJ, DE, and MD, respectively (NOAA 2015a).

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 rescheduled 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. 2014). 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. 2014). 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 40ºN and 40ºS (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 rescheduled 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. 2014). 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. 2014). 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 ~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. 2014).

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. 2014). Sightings off New Jersey have been made during all seasons (Fig. B-19a *in* DoN 2055). 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 rescheduled 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 ~38ºN (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. 2014). 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 occurs 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. 2014). 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 40ºN and 35ºS (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 rescheduled survey.

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found worldwide in tropical and temperate waters generally between 50ºN and 50ºS (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 rescheduled 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 rescheduled 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. 2014).

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. 2014). 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. 2014). 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. 2014).

GMI (2010) reported 51 sightings of harbor 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 rescheduled survey.

Sea Turtles

Two species of sea turtle, the leatherback and loggerhead turtles, are common off the U.S. east coast. Kemp's ridley and green turtles also occur in this area at much lower densities. A fifth species, the hawksbill turtle, is considered very rare in the northwest Atlantic Ocean. In fact, only one species was observed and identified during the 13-day cruise in 2014, the loggerhead turtle. Thirteen additional shelled sea turtles were also sighted, but were not identified. General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of sea turtles are given in § 3.4.1 of the PEIS. The general distribution of sea turtles in the northwest Atlantic is also discussed in § 3.4.2.1 of the PEIS and § 4.2.3.1 of the BOEM Final PEIS (BOEM 2014). The rest of this section deals specifically with their distribution off the northeastern coast of the U.S., particularly off New Jersey.

(1) Leatherback Turtle (*Dermochelys coriacea*)

Leatherback turtles commonly occur along the eastern U.S. coast and as far north as New England (Eckert 1995a), although important nesting areas occur only as far north as Florida (NMFS and USFWS 2013a). Leatherback occurrence in New England waters has been documented for many years, with most historic records during March–August focused around the Gulf of Maine and Georges and Browns Banks; in fall, they were focused more southerly in New England bays and sounds (Lazell 1980). Leatherbacks tagged off Cape Breton and mainland Nova Scotia during summer remained off eastern Canada and the northeastern U.S. coast before most began migrating south in October (James et al. 2005); foraging adults off Nova Scotia mainly originate from Trinidad (NMFS and USFWS 2013a). Some of these tags remained attached long enough to observe northward migrations, with animals leaving nesting grounds during February–March and typically arriving north of 38ºN during June, usually in areas within several hundred km of where they were observed in the previous year. Virtually all of the leatherbacks in sighting records off the northeastern U.S. occurred in summer off southern New Jersey, the southeastern tip of Long Island, and southern Nova Scotia (Fig. C-2a *in* DoN 2005).

GMI (2010) reported 12 sightings of leatherback sea turtles on the continental shelf off New Jersey during surveys conducted in January 2008–December 2009, with all sightings occurring during summer. There are over 200 OBIS sighting records for the waters off New Jersey (IOC 2013). Palka (2012) also reported several sightings off northern New Jersey south of Long Island during June–August 2011 surveys.

(2) Green Turtle (*Chelonia mydas*)

Important feeding areas for green turtles in U.S. waters are primarily located in Florida and southern Texas, but Long Island Sound and inshore waters of North Carolina appear to be important to juveniles during summer months (NMFS and USFWS 2007). Small numbers of juvenile green turtles have occurred historically in Long Island and Nantucket Sounds in New England (Lazell 1980). There are few sighting records, but DoN (Fig. C-5 *in* DoN 2005) suggested that small numbers can be found from spring to fall as far north as Cape Cod Bay, including off New Jersey. There are seven OBIS sightings of green turtles off the coast of New Jersey (IOC 2013). Palka (2012) also reported several sightings off northern New Jersey south of Long Island during June–August 2011 surveys.

(3) Loggerhead Turtle (*Caretta caretta*)

Major nesting areas for loggerheads in the western North Atlantic are located in the southeastern U.S., principally southern Florida, but also as far north as the Carolinas and occasionally Virginia; the nesting season is from May to August (Spotila 2004). Most females tagged on North Carolina nesting beaches traveled north to forage at higher latitudes (primarily off New Jersey, Maryland, and Delaware) during summer, and south to wintering grounds off the southeastern U.S. in the fall (Hawkes et al. 2007).

Some juveniles make seasonal foraging migrations into temperate latitudes as far north as Long Island, New York (Shoop and Kenney 1992 *in* Musick and Limpus 1997). Lazell (1980) reported that loggerheads were historically common in New England waters and the Gulf of Maine. Sighting records of loggerheads off the northeastern U.S. were in all seasons in continental shelf and slope waters from Cape Cod to southern Florida, with greatest concentrations in mid-continental shelf waters off New Jersey during the summer (Fig. C-3a *in* DoN 2005). There are increased stranding records of loggerheads from Cape Cod Bay and Long Island Sound in the fall (DoN 2005); loggerheads may be unable to exit these inshore habitats, which can result in hypothermia as temperatures drop in late fall (Burke et al. 1991 *in* DoN 2005).

GMI (2010) reported 69 sightings of loggerhead turtles on the continental shelf off New Jersey during surveys conducted in January 2008–December 2009; sightings occurred from spring through fall, with most sightings during summer. There are over 1000 OBIS sighting records off the coast of New Jersey, including within the proposed project area (IOC 2013). Palka (2012) also reported several sightings off northern New Jersey south of Long Island during June–August 2011 surveys. There were 16 sightings of a single loggerhead turtle during the 13-day cruise in 2014.

(4) Hawksbill Turtle (*Eretmochelys imbricata*)

The hawksbill is the most tropical of all sea turtles, generally occurring between ~30ºN and ~30ºS (Eckert 1995b). In the Atlantic Ocean, most nesting beaches are in the Caribbean Sea as far north as

Cuba and the Bahamas (NMFS and USFWS 2013b). It is considered very rare and possibly extralimital in the northwest Atlantic (Lazell 1980; Eckert 1995b). Nonetheless, DoN (Fig. C-6 *in* DoN 2005) mapped two hawksbill turtle sightings off New Jersey (one during spring and one during fall) and several south of New Jersey. In addition, there is one OBIS sighting record offshore New Jersey, east of the proposed survey area (SEFSC 1992 *in* IOC 2013).

(5) Kemp's Ridley Turtle (*Lepidochelys kempii*)

Kemp's ridley turtle has a more restricted distribution than other sea turtles, with adults primarily located in the Gulf of Mexico; some juveniles also feed along the U.S. east coast, including Chesapeake Bay, Delaware Bay, Long Island Sound, and waters off Cape Cod (Spotila 2004). Nesting occurs primarily along the central and southern Gulf of Mexico coast during May–late July (Morreale et al. 2007). There have also been some rare records of females nesting on Atlantic beaches of Florida, North Carolina, and South Carolina (Plotkin 2003). After nesting, female Kemp's ridley turtles travel to foraging areas along the coast of the Gulf of Mexico, typically in waters <50 m deep from Mexico's Yucatan Peninsula to southern Florida; males tend to stay near nesting beaches in the central Gulf of Mexico year-round (Morreale et al. 2007). Only juvenile and immature Kemp's ridley turtles appear to move beyond the Gulf of Mexico into more northerly waters along the U.S. east coast.

Hatchlings are carried by the prevalent currents off the nesting beaches and do not reappear in the neritic zone until they are about two years old (Musick and Limpus 1997). Those juvenile and immature Kemp's ridley turtles that migrate northward past Cape Hatteras probably do so in April and return southward in November (Musick et al. 1994). North of Cape Hatteras, juvenile and immature Kemp's ridleys prefer shallow-water areas, particularly along North Carolina and in Chesapeake Bay, Long Island Sound, and Cape Cod Bay (Musick et al. 1994; Morreale et al. 1989; Danton and Prescott 1988; Frazier et al. 2007). There are historical summer sightings and strandings of Kemp's ridley turtles from Massachusetts into the Gulf of Maine (Lazell 1980). Occasionally, individuals can be carried by the Gulf Stream as far as northern Europe, although those individuals are considered lost to the breeding population. Virtually all sighting records of Kemp's ridley turtles off the northeastern U.S. were in summer off the coast of New Jersey (Fig. C-4a *in* DoN 2005). There are 60 OBIS sighting records off the coast of New Jersey, some within the proposed survey area (SEFSC 1992 *in* IOC 2013). Kemp's ridley turtle has been the most common sea turtle observed at the Oyster Creek Nuclear Generating Station located in Forked River, New Jersey (Houlahan and Paez 2014).

Seabirds

Two ESA-listed seabird species could occur in or near the Project area: the ***Threatened*** piping plover and the ***Endangered*** roseate tern. Neither species was observed during the 13-day cruise in 2014. General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of seabird families are given in § 3.5.1 of the PEIS.

(1) Piping Plover (*Charadrius melodus*)

The Atlantic Coast Population of the piping plover is listed as ***Threatened*** under the U.S. ESA, and the species is listed as ***Near Threatened*** on the IUCN Red List of Threatened Species (IUCN 2013). It breeds on coastal beaches from Newfoundland to North Carolina during March–August and it winters along the Atlantic Coast from North Carolina south, along the Gulf Coast, and in the Caribbean (USFWS 1996). Its marine nesting habitat consists of sandy beaches, sandflats, and barrier islands (Birdlife International 2013). Feeding areas include intertidal portions of ocean beaches, mudflats, sandflats, and shorelines of coastal ponds, lagoons, or salt marshes (USFWS 1996). Wintering plovers are generally found on barrier islands, along sandy peninsulas, and near coastal inlets (USFWS 1996).

Because it is strictly coastal, the piping plover likely would not be encountered at the proposed survey site.

(2) Roseate Tern (*Sterna dougallii*)

The Northeast Population of the roseate tern is listed as ***Endangered*** under the U.S. ESA, and the species is listed as ***Near Threatened*** on the IUCN Red List of Threatened Species (IUCN 2013). It breeds on islands along the northeast coast of the U.S from New York to Maine and north into Canada, and historically as far south as Virginia (USFWS 1998, 2010). It is thought to migrate beginning in mid September through the eastern Caribbean and along the north coast of South America, and to winter mainly on the east coast of Brazil (USFWS 2010). During the breeding season, roseate terns forage over shallow coastal waters, especially in water depths <5 m, sometimes near the colony and at other times at distances of over 30 km. They usually forage over shallow bays, tidal inlets and channels, tide rips, and sandbars (USFWS 2010).

Because of its distribution during the breeding season, the roseate tern likely would not be encountered at the proposed survey site.

Fish, Essential Fish Habitat, and Habitat Areas of Particular Concern

(1) ESA-Listed Fish and Invertebrate Species

There are two fish species listed under the ESA as ***Endangered*** that could occur in the study area: the New York Bight distinct population segment (DPS) of the Atlantic sturgeon, and the shortnose sturgeon. There are two species that are candidates for ESA listing: the cusk and the Northwest Atlantic and Gulf of Mexico DPS of the dusky shark. There are no listed or candidate invertebrate species. In the July 2014 Final EA, the great hammerhead shark was also included as a Candidate Species, but it has been removed from that status.

(a) Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)

Five DPSs of the Atlantic sturgeon are listed under the U.S. ESA, one as ***Threatened*** and four as ***Endangered***, including the New York Bight DPS, and the species is listed as ***Near Threatened*** on the IUCN Red List of Threatened Species (IUCN 2014). It is a long-lived, late maturing (11–21 years in the Hudson River), anadromous fish. Spawning adults migrate upriver in spring, beginning in April–May in the mid Atlantic. The New York Bight DPS primarily uses the Delaware and Hudson rivers for spawning. Following spawning, males can remain in the river or lower estuary until fall, and females usually exit the rivers within 4–6 weeks. Juveniles move downstream and inhabit brackish waters for a few months before moving into nearshore coastal waters (NOAA 2012b).

(b) Shortnose Sturgeon (*Acipenser brevirostrum*)

The shortnose sturgeon is listed as ***Endangered*** throughout its range under the U.S. ESA and ***Vulnerable*** on the IUCN Red List of Threatened Species (IUCN 2014). It is an anadromous species that spawns in coastal rivers along the east coast of North America from Canada to Florida. The shortnose sturgeon prefers the nearshore marine, estuarine, and riverine habitats of large river systems, and apparently does not make long-distance offshore migrations (NOAA 2013c).

(c) Cusk (*Brosme brosme*)

The cusk is an ESA ***Candidate Species*** throughout its range, and has not been assessed for the IUCN Red List. In the Northwest Atlantic, it occurs from New Jersey north to the Strait of Belle Isle and the Grand Banks of Newfoundland and rarely to southern Greenland. It is a solitary, benthic species found in rocky, hard bottom areas to a depth of 100 m. In U.S waters, it occurs primarily in deep water of the central Gulf of Maine (NOAA 2013d).

(d) Dusky Shark (*Carcharhinus obscurus*)

The Northwest Atlantic and Gulf of Mexico DPS of the dusky shark is an ESA ***Candidate Species***, and the species is listed as ***Vulnerable*** on the IUCN Red List of Threatened Species (IUCN 2014). It is a coastal-pelagic species that inhabits warm temperate and tropical waters throughout the world. In the Northwest Atlantic, it is found from southern Massachusetts and Georges Bank to Florida and the northern Gulf of Mexico. The dusky shark occurs in both inshore and offshore waters, although it avoids areas of low salinity from the surface to depths of 575 m. Along U.S. coasts, it undertakes long temperature-related migrations, moving north in summer and south in fall (NMFS 2013b).

(2) Essential Fish Habitat (EFH)

EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity”. “Waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish. “Substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities (NMFS 2013c). The entire eastern sea-board from the coast to the limits of the EEZ is EFH for one or more species or life stage for which EFH has been designated.

Two fishery management councils, created by the 1976 Magnuson Fisheries Conservation and Management Act (renamed Magnuson Stevens Fisheries Conservation and Management Act in 1996) are responsible for the management of fishery resources, including designation of EFH, in federal waters of the survey area: the Mid-Atlantic Fishery Management Council (MAFMC) and the New England Fishery Management Council (NEFMC). The Highly Migratory Division of the National Marine Fisheries Service in Silver Spring, MD, manages highly migratory species (sharks, swordfish, billfish, and tunas).

The life stages and associated habitats for those species with EFH in the survey area are described in Table 4.

Two EFH areas located ~150 km northeast of the proposed survey area, the Lydonia and Oceanographer canyons, were previously protected from fishing. Bottom trawling was prohibited in these areas because of the presence of *Loligo* squid eggs, under the Fisheries Management Plan for Atlantic mackerel, butterfish, and *Illex* and *Loligo* squid. This protection was valid as of 31 July 2008 for up to three years, after which it was to be subject to review for the possibility of extension (NOAA 2008).

(3) Habitat Areas of Particular Concern

Habitat Areas of Particular Concern (HAPC) are subsets of EFH that provide important ecological functions and/or are especially vulnerable to degradation, and are designated by Fishery Management Councils. All four life stages of summer flounder have EFH within the proposed survey area, whereas HAPC have only been designated for the juvenile and adult EFH: demersal waters over the continental shelf, from the coast to the limits of the EEZ, from the Gulf of Maine to Cape Hatteras, North Carolina (NOAA 2012c). Specifically, the HAPC include “all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile EFH. If native species of submerged aquatic vegetation are eliminated then exotic species should be protected because of functional value, however, all efforts should be made to restore native species” (NOAA 2012c). No other HAPC have been designated for those species with EFH within the proposed survey area.

TABLE 4. Marine species with Essential Fish Habitat (EFH) overlapping the proposed survey area.

Species	Life stage[1] and habitat[2]				
	E	L/N	J	A	SA
Atlantic cod *Gadus morhua*				B	B
Atlantic haddock *Melanogrammus aeglefinus*		P	B		
Pollock *Pollachius virens*				B	
Black sea bass *Centropristis striata*	P	P	D	D	D
Bluefish *Pomatomus saltatrix*	P	P	P	P	P
Butterfish *Peprilus triacanthus*	P	P	P	P	P
Atlantic herring *Clupea harengus*			P	P	B
Atlantic mackerel *Scomber scombrus*	P	P	P	P	P
Red hake *Urophycis chuss*	P	P	B		
Silver hake *Merluccius bilinearis*	P	P	B		
Scup *Stenotomus chrysops*			D	D	
Monkfish *Lophius americanus*	P	P	B	B	B
Ocean pout *Macrozoarces americanus*	B	B	B	B	B
Summer flounder *Paralichthys dentatus*	P	P	B	B	B
Windowpane flounder *Scophthalmus acquosus*	P	P		B	B
Winter flounder *Pleuronectes americanus*	B	D/P	B	B	B
Witch flounder *Glyptocephalus cynoglossus*	P	P			B
Yellowtail flounder *Limanda ferruginea*	P				
Albacore tuna *Thunnus alalunga*			P		
Bigeye tuna *Thunnus obesus*				P	
Bluefin tuna *Thunnus thynnus*			P		
Skipjack tuna *Katsuwonus pelamis*				P	
Yellowfin tuna *Thunnus albacres*			P		
Swordfish *Xiphias gladius*			P		
Little skate *Leucoraja erinacea*			B	B	
Winter skate *Leucoraja ocellata*			B		
Basking shark *Cetorhinus maximus*			P	P	
Blue shark *Prionace glauca*		P	P	P	
Dusky shark *Carcharhinus obscurus*		P	P	P	
Common thresher shark *Alopias vulpinus*		P	P	P	
Porbeagle shark *Lamna nasus*				P	
Sandbar shark *Carcharhinus plumbeus*		B	B	B	
Scalloped hammerhead shark *Sphyrna lewini*			P	P	
Shortfin mako shark *Isurus oxyrinchus*		P	P	P	
Smooth (spiny) dogfish *Squalus acanthias*		P	P	P	
Sand tiger shark *Carcharias taurus*		P	P		
Tiger shark *Galeocerdo cuvier*			P	P	
White shark *Carcharodon carcharias*		P	P	P	
Atlantic sea scallop *Placopecten magellanicus*	B	P	B	B	B
Atlantic surfclam *Spisula solidissima*	P	P	B	B	B
Ocean quahog *Arctica islandica*	P	P	B	B	B
Northern shortfin squid *Illex illecebrosus*	P	P	D/P	D/P	D/P
Longfin inshore squid *Loligo pealeii*	B	P	D/P	D/P	D/P

Source: NOAA 2012c

[1] E = eggs; L/N = larvae for bony fish and invertebrates, neonate for sharks; J = juvenile; A = adult; SA = spawning adult

[2.] P = pelagic; D = demersal; B = benthic

Fisheries

Commercial and recreational fisheries data are collected by NMFS, including species, gear type and landings mass and value, all of which are reported by state of landing (NOAA 2013e). Fisheries data from 2008 to 2013 were used in the analysis of New Jersey's commercial and recreational fisheries near the proposed survey area. To sample fishing vessel traffic during the proposed survey period off New Jersey, we requested historical National Automated Identification System (NAIS)[5] data from the USCG Navigation Center for June and July 2013 and 2014. The number of fishing vessels equipped with AIS was 21–27 per month, with only 4–6 of those spending more than a few hours in the proposed survey area. Some, but not all, small recreational fishing vessels would be included, as the use of AIS systems is voluntary for small vessels.

(1) Commercial Fisheries

The average annual catch weights and values, fishing season, and gear types for major commercial species are summarized in Table 5. In the waters off New Jersey, commercial fishery catches are dominated by menhaden, various shellfish, and squid. Menhaden accounted for 33% of the catch weight, followed by Atlantic surf clam (17%), ocean quahog (9%), sea scallop (7%), northern shortfin squid (6%), shellfish (5%), and blue crab (4%). Numerous other fish and invertebrate species accounted for the remaining proportion of catch weight. In 2010 (the only such dataset available in NOAA 2013g), most finfish by weight (68.8%) were caught within 5.6 km from shore; that catch was almost all (98.1%) accounted for by menhaden. Fish dominating the offshore (5.6–370 km from shore) finfish catch by weight were American mackerel (20.1% of total finfish weight), American herring (17.7%), skates (12.8%), and summer flounder (8.8%). Most finfish by value (73.3%) were caught between 5.6 and 370 km from shore; dominant fish by value were summer flounder (25.7% of total finfish value), goosefish/anglerfish (15.2%), yellowfin tuna (6.8%), and bigeye tuna (6.4%). Most shellfish and squid were captured between 5.6 and 370 km from shore, both by weight (73.6% of total shellfish and squid catch) and value (89.1%).

During 2002–2006 (the last year reported), commercial catch in the EEZ along the U.S east coast has only been landed by U.S. and Canadian vessels, with the vast majority of the catch (>99%) taken by U.S. vessels (Sea Around Us Project 2011). Typical commercial fishing vessels in the New Jersey area include trawlers, gill netters, lobster/crab boats, dredgers, longliners, and purse seiners.

(2) Recreational Fisheries

In 2013, marine recreational fishers caught over 5 million fish for harvest or bait, and >17.8 million fish in catch and release programs in New Jersey waters. These catches were taken by over 900,000 recreational fishers during more than 4 million trips. The majority of the trips (87%) occurred within 5.6 km from shore. The periods with the most boat-based trips (including charter, party, and private/rental boats) were July–August (1.03 million trips or 44% of total), followed by 1.03 million trips or 44%), and September–October (445,923 or 19%). Most shore-based trips (from beaches, marshes, docks, and/or piers; DoN 2005) occurred in July–August (600,400 or 32%), then September–October (442,464 or 23%), and May–June (370,832 or 20%).

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[5] Using the NAIS, detailed information on marine vessel traffic is collected, consolidated, and disseminated to the Coast Guard and other government agencies; the information includes vessel type, name, and other information that allows the data to be sorted by activities, e.g., fishing, diving, sailing, recreational, and cargo. Because AIS-equipped vessels transmit at regular intervals, it is possible to discriminate between vessels that are in the area for a period of time and those that are passing through.

TABLE 5. Commercial fishery catches for major marine species for New Jersey waters by weight, value, season, and gear type, averaged from 2008 to 2013.

Species	Average annual landings (mt)	% total	Average annual landings (1000$)	% total	Fishing season (peak season)	Gear Type: Fixed	Gear Type: Mobile
Menhaden	24,056	34	5,328	3	Year-round (May–Oct)	Gill nets, pots, traps, pound nets	Dip nets, trawls, dredge, purse seines, tongs, grabs
Atlantic surf clam	12,324	18	16,745	10	Year-round	N/A	Dredge, tongs, grabs
Ocean quahog	6,697	10	9,245	6	Year-round (spring–fall)	N/A	Dredge
Sea scallop	5,524	8	101,497	63	Year-round (Mar–Oct)	Gill nets, long lines, pots, traps, pound nets	Dredge, trawls
Northern shortfin squid	4,593	7	3,424	2	Year-round (Jun–Oct)	N/A	Dredge, trawls
Shellfish	3,607	5	1,464	1	Year-round (May–Oct)	Gill nets, long lines, pots, traps, pound nets, weirs	Trawls, cast nets, dip nets, diving, dredge, fyke net, hand lines, Scottish seine
Blue crab	2,768	4	7,718	5	Year-round (May–Oct)	Lines trot with bait, pots, traps	Dredge, hand lines, trawls
Atlantic herring	2,284	3	574	<1	Year-round (Jan–Feb)	Gill nets, pound nets	Trawls, fyke net
Atlantic mackerel	2,007	3	769	<1	Fall–spring (Jan–Apr)	Gill nets, pound nets	Dredge, trawls
Longfin squid	1,533	2	3,278	2	Year-round (Jan–Mar; Jul–Nov)	Gill nets, pound nets	Dredge, trawls
Monkfish (Goosefish)	1,144	2	3,199	2	Year-round (Oct–Mar; May–Jun)	Gill nets, long lines, pots, traps, pound nets	Dredge, trawls
Skate	1,036	1	667	<1	Year-round (Nov–Jan; May–Jun)	Gill nets, pots, traps, pound nets	Dredge, trawls
Summer flounder	953	1	4,527	3	Year-round	Gill nets, pots, traps, pound nets	Dredge, hand lines, trawls, rod and reel
Scup	669	1	831	1	Year-round (Jan–Apr)	Gill nets, pots, traps, pound nets	Dredge, trawls, hand lines
Spiny dogfish shark	554	1	247	<1	Fall–spring (Nov–Jan; May)	Gill nets, long lines, pots, traps, pound nets	Dredge, trawls, hand lines
Bluefish	422	1	452	<1	Year-round (Apr–Nov)	Gill nets, pots, traps, pound nets	Dredge, hand lines, trawls
Total	70,172	100	159,964	100			

Source: NOAA 2013e

In 2004, there were eight recreational fishing tournaments around New Jersey between May and November, all of which were within 150 km (~80 nm) from shore (DoN 2005). Of the 'hotspots' (popular fishing sites commonly visited by recreational anglers) mapped by DoN (2005), most are to the north or south of the proposed survey area; however, there are several hotspots located within or very near the northwestern corner of the survey area. As of May 2015, 20 tournaments were scheduled in 2015 for central New Jersey ports of call (Table 6). No detailed information about locations is given in the sources cited.

In 2013, at least 75 species of fish were targeted by recreational fishers off New Jersey. Species with 2013 recreational catch numbers exceeding one million include summer flounder (33% of total catch), black sea bass (12%), Atlantic croaker (7%), bluefish (7%), striped searobin (7%), striped bass (6%), and spot (5%). Other notable species or species groups representing at least 1% each of the total catch included unidentified sea robin, tautog, smooth dogfish, Atlantic menhaden, little skate, spiny

TABLE 6. Fishing tournaments off New Jersey, June–mid August 2014.

Dates	Tournament name	Port/ waters	Marine species/groups targeted	Source
1 Apr–30 Nov	Jersey Shore Beach N Boat Fishing Tournament	Beach Haven/ all saltwater out to 20 n.mi.	Striper; fluke; bluefish; black drum; weakfish; northern kingfish; sea bass; tautog (blackfish)	1
1 Apr–31 Dec	Beach Haven MTC Annual Fishing Contest	Beach Haven	Marlin; roundscale spearfish; sword-fish; pelagic sharks; bluefin/bigeye/ albacore/yellowfin/skipjack tuna	2
1 May–30 Nov	Manasquan River MTC Monthly & Mako Tournament	Brielle	Pelagic sharks; bigeye/albacore/ yellowfin tuna	2
5 Jun–31 Jul	Manasquan River Marlin & Tuna Club Bluefin Tournament	Manasquan/ Atlantic Ocean	Bluefin tuna	1, 3
5–8 Jun	Manasquan River Marlin & Tuna Club Spring Striped Bass Tournament	Manasquan	Striped bass	3
5–7 Jun	11th Annual Brielle Family Fishing Tournament	Brielle	Fluke; striped bass; bluefish	4
6 Jun	28th Greater Atlantic Bluefish Tournament	Sheltered Cove Kammerman's Seaview Harbour	Bluefish	5
12–13 Jun	Warriors for Warriors Charity Shark Tournament	Point Pleasant	Pelagic sharks	2
12–13 Jun	Brett T Bailey Mako Rodeo	Brielle	Pelagic sharks	2, 4
13 June	Atlantic City ASAC Just For Kids Youth Fish Tournament	Atlantic City	Unlisted	6
19–20 Jun	Beach Haven MTC Mako & Tuna Tournament	Beach Haven	Pelagic sharks; bluefin/bigeye/albacore/yellowfin tuna	2
26 Jun–5 Jul	Manasquan River Marlin & Tuna Club Jack Meyer Memorial Trolling Tournament	Manasquan	Marlins; tunas	3
26–28 Jun	Jersey Coast Shark Anglers 37th Annual Shark Tournament	Brielle	Pelagic sharks	4
27–28 Jun	Mako Mania	Point Pleasant	Pelagic sharks	2
1 Jul–30 Sep	Manasquan River MTC Super Monthly Marlin	Brielle	Blue/white marlin	2
4 Jul	World Cup Blue Marlin Championship	Statewide/ offshore	Blue marlin	1
11–12 Jul	Manasquan River Marlin & Tuna Club Ladies and Juniors Tournament	Manasquan	Unlisted	3
17–18 Jul	Beach Haven MTC 1st Offshore Tournament	Beach Haven	Blue/white marlin; roundscale spear-fish; swordfish; bluefin/bigeye/albacore/ yellowfin tuna	2
18 Jul	Ladies Catch of the Day Tournament	Forked River Tuna Club	Bluefish; fluke (likely summer/winter fluke); crab	5
30 Jul–1 Aug	Beach Haven MTC White Marlin Invitational	Beach Haven	Blue/white marlin; roundscale spearfish; bluefin/bigeye/albacore/ yellowfin tuna	2

Sources: 1: American Fishing Contests (2015); 2: NOAA (2015); 3: MRMTC (2015); 4: Hoffman's Marina (2015); 5: SBT (2015); 6: ASAC (2015).

dogfish, clearnose skate, tilefish, scup, cunner, red hake, unidentified skate, northern searobin, and weakfish. Most of these species/species groups were predominantly caught within 5.6 km from shore (on average 90% of total catch); summer flounder, skates/rays, and cunner were caught roughly equally within and beyond 5.6 km from shore, and red hake were mainly taken beyond 5.6 km from shore (80%).

A part of the proposed survey area is known as "The Fingers", a recognized productive and historical fishing area under the New Jersey Department of Environmental Protection (NJDEP)'s Prime Fisheries Area Mapping. The Fingers is 1 of 371 identified sport ocean fishing grounds in New Jersey; at 10,282 ha in area, it comprises ~0.9% of New Jersey's sport ocean fishing grounds (NJDEP 2003).

Recreational SCUBA Diving

Wreck diving is a popular form of recreation in the waters off New Jersey. A search for shipwrecks in New Jersey waters was made using NOAA's automated wreck and obstruction information system (NOAA 2014a). Results of the search are plotted in Figure 2 together with the survey lines. There are over 900 shipwrecks/obstructions in New Jersey waters, most (58%) of which are listed by NOAA (2014b) as unidentified. Only one shipwreck, a known dive site, is in or near the survey area (Fig. 2): the *Lillian* (Galiano 2009; Fisherman's Headquarters 2014; NOAA 2014a). Although it was noted during the public comment period for the Draft Amended EA that there might be other undocumented dive sites within the vicinity of the survey site, no specific dive site locations were identified.

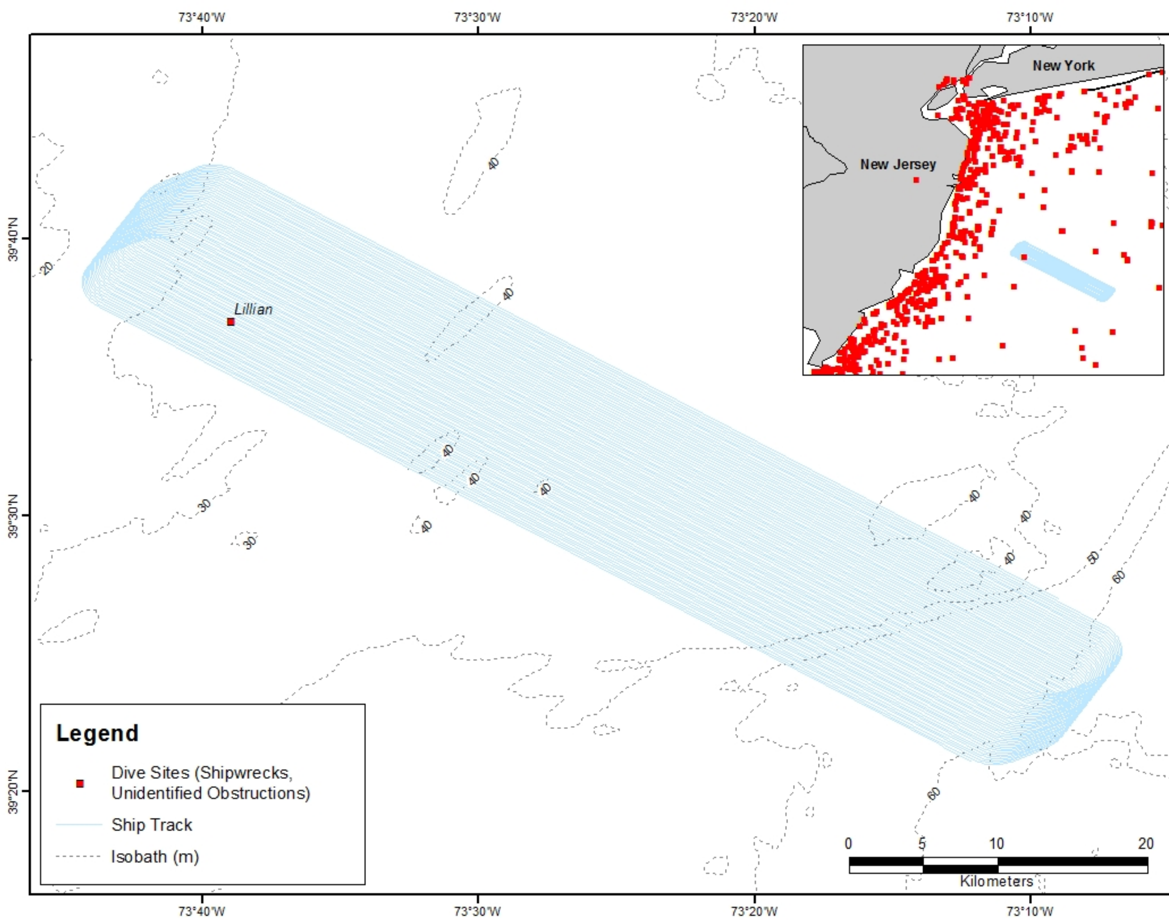

FIGURE 2. Potential dive sites (shipwrecks or unidentified obstructions) in New Jersey waters. Source: NOAA (2014b).

To sample diving activity during the proposed rescheduled survey period off New Jersey, historical NAIS data for both diving boats and pleasure craft in June and July 2013 and 2014 were requested and evaluated. There was only one AIS-identified dive boat in the survey area, apparently moving through the area in June 2013 and June 2014. In 2015, one dive operator had scheduled summer dives on the *Lillian*, on 11 July and 23 August (Deep Expeditions 2015). As of 1 May 2015, no other operators were found that have scheduled dives on the *Lillian* during the summer of 2015.

IV. Environmental Consequences

Proposed Action

The PEIS presented analyses of potential impacts from acoustic sources in general terms and for specific analysis areas. The proposed rescheduled survey and effects analysis differ from those in the NW Atlantic DAA presented in the PEIS in that different sources were used, the survey areas covered a different range of depths, and different modeling methods were used. The following section includes site-specific details of the proposed survey, summary effects information from the PEIS, and updates to the effects information from recent literature. Analysis conducted for the proposed 2015 survey remains the same as described in the 2014 Final EA for the 2014 survey, except for the smaller size of the airgun array. Seismic effects literature is updated in this Final Amended EA, and additional effects literature given in the 2015 NMFS EA (Appendix E) is incorporated into this Final Amended EA by reference as if fully set forth herein. In the conclusions of this section, we also refer to conclusions of the Final EAs, FONSIs, IHAs, and Biological Opinions issued by NMFS for the New Jersey survey in 2014 and 2015, 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 2015 NMFS Final EA, FONSI, IHA, Biological Opinion, and EFH concurrence letter, and which are incorporated herein by reference.

(1) Direct Effects on Marine Mammals and Sea Turtles and Their Significance

The material in this section includes a brief summary of the expected potential effects (or lack thereof) of airgun sounds on marine mammals and sea turtles, and reference to recent literature that has become available since the PEIS was released in 2011. A more comprehensive review of the relevant background information, as well as information on the hearing abilities of 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.

Estimates of the numbers of marine mammals that could be affected by the proposed seismic survey scheduled to occur during June–August 2015 are provided in (e) below, along with a description of the rationale for NSF's estimates of the numbers of individuals exposed to received sound levels ≥160 dB re 1 μPa_{rms}. Although the PEIS included modeling for the NW Atlantic DAA, it was done for a different energy source level and survey parameters (e.g., survey water depths and source tow depth), and modeling methods were different from those used by L-DEO (see PEIS, Appendix B, for further modeling details regarding the NW Atlantic DAA). Acoustic modeling for the proposed action was conducted by L-DEO, consistent with past EAs and determined to be acceptable by NMFS to use in the calculation of estimated takes under the MMPA (e.g., NMFS 2013d,e), including for the 2014 survey.

(a) 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 considered 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 proposed survey 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., Nieukirk 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; Klinck et al. 2012), 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. 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; Broker et al. 2013). 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. We are not aware of any information concerning masking of hearing in sea turtles.

***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 μPa 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). 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; Robertson et al. 2013). Subtle but statistically significant changes in surfacing–respiration–dive cycles were shown by traveling and socializing bowheads exposed to airgun sounds in the Beaufort Sea, including shorter surfacing intervals, shorter dives, and decreased number of blows per surface interval (Robertson et al. 2013).

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 μPa. Therefore, bowhead whales in the Beaufort Sea apparently decreased their calling rates in response to seismic operations, although movement out of the area could also have contributed 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 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa_{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 ensonified 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 vs. 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; Wole and Myade 2014). 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., Pirotta 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 μPa, SELs of 145–151 dB $\mu Pa^2 \cdot s$). For the same survey, Pirotta et al. (2014) reported that the probability of recording a porpoise buzz decreased by 15% in the ensonified area, and that the probability was positively related to the distance from the seismic ship; the decreased buzzing occurrence could indicate reduced foraging efficiency. Nonetheless, animals returned to the area within a few hours (Thompson et al. 2013). Kastelein et al. (2013a) reported that a harbor porpoise showed no response to an impulse sound with an SEL below 65 dB, but there was a 50% brief response rate at an SEL of 92 dB and an SPL of 122 dB re 1 $\mu Pa_{0\text{-peak}}$. The apparent tendency for greater responsiveness in the harbor porpoise is consistent with its 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.

Sea Turtles

Several recent papers discuss the morphology of the turtle ear (e.g., Christensen-Dalsgaard et al. 2012; Willis et al. 2013) and the hearing ability of sea turtles (e.g., Martin et al. 2012; Piniak et al. 2012a,b; Lavender et al. 2014). The limited available data indicate that sea turtles will hear airgun sounds and sometimes exhibit localized avoidance (see PEIS, § 3.4.4.3).

DeRuiter and Doukara (2012) observed that immediately following an airgun pulse, small numbers of basking loggerhead turtles (6 of 86 turtles observed) exhibited an apparent startle response (sudden raising of the head and splashing of flippers, occasionally accompanied by blowing bubbles from the beak and nostrils, followed by a short dive). Diving turtles (49 of 86 individuals) were observed at distances from the center of the airgun array ranging from 50 to 839 m. The estimated sound level at the median distance of 130 m was 191 dB re 1 μPa_{peak}. These observations were made during ~150 h of vessel-based monitoring from a seismic vessel operating an airgun array (13 airguns, 2440 in^3) off Algeria; there was no corresponding observation effort during periods when the airgun array was inactive (DeRuiter and Doukara 2012).

Based on available data, it is likely that sea turtles will exhibit behavioral changes and/or avoidance within an area of unknown size near a seismic vessel. To the extent that there are any impacts on sea turtles, seismic operations in or near areas where turtles concentrate would likely have the greatest impact; concentration areas are not known to occur in the proposed survey area. There are no specific data that demonstrate the consequences to sea turtles if seismic operations with large or small arrays of airguns occur in important areas at biologically important times of the year.

***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 (SEL); however, this assumption is likely an over-simplification (Finneran 2012). 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, 2013; Finneran et al. 2010a,b; Popov et al. 2011, 2013a; Finneran 2012; Kastelein et al. 2012a,b; 2013a,b,c, 2014; Ketten 2012).

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 $\mu Pa^2 \cdot s$; 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 µPa 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).

Additionally, 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). Similarly, several other studies have shown that some marine mammals (e.g., bottlenose dolphins, false killer whales) can decrease their hearing sensitivity in order to mitigate the impacts of exposure to loud sounds (e.g., Nachtigall and Supin 2013, 2014, 2015)

Previous information on TTS for odontocetes was primarily derived from studies on the bottlenose dolphin and beluga, and that for pinnipeds has mostly been obtained from California sea lions and elephant seals (see § 3.4.4.3, § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS). Therefore, it is inappropriate to assume that onset of TTS occurs at similar received levels in all cetaceans or pinnipeds (*cf.* Southall et al. 2007). Some cetaceans or pinnipeds could incur TTS at lower sound exposures than are necessary to elicit TTS in the beluga and bottlenose dolphin or California sea lion and elephant seal, respectively.

Several studies on TTS in porpoises (e.g., Lucke et al. 2009; Popov et al. 2011; Kastelein et al. 2012a, 2013a, 2014) indicate that received levels that elicit onset of TTS are lower in porpoises than in other odontocetes. Kastelein et al. (2012a) exposed a harbor porpoise to octave band noise centered at 4 kHz for extended periods. A 6-dB TTS occurred with SELs of 163 dB and 172 dB for low-intensity sound and medium-intensity sound, respectively; high-intensity sound caused a 9-dB TTS at a SEL of 175 dB (Kastelein et al. 2012a). Kastelein et al. (2013a) exposed a harbor porpoise to a long, continuous 1.5-kHz tone, which induced a 14-dB TTS with a total SEL of 190 dB. 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 µPa 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. Popov et al. (2011) reported a TTS of 25 dB for a Yangtze finless porpoise that was exposed to high levels of 3-min pulses of half-octave band noise centered at 45 kHz with an SEL of 163 dB.

Initial evidence from prolonged (non-pulse and pulse) exposures has also suggested that some pinnipeds (harbor seals in particular) incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999, 2005, 2008; Ketten et al. 2001; Kastelein et al. 2013c). Kastelein et al. (2012b) exposed two harbor seals to octave-band white noise centered at 4 kHz at three mean received SPLs of 124, 136, and 148 dB re 1 µPa; TTS >2.5 dB was induced at an SEL of 170 dB (136 dB SPL for 60 min), and the maximum TTS of 10 dB occurred after a 120-min exposure to 148 dB re 1 µPa or an SEL of 187 dB. Kastelein et al. (2013c) reported that a harbor seal unintentionally exposed to the same sound source with a mean received SPL of 163 dB re 1 µPa for 1 hr induced a 44 dB TTS. For a harbor seal exposed to octave-band white noise centered at 4 kHz for 60 min with mean SPLs of 124–148 re 1 µPa, the onset of PTS would require a level of at least 22 dB above the TTS onset (Kastelein et al. 2013c).

Based on the best available information at the time, Southall et al. (2007) recommended a TTS threshold for exposure to single or multiple pulses of 183 dB re 1 $\mu Pa^2 \cdot s$ for all cetaceans and 173 dB re 1 $\mu Pa^2 \cdot s$ for pinnipeds in water. Tougaard et al. (2015) suggested that SELs that induce TTS in porpoises are 100–110 dB above the pure tone hearing threshold at a specific frequency; they also suggested an exposure limit of $L_{eq\text{-}fast}$ (rms average over the duration of the pulse) of 45 dB above the hearing threshold for behavioral responses (i.e., negative phonotaxis). In addition, M-weighting, as used by Southall et al. (2007), might not be appropriate for the harbor porpoise (Wensveen et al. 2014; Tougaard et al. 2015); therefore, Wensveen et al. (2014) developed six auditory weighting functions for the harbor porpoise that could be useful in predicting TTS onset. 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.

It is unlikely that a marine mammal would remain close enough to a large airgun array for sufficiently long to incur TTS, let alone PTS. 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 possibility 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. 372*ff*; 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 μPa_{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 Final Amended 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 § II and § IV[2], below). 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) are 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) 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 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.

Sea Turtles

There is substantial overlap in the frequencies that sea turtles detect vs. the frequencies in airgun pulses. We are not aware of measurements of the absolute hearing thresholds of any sea turtle to waterborne sounds similar to airgun pulses. In the absence of relevant absolute threshold data, we cannot estimate how far away an airgun array might be audible. Moein et al. (1994) and Lenhardt (2002) reported TTS for loggerhead turtles exposed to many airgun pulses (see PEIS). This suggests that sounds from an airgun array might cause temporary hearing impairment in sea turtles if they do not avoid the (unknown) radius where TTS occurs. However, exposure duration during the proposed survey would be much less than during the aforementioned studies. Also, recent monitoring studies show that some sea turtles do show localized movement away from approaching airguns. At short distances from the source, received sound level diminishes rapidly with increasing distance. In that situation, even a small-scale avoidance response could result in a significant reduction in sound exposure.

Although it is possible that exposure to airgun sounds could cause mortality or mortal injuries in sea turtles close to the source, this has not been demonstrated and seems highly unlikely (Popper et al. 2014), especially because sea turtles appear to be highly resistant to explosives (Ketten et al. 2005 *in* Popper et al. 2014). Nonetheless, Popper et al. (2014) proposed sea turtle mortality/mortal injury criteria of 210 dB SEL or >207 dB_{peak} for sounds from seismic airguns.

The PSOs stationed on the *Langseth* would also watch for sea turtles, and airgun operations would be shut down if a turtle enters the designated EZ.

(b) 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, but not during transits. Information about this equipment was provided in § 2.2.3.1 of the PEIS. A review of the expected 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 International Whaling Commission (IWC) independent scientific review panel (ISRP) linking the operation of an 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. The proposed survey design and environmental context of the proposed survey are quite different from the mass melon-headed whale stranding described by the ISRP. It should be noted that this event is the first known marine mammal mass stranding closely associated with the operation of an MBES. It is noted that 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; Baird et al. 2014). 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 μPa. 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. Hastie et al. (2014) reported behavioral responses by grey seals to echosounders with frequencies of 200 and 375 kHz.

Despite the aforementioned information that has recently become available, this Final Amended EA is in agreement with the assessment presented in § 3.4.7, 3.6.7, 3.7.7, and 3.8.7 of the PEIS that operation of MBESs, SBPs, and pingers is not likely to impact marine mammals, and is not expected to affect sea turtles, (1) given the lower acoustic exposures relative to airguns and (2) because the intermittent and/or narrow downward-directed nature of these sounds would result in no more than one or two brief ping exposures of any individual marine mammal or sea turtle given the movement and speed of the vessel. Also, for sea turtles, the associated frequency ranges are above their known hearing range.

(c) Other Possible Effects of Seismic Surveys

Other possible effects of seismic surveys on marine mammals and/or sea turtles include masking by vessel noise, disturbance by vessel presence or noise, and injury or mortality from collisions with vessels or entanglement in seismic gear.

Vessel noise from the *Langseth* could affect marine animals in the proposed survey area. Sounds produced by large vessels generally dominate ambient noise at frequencies from 20 to 300 Hz (Richardson et al. 1995). Ship noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Hatch et al. 2012). In order to compensate for increased ambient noise, some cetaceans are known to increase the source levels of their calls in the presence of elevated noise levels from shipping, shift their peak frequencies, or otherwise change their vocal behavior (e.g., Parks et al. 2011; 2012; Castellote et al. 2012; Melcón et al. 2012; Tyack and Janik 2013).

Baleen whales are thought to be more sensitive to sound at these low frequencies than are toothed whales (e.g., MacGillivray et al. 2014), possibly causing localized avoidance of a survey area during seismic operations. Reactions of gray and humpback whales to vessels have been studied, and there is limited information available about the reactions of right whales and rorquals (fin, blue, and minke whales). Reactions of humpback whales to boats are variable, ranging from approach to avoidance (Payne 1978; Salden 1993). Baker et al. (1982, 1983) and Baker and Herman (1989) found humpbacks often move away when vessels are within several kilometers. Humpbacks seem less likely to react overtly when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984, 1986).

Many odontocetes show considerable tolerance of vessel traffic, although they sometimes react at long distances if confined by ice or shallow water, if previously harassed by vessels, or have had little or no recent exposure to ships (Richardson et al. 1995). Dolphins of many species tolerate and sometimes approach vessels. Some dolphin species approach moving vessels to ride the bow or stern waves (Williams et al. 1992). There are few data on the behavioral reactions of beaked whales to vessel noise, though they seem to avoid approaching vessels (e.g., Würsig et al. 1998) or dive for an extended period when approached by a vessel (e.g., Kasuya 1986). Based on a single observation, Aguilar-Soto et al. (2006) suggest foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels.

The PEIS concluded that project vessel sounds would not be at levels expected to cause anything more than possible localized and temporary behavioral changes in marine mammals or sea turtles, and would not be expected to result in significant negative effects on individuals or at the population level. In addition, in all oceans of the world, large vessel traffic is currently so prevalent that it is commonly considered a usual source of ambient sound.

Another concern with vessel traffic is the potential for striking marine mammals or sea turtles. Information on vessel strikes is reviewed in § 3.4.4.4 and § 3.6.4.4 of the PEIS. The PEIS concluded that the risk of collision of seismic vessels or towed/deployed equipment with marine mammals or sea turtles exists but is extremely unlikely, because of the relatively slow operating speed (typically 7–9 km/h) of the vessel during seismic operations, and the generally straight-line movement of the seismic vessel. There has been no history of marine mammal vessel strikes with the *Langseth*, or its predecessor, R/V *Maurice Ewing* over the last two decades, including those conducted off New Jersey.

Entanglement of sea turtles in seismic gear is also a concern. There have been reports of turtles being trapped and killed between the gaps in tail-buoys offshore from West Africa (Weir 2007); however, these tailbuoys are significantly different than those used on the *Langseth*. In April 2011, a dead olive ridley turtle was found in a deflector foil of the seismic gear on the *Langseth* during equipment recovery at the conclusion of a survey off Costa Rica, where sea turtles were numerous. Such incidents are possible, but this is the first case of sea turtle entanglement in seismic gear for the *Langseth*, which has been conducting seismic surveys since 2008, or for R/V *Maurice Ewing*, during 2003–2007. Towing the seismic equipment during the proposed survey is not expected to significantly interfere with sea turtle movements, including migration. Although sea turtles were observed during the 2014 survey, no such effects were detected nor were strandings reported during survey activities.

(d) Mitigation Measures

Several mitigation measures are built into the proposed seismic survey as an integral part of the planned activity. These measures include the following: ramp ups; typically two, however a minimum of one dedicated observer maintaining a visual watch during all daytime airgun operations; two observers for 30 min before and during ramp ups; PAM during the day and night to complement visual monitoring (unless the system and back-up systems are damaged during operations); and power downs (or if necessary shut downs) when mammals or turtles are detected in or about to enter designated EZ. These mitigation measures are described in § 2.4.4.1 of the PEIS and summarized earlier in this document, in § II(3). The fact that the 4-airgun subarray, because of its design, would direct the majority of the energy downward, and less energy laterally, is an inherent mitigation measure.

Previous and subsequent analysis of the potential impacts takes account of these planned mitigation measures. It would not be meaningful to analyze the effects of the planned activity without mitigation, as the mitigation (and associated monitoring) measures are a basic part of the activity, and would be implemented under the Proposed Action or Alternative Action. The same monitoring and mitigation measures proposed for the 2014 survey are proposed for the 2015 rescheduled survey.

(e) Potential Numbers of Cetaceans Exposed to Received Sound Levels ≥160 dB

All expected takes would be "takes by harassment" as described in § I, involving temporary changes in behavior. The mitigation measures to be applied would minimize the possibility of injurious takes. (However, as noted earlier and in the PEIS, 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 sound levels >160 dB re 1 μPa_{rms}, and present estimates of the numbers of marine mammals that could be affected during the proposed seismic program. The estimates are based on consideration of the number of marine mammals that could be disturbed appreciably by ~4900 km of seismic surveys off the coast of New Jersey. The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

Basis for Estimating Exposure.**—**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 μPa_{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 μPa_{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 μPa_{rms}. Likewise, they are less likely to approach within the ≥180 dB re 1 μPa_{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. (A new version of the SERDP GIS was released on 19 November 2013; the old version was used to calculate densities for the 2014 Final EA and Draft Amended EA, and the new version was used to calculate densities for this Final Amended EA.) The GIS provides minimum, mean, and maximum estimates for four seasons, and we have used the mean estimates for summer (June–August). 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. In the new version of the SERDP GIS, minimum, mean, and maximum densities are the same for most species. Differences in species densities between this Final Amended EA and the 2014 Final EA and Draft Amended EA are attributable to the different versions of the model.

The estimated numbers of individuals potentially exposed presented below are based on the 160-dB re 1 μPa_{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 7 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 μPa_{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 7. 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 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 EZ would result in the shutdown of seismic operations as a mitigation measure. Therefore, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 μPa_{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. For the proposed survey, NMFS included a 25% contingency factor rather than a turnover rate in their analysis for the 2015 IHA (described further below). NSF's methodology used for estimating take has rarely resulted in underestimation of take and has traditionally not included a turnover factor in take calculations; therefore, one was not included here.

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 therefore considered precautionary. As noted previously, in December 2013, NOAA made available for public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), although at the time of preparation of this Final Amended EA, the date of release of the final guidelines and how they would be implemented are unknown. 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, while 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).

TABLE 7. Densities and estimates of the possible numbers of individuals that could be exposed to ≥160 dB re 1 μPa_{rms} during the proposed seismic survey in the northwest Atlantic off New Jersey during June–August 2015. The proposed sound source consists of an 4-airgun subarray with a total discharge volume of ~700 in^3. 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							
North Atlantic right whale	*0*		*0*	*2037*	*0*	*0*	***0***
Humpback whale	*0*		*0*	*2037*	*0*	*0.01*	***1***[5]
Minke whale	0		0	2037	0	0	**0**
Sei whale	*0.740*		*0.740*	*2037*	*2*	*0.02*	***2***
Fin whale	*0.016*		*0.016*	*2037*	*0*	*<0.01*	***1***[5]
Blue whale	*0*		*0*	*2037*	*0*	*0*	***0***
Odontocetes							
Sperm whale	*17.07*		*17.07*	*2037*	*35*	*0.26*	***35***
Pygmy/dwarf sperm whale	0.004		0.004	2037	0	0.05	**2**[5]
Beaked whales[6]	0.570		0.570	2037	1	0.02	**3**[5]
Rough-toothed dolphin	0		0	2037	0	0	**0**
Bottlenose dolphin/WNAOS[7]	234.1		234.1	2037	477	0.62	**477**
Bottlenose dolphin/NMCS[7]	34.87		34.87	2037	71	0.62	**71**
Pantropical spotted dolphin	0		0	2037	0	0	**0**
Atlantic spotted dolphin	87.30		87.30	2037	178	0.40	**178**
Spinner dolphin[8]	0		0	2037	0	0	**0**
Striped dolphin	0		0	2037	0	0.08	**46**[5]
Short-beaked common dolphin	0		0	2037	0	0.01	**18**[5]
White-beaked dolphin[8]	0		0	2037	0	0	**0**
Atlantic white-sided dolphin	0		0	2037	0	0.03	**15**[5]
Risso's dolphin	32.88		32.88	2037	67	0.37	**67**
Pygmy killer whale[8]	0		0	2037	0	N/A	**0**
False killer whale[7]	0		0	2037	0	N/A	**0**
Killer whale [8]	0		0	2037	0	N/A	**0**
Pilot whale	0.444		0.444	2037	1	<0.01	**9**[5]
Harbor porpoise	0		0	2037	0	0	**0**

[1] Densities are the mean values for the survey area, calculated from the new version of the SERDP model of Read et al. (2009); differences in densities between this and the 2014 Final EA and Draft Amended EA are attributable to the different versions of the model
[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 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 3), 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] WNAOS = Western North Atlantic Offshore Stock, NMCS = Northern Migratory Coastal Stock; bottlenose dolphin density from Read et al. (2009) separated into stocks based on stock size (77,532 offshore and 11,548 coastal)
[8] Atlantic waters not included in the SERDP model of Read et al. (2009)

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 μPa_{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. Therefore, 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 μPa_{rms} were calculated by multiplying the expected species density times the expected 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, ~1630 km^2 (~2037 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 re 1 μPa_{rms}. 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 μPa_{rms}.

The estimate of the number of individual cetaceans that could be exposed to seismic sounds with received levels ≥160 dB re 1 μPa_{rms} during the proposed survey is 832 (Table 7). That total includes 37 cetaceans listed as ***Endangered*** under the ESA: 2 sei whales (0.02% of the regional population) and 35 sperm whales (0.26% of the regional population). Most (95%) 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 548 (0.62% of the regional population for each stock), 178 (0.40%), and 67 (0.37%) exposed to ≥160 dB re 1 μPa_{rms}, respectively.

As part of the IHA process in 2014 and 2015, NMFS reviewed the take estimates presented in Table 7 of the July 2014 Final EA, which were based on an 8-airgun subarray with a volume of ~1400 in^3, and Table 7 of this Final Amended EA, which are based on a 4-airgun subarray with a volume of ~700 in^3. As part of NMFS's analyses process, however, in 2014 they revised the take calculations for most species based on the summer or spring density information from SERDP GIS and from other sources, and most recent population estimates from the 2013 SAR. In 2015, they used only summer density information from the (new) SERDP GIS and a different source for mean group size, the Atlantic Marine Assessment Program for Protected Species (AMAPPS) surveys in 2010, 2011, and 2013. With some exceptions, for species with no density information or where the SERDP NODES summer model produced a density estimate of <1, NMFS increased the take estimates based on sighting information and mean group size from the 2010, 2011, and 2013 AMAPPS surveys. In 2015, they also introduced a new approach for calculating takes: with some exceptions, "The modeled number of instances of exposures to sound levels ≥160 dB re: 1 µPa is the product of the species density (where available), the daily ensonified area of 1,226 km^2, and the number of survey days (30 plus 25 percent contingency for a total of 38 days)". The use of the numbers of exposures, not the numbers of individuals, to calculate take authorization differs from NMFS' practice for more than a decade for NSF-funded seismic surveys. For those species, because of this different approach, authorized takes are 1.8–214 times what they were in 2014, despite the smaller airgun array being used in 2015. The IHA issued by NOAA on 7 May 2015 therefore included different estimates of the possible numbers of marine mammals exposed to sound levels ≥160 dB re 1 mPa during the proposed seismic survey than those presented in Table 7. Additionally, the 2014 and 2015 BOs used take estimation methods that differed from each other and from those in the IHAs and the NMFS EAs (for details, see Appendix C, p. 107-111). Whereas NMFS' analysis does result in an increase in take from 2014 and 2015, the number of takes for both years falls well within the range of insignificance and meets the criteria for issuing an IHA.

NMFS does not provide specific guidance or requirements for IHA Applicants or for Section 7 ESA consultation for the development of take estimates and multiple exposure analysis, therefore variation in methodologies and calculations are likely to occur. The analysis presented in this Final Amended EA and the Final EA dated 1 July 2014, however, follows a methodology that has been used successfully for past NSF seismic surveys to generate take estimates and multiple exposures for the MMPA and ESA processes. Although NSF did not, and has not historically, estimated take for sea turtles, the Biological Opinion and ITS included analysis and take estimates for sea turtles (Appendix C). NSF and LDEO would adhere to the requirements of the ITS and the IHA and associated take levels issued.

(f) Conclusions for Marine Mammals and Sea Turtles

The proposed seismic project would involve towing a 4-airgun subarray, with a total discharge volume of 700 in^3, that introduces pulsed sounds into the ocean. Routine vessel operations, other than the proposed seismic operations, are conventionally assumed not to affect marine mammals sufficiently to constitute "taking".

Cetaceans.—In § 3.6.7 and 3.7.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures could result in a small number of Level B behavioral effects in some mysticete and odontocete species in the NW Atlantic DAA; that Level A effects were highly unlikely; and that operations were unlikely to adversely affect ESA-listed species. The information from recent literature summarized in sections (a) to (c) above complements, and does not affect the outcome of the effects assessment as presented in the PEIS.

In this analysis, estimates of the numbers of marine mammals that could be exposed to 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 7). The estimates are likely overestimates of 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. Therefore, no significant impacts on cetaceans would be expected from the proposed activity.

In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, PSOs and other crew members have seen no seismic sound-related marine mammal injuries or mortality, including during the 2014 survey. Also, actual numbers of animals potentially exposed to sound levels sufficient to cause disturbance (i.e., are considered takes) have almost always been much lower than predicted and authorized takes. For example, during an NSF-proposed, ~5000-km, 2-D seismic survey from the *Langseth* off the coast of North Carolina in September–October 2014, only 296 cetaceans were observed within the predicted 160-dB zone and potentially taken, representing <2% of the 15,498 takes authorized by NMFS (RPS 2015). During an USGS, ~2700 km, 2-D seismic survey from the *Langseth* along the U.S. east coast in August–September 2014, only 3 unidentified dolphins were observed within the predicted 160-dB zone and potentially taken, representing <0.03% of the 11,367 authorized takes (RPS 2014c).

For each of the 2014 and 2015 surveys, NMFS issued a Final EA and a FONSI. NMFS also issued IHAs on 1 July 2014 and 7 May 2015, therefore the proposed activity meets the criteria that the proposed activity "must not cause serious physical injury or death of marine mammals, must have negligible impacts on the species and stocks, must "take" no more than small numbers of those species or stocks, and must not have an unmitigable adverse impact on the availability of the species or stocks for legitimate subsistence uses." In the Biological Opinions dated 1 July 2014 and 7 May 2015, NMFS determined that the level of incidental take was not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat**.** The issuance of the Final EAs, FONSIs, IHAs, and Biological Opinions by NMFS in July 2014 and May 2015 further verifies that significant impacts would not be expected from the proposed activity, especially given that the activity would be using the smaller 700-in^3 source, rather than the larger size source also analyzed and authorized by NMFS in 2014. Observations from the brief 2014 survey support this conclusion (RPS 2014b).

Sea Turtles.—In § 3.4.7, the PEIS concluded that with implementation of the proposed monitoring and mitigation measures, no significant impacts of airgun operations are likely to sea turtle populations in any of the analysis areas, and that any effects are likely to be limited to short-term behavioral disturbance and short-term localized avoidance of an area of unknown size near the active airguns. Five species of sea turtle—the leatherback, loggerhead, green, hawksbill, and Kemp's ridley—could be encountered in the proposed survey area. Only foraging or migrating individuals would occur. Given the proposed activity, no significant impacts on sea turtles would be expected. In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, PSOs and other crew members have seen no seismic sound-related sea turtle injuries or mortality, including during the 2014 survey. In their July 2014 and May 2015 Final EAs, FONSIs, and Biological Opinions, NMFS determined that the level of incidental take was not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat**.** The Biological Opinions further verify that significant impacts would not be expected from the proposed activity. Observations from the brief 2014 survey support this conclusion (RPS 2014b).

(2) Direct Effects on Invertebrates, Fish, Fisheries, and EFH and Their Significance

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. Relevant new studies on the effects of sound on marine invertebrates, fish, and fisheries that have been published since the release of the PEIS are summarized below.

(a) Effects of Sound on Marine Invertebrates

Fewtrell and McCauley (2012) exposed captive squid (*Sepioteuthis australis*) to pulses from a single airgun; the received sound levels ranged from 120 to 184 dB re 1 dB re 1 μPa^2 · s SEL. Increases in alarm responses were seen at SELs >147–151 dB re 1 μPa^2 · s; the squid were seen to discharge ink or change their swimming pattern or vertical position in the water column. Solé et al. (2013) exposed four cephalopod species to low-frequency (50–400 Hz) sinusoidal wave sweeps (with a 1-s sweep period for 2 h) with received levels of 157 ± 5 dB re 1 μPa, and peak levels up to 175 dB re 1 μPa. Besides exhibiting startle responses, all four species examined received damage to the statocyst, which is the organ responsible for equilibrium and movement. The animals showed stressed behavior, decreased activity, and loss of muscle tone.

When New Zealand scallop (*Pecten novaezelandiae*) larvae were exposed to recorded seismic pulses, significant developmental delays were reported, and 46% of the larvae exhibited body abnormalities; it was suggested that the malformations could be attributable to cumulative exposure (de Soto et al. 2013). Their experiment used larvae enclosed in 60-ml flasks suspended in a 2-m diameter by 1.3-m water depth tank and exposed to a playback of seismic sound at a distance of 5–10 cm. Other studies conducted in the field have shown no effects on Dungeness crab larvae or snow crab embryos (Pearson et al. 1994; DFOC 2004 *in* NSF PEIS). Moreover, a major annual scallop-spawning period occurs in the Mid-Atlantic Bight during late summer to fall (August–October), although MacDonald and Thompson (1988 in NMFS 2004) reported scallop spawning off New Jersey during September–November. The timing of the proposed survey would not coincide with the time when scallops are spawning.

Celi et al. (2013) exposed captive red swamp crayfish (*Procambarus clarkia*) to linear sweeps with a frequency range of 0.1–25 kHz and a peak amplitude of 148 dB re 1 µPa rms at 12 kHz for 30 min. They found that the noise exposure caused changes in the haemato-immunological parameters (indicating stress) and reduced agonistic behaviors.

(b) Effects of Sound on Fish

Potential impacts of exposure to airgun sound on marine fish have been reviewed by Popper (2009), Popper and Hastings (2009a,b), and Fay and Popper (2012); they include pathological, physiological, and behavioral effects. Radford et al. (2014) suggested that masking of key environmental sounds or social signals could also be a potential negative effect from sound. Popper et al. (2014) presented guidelines for seismic sound level thresholds related to potential effects on fish. The effect types discussed include mortality, mortal injury, recoverable injury, temporary threshold shift, masking, and behavioral effects. Seismic sound level thresholds were discussed in relation to fish without swim bladders, fish with swim bladders, and fish eggs and larvae.

Bui et al. (2013) examined the behavioral responses of Atlantic salmon (*Salmo salar L.*) to light, sound, and surface disturbance events. They reported that the fish showed short-term avoidance responses to the three stimuli. Salmon that were exposed to 12 Hz sounds and/or surface disturbances increased their swimming speeds.

Peña et al. (2013) used an omnidirectional fisheries sonar to determine the effects of a 3D seismic survey off Vesterålen, northern Norway, on feeding herring (*Clupea harengus*). They reported that herring schools did not react to the seismic survey; no significant changes were detected in swimming speed, swim direction, or school size when the drifting seismic vessel approached the fish from a distance of 27 km to 2 km over a 6 h period. Peña et al. (2013) attributed the lack of response to strong motivation for feeding, the slow approach of the seismic vessel, and an increased tolerance to airgun sounds.

Miller and Cripps (2013) used underwater visual census to examine the effect of a seismic survey on a shallow-water coral reef fish community in Australia. The census took place at six sites on the reef before and after the survey. When the census data collected during the seismic program were combined with historical data, the analyses showed that the seismic survey had no significant effect on the overall abundance or species richness of reef fish. This was in part attributed to the design of the seismic survey (e.g., ≥400 m buffer zone around reef), which reduced the impacts of seismic sounds on the fish communities by exposing them to relatively low SELs (<187 dB re 1 $\mu Pa^2 \cdot s$). Fewtrell and McCauley (2012) exposed pink snapper (*Pagrus auratus*) and trevally (*Pseudocaranx dentex*) to pulses from a single airgun; the received sound levels ranged from 120 to 184 dB re 1 dB re 1 $\mu Pa^2 \cdot s$ SEL. Increases in alarm responses were seen in the fish at SELs >147–151 dB re 1 µPa^2 · s; the fish swam faster and formed more cohesive groups in response to the airgun sounds.

Hastings and Miksis-Olds (2012) measured the hearing sensitivity of caged reef fish following exposure to a seismic survey in Australia. When the auditory evoked potentials (AEP) were examined for fish that had been in cages as close as 45 m from the pass of the seismic vessel and at water depth of 5 m, there was no evidence of temporary threshold shift (TTS) in any of the fish examined, even though the cumulative SELs had reached 190 dB re 1 µPa^2 · s.

Popper et al. (2013) conducted a study that examined the effects of exposure to seismic airgun sound on caged pallid sturgeon (*Scaphirhynchus albus*) and paddlefish (*Polyodon spathula*); the maximum received peak SPL in this study was 224 dB re 1 µPa. Results of the study indicated no mortality, either during or seven days after exposure, and no statistical differences in effects on body tissues between exposed and control fish.

Andrews et al. (2014) conducted functional genomic studies on the inner ear of Atlantic salmon (*Salmo salar*) that had been exposed to seismic airgun sound. The airguns had a maximum SPL of ~145 dB re 1 µPa^2/Hz and the fish were exposed to 50 discharges per trial. The results provided evidence that fish exposed to seismic sound either increased or decreased their expressions of different genes, demonstrating that seismic sound can affect fish on a genetic level.

Two spawning stocks that migrate inshore/offshore off New Jersey are the summer flounder and black sea bass. Summer flounder normally inhabit shallow coastal and estuarine waters in summer and move offshore in 60–150 m depth in fall and winter. They spawn in fall and winter (September–December) (MAFMC 1988), after the proposed seismic survey period. Black sea bass normally inhabit shallow waters in summer and move offshore and south in 75–165 m depth in fall and winter (MAFMC 1996). Spawning in the Middle Atlantic Bight population occurs primarily on the inner continental shelf from May to July during inshore migrations (NMFS 1999), largely before the survey's proposed timing. Therefore, spawning of at least two important species would not be affected to any great degree.

(c) Effects of Sound on Fisheries

Handegard et al. (2013) examined different exposure metrics to explain the disturbance of seismic surveys on fish. They applied metrics to two experiments in Norwegian waters, during which fish distribution and fisheries were affected by airguns. Even though the disturbance for one experiment was greater, the other appeared to have the stronger SEL, based on a relatively complex propagation model. Handegard et al. (2013) recommended that simple sound propagation models should be avoided and that the use of sound energy metrics like SEL to interpret disturbance effects should be done with caution. In this case, the simplest model (exposures per area) best explained the disturbance effect.

Hovem et al. (2012) used a model to predict the effects of airgun sounds on fish populations. Modeled SELs were compared with empirical data and were then compared with startle response levels for cod. This work suggested that in the future, particular acoustic-biological models could be useful in designing and planning seismic surveys to minimize disturbance to fishing. Their preliminary analyses indicated that seismic surveys should occur at a distance of 5–10 km from fishing areas, in order to minimize potential effects on fishing.

In their introduction, Løkkeborg et al. (2012) described three studies in the 1990s that showed effects on fisheries. Results of their study off Norway in 2009 indicated that fishes reacted to airgun sound based on observed changes in catch rates during seismic shooting; gillnet catches increased during the seismic shooting, likely a result of increased fish activity, whereas longline catches decreased overall (Løkkeborg et al. 2012).

(d) Conclusions for Invertebrates, Fish, and Fisheries

This newly available information does not affect the outcome of the effects assessment as presented in 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 and associated EFH. The PEIS also concluded that seismic surveys could cause temporary, localized reduced fish catch to some species, but that effects on commercial and recreation fisheries were not significant.

Most commercial fish catches by weight (almost all menhaden) and most recreational fishing trips off the coast of New Jersey (87% in 2013) occurred in waters within 5.6 km from shore, although the highest-value fish (e.g., flounder and tuna) were caught farther offshore. The closest distance between the proposed survey and shore is >30 km, so interactions between the proposed survey and recreational and some commercial fisheries would be relatively limited. Also, most of the recreational fishery "hotspots" described in § III are to the north or south of the proposed survey area; however, there are several hotspots located within or very near the northwestern corner of the survey area. Two possible conflicts are the *Langseth*'s streamer entangling with fixed fishing gear and temporary displacement of fishers within the survey area, although the survey area is relatively small (12 x 50 km). Fishing activities could occur within the survey area; however, a safe distance would need to be kept from the *Langseth* and the towed seismic equipment. Conflicts would be avoided through communication with the fishing community and publication of a Notice to Mariners about operations in the area, therefore impacts would be negligible.

The number of fishing vessels equipped with AIS in June and July 2013 and 2014 was 21–27 per month, with only 4–6 of those spending more than a few hours in the proposed survey area. No fisheries activities except vessels in transit were observed in the survey area during the 13 days that the Langseth was there in July 2014.

The rescheduled survey is proposed to take place ~33–92 km off the coast of New Jersey (27–87 km from New Jersey state waters). The area of the proposed survey is relatively small, ~600 km^2. If we were to make a comparison of that survey area to blocks in New York City, it would essentially be equivalent to an area of 8 by 22 city blocks. The overall area of New Jersey marine waters from shore to the EEZ encompasses ~210,768 km^2. Therefore the proposed survey area represents less than one half percent (0.28%) of the area of waters from the New Jersey shore to the EEZ (600 km^2/210,768 km^2). The survey area plus the largest mitigation zone (8.15 km) would represent less than one percent (0.88%) of the area of waters from the New Jersey shore to the EEZ (1159 km^2/210,768 km^2). The seismic survey is proposed to take place for ~30 days within the June to August timeframe in 2015, not over the entire time that would be allowable under the IHA. As noted previously, fishing activities would not be precluded from operating in the proposed survey area. Any impacts to fish species would occur very close to the survey vessel and would be temporary. No fish kills or injuries were observed during the 2014 survey (RPS 2014b).

Given the proposed activity, no significant impacts on marine invertebrates, marine fish, their EFH, and their fisheries would be expected. In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, PSOs and other crew members have seen no seismic sound-related fish or invertebrate injuries or mortality. Furthermore, past seismic surveys in the proposed survey area (2002, 1998, 1995, 1990) did not result in noticeable effects on commercial or recreational fish catches, based on a review of multi-year NMFS fish catch data in the months when seismic surveys were undertaken. The issuance of the Final EAs, FONSIs, IHAs, and Biological Opinions by NMFS in July 2014 and May 2015 further verifies that significant impacts would not be expected from the proposed activity. Observations from the brief 2014 survey support this conclusion (RPS 2014b).

NSF consulted in 2014, and did so again in 2015, with the NMFS Greater Atlantic Regional Fisheries Office under the Magnuson-Stevens Act for EFH (see below "Coordination with Other Agencies and Processes" for further details). The NMFS Greater Atlantic Regional Fisheries Office concluded, in both 2014 (Appendix H of the 1 July 2014 Final EA) and 2015 (Appendix I of the May 2015 Final Amended EA), that the proposed activity may at some level adversely affect EFH, however, no specific conservation measures were identified for the proposed activity.

(3) Direct Effects on Seabirds and Their Significance

Effects of seismic sound and other aspects of seismic operations (collisions, entanglement, and ingestion) on seabirds are discussed in § 3.5.4 of the PEIS. The PEIS concluded that there could be transitory disturbance, but that there would be no significant impacts of NSF-funded marine seismic research on seabirds or their populations. Given the proposed activity, no significant impacts on seabirds would be expected. In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, PSOs and other crew members have seen no seismic sound-related seabird injuries or mortality. Furthermore, NSF received concurrence from USFWS in 2014 (Appendix F of the 1 July 2014 Final EA) and again in 2015 that the proposed activities "may affect" but "are not likely to adversely affect" species under their jurisdiction (Appendix H of the 2015 Final EA). Observations from the July 2014 survey support this conclusion (RPS 2014b).

(4) Indirect Effects on Marine Mammals, Sea Turtles, and Their Significance

The proposed seismic operations would not result in any permanent impact on habitats used by marine mammals or sea turtles, or to the food sources they use. The main impact issue associated with the proposed activity would be temporarily elevated noise levels and the associated direct effects on marine mammals and sea turtles, as discussed above.

During the proposed seismic survey, only a small fraction of the available habitat would be ensonified at any given time. Disturbance to fish species and invertebrates would be short-term, and fish would return to their pre-disturbance behavior once the seismic activity ceased. Therefore, the proposed survey would have little impact on the abilities of marine mammals or sea turtles to feed in the area where seismic work is planned. No other indirect effects on other species would be expected.

(5) Direct Effects on Recreational SCUBA Divers and Dive Sites and Their Significance

No significant impacts on dive sites, including shipwrecks, would be expected. Airgun sounds would have no effects on solid structures. The only potential effects could be temporary displacement of fish and invertebrates from the structures.

Significant impacts on, or conflicts with, divers or diving activities would be avoided through communication with the diving community before and during the survey and publication of a Notice to Mariners about operations in the area. In particular, dive operators with dives scheduled on the shipwreck *Lillian* during the survey would be contacted directly. That dive site represents only a very small percentage of the recreational dive sites in New Jersey waters. In June and July 2013 and 2014, there was only one AIS-identified dive boat passing through the survey area. No dive vessels were observed in the survey area during the ~13 days that the *Langseth* was there in July 2014.

The New Jersey Council of Diving Clubs (NJCDC) suggested that a 145-dB low-frequency sound limit could provide a suitable margin of safety for divers. Based on in situ measurements collected during

2014 using seismic streamer data and analyzed by Crone (2015, pers. comm.), a 145-dB level would be ~14 km (~7.5 nm) from the vessel. This 145-dB value is extrapolated from measured values; measured values at 160-dB and 180-dB distances were significantly lower, by 30–50%, than modeled values. Except for the *Lillian*, there is only one potential dive site in a 14-km buffer around the survey area, an unidentified wreck very near the outer edge of the buffer in >60 m water depth. The 14-km buffer is conservative, as it is around the entire survey area, not the vessel itself. The vessel, which would be constantly moving, would be a minimum of 14 km from a point on the edge of the buffer, but could be as far away as ~65 km from that point when it is at the far end of the survey area.

(6) Cumulative Effects

The results of the cumulative impacts analysis in the PEIS indicated that there would not be any significant cumulative effects to marine resources from the proposed NSF-funded marine seismic research. However, the PEIS also stated that, "A more detailed, cruise-specific cumulative effects analysis would be conducted at the time of the preparation of the cruise-specific EAs, allowing for the identification of other potential activities in the area of the proposed seismic survey that may result in cumulative impacts to environmental resources." Here we focus on activities that could impact animals specifically in the proposed survey area (research activities, vessel traffic, and commercial fisheries). Additionally, the 2015 NMFS EA Cumulative Effects Section on Climate Change is incorporated into this Final Amended EA by reference as if fully set forth herein.

(a) Past and future research activities in the area

As part of the IODP, the liftboat *Kayd* conducted scientific research and drilling on Expedition 313, New Jersey Shallow Shelf, at several sites off New Jersey during 30 April–17 July 2008. In the more distant past, there have been other scientific drilling activities in the vicinity. There have also been numerous prior seismic surveys, all of which were 2-D, ranging from poor quality, low resolution data collected in 1978 to the most recent, excellent quality, high resolution but shallow penetration data from 2002. These include surveys with a 6-airgun, 1350-in^3 array in 1990; with a single, 45-in^3 GI Gun in 1995 and 1998; and with two 45-in^3 GI Guns in 2002. In July 2014, the *Langseth* attempted to conduct the proposed survey, but it was not possible 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, and only ~61 h of seismic survey data were collected, with only ~43 h at full power (700 in^3) on survey tracklines. No seismic sound-related marine mammal, fish, or seabird injuries or mortality were observed by crew or scientists during any of these past seismic surveys in the proposed survey area.

In 2014, the *Langseth* also supported an NSF-proposed 2-D seismic survey off the coast of North Carolina to study the U.S. mid-Atlantic margin. That cruise lasted ~34 days and collected ~5000 km of track lines in September/October 2014. During the survey, only 296 cetaceans were observed within the predicted 160-dB zone and potentially taken, representing <2% of the 15,498 authorized takes (RPS 2015). Additionally, the *Langseth* conducted a 2-D seismic survey (~2700 km) for ~3 weeks in August/September 2014, and conducted a similar ~3 week-survey in April 2015, for the USGS in support of the delineation of the U.S. Extended Continental Shelf (ECS) along the east coast. Separate EAs were prepared for those activities, and neither project would overlap with the proposed survey area. During the 2014 USGS survey, only 3 unidentified dolphins were observed within the predicted 160-dB zone and potentially taken, representing <0.03% of the 11,367 takes issued by NMFS for the 2014 USGS survey (RPS 2014c). During the 2015 USGS survey, several visual and acoustic detections of marine mammals were made, however, only one resulted in implementation of a mitigation measure (shut down) for an unidentified dolphin (Hutchinson 2015, pers. comm.).

Other scientific research activities may be conducted in this region in the future; however, no other marine geophysical surveys are proposed at this specific site using the *Langseth* in the foreseeable future. At the present time, the proponents of the survey are not aware of other similar seismic research activities planned to occur in the proposed survey area during the June–August 2015 timeframe, but research activities planned by other entities are possible, although unlikely.

(b) Vessel traffic

Based on data available through the Automated Mutual-Assistance Vessel Rescue (AMVER) system managed by the U.S. Coast Guard, 15–49 commercial vessels per month travelled through the proposed survey area during the months of June and July from 2008 to 2013, and for each month in 2012 and 2013 (2013 data are available for January–June, the most recent data available as of May 2015). Over 50 commercial vessels per month were recorded during this time closer to shore (particularly around New York City), to the immediate west and northwest of the proposed survey area (USCG 2013).

Based on historical NAIS data requested from the USCG Navigation Center, in June 2014 vessels in the proposed survey area consisted of cargo vessels and tankers (60% of total numbers), pleasure craft/sailboats (25%), fishing vessels (9%), towing/dredging vessels (3%), other, including research vessels (2%), and military vessel (1%). During the 13 days in July 2014 that the *Langseth* was in the survey area, there was limited merchant vessel activity; most merchant traffic was lining up for "safety fairway" to the west of the survey area.

The total transit distance (~5200 km) by L-DEO's vessel *Langseth* would be minimal relative to total transit length for vessels operating in the proposed survey area during June–August 2015. Therefore, the projected increases in vessel traffic attributable to implementation of the proposed activity would constitute only a negligible portion of the total existing vessel traffic in the analysis area, and only a negligible increase in overall ship disturbance effects on marine mammals.

(c) Marine Mammal Disease

As discussed in § III, since July 2013, an unusually high number of dead or dying bottlenose dolphins have washed up on the mid-Atlantic coast from New York to Florida. NOAA noted that the triggers for disease outbreaks are unknown, but that contaminants and injuries may reduce the fitness of dolphin populations by stressing the immune system. Morbillivirus outbreaks can also be triggered by a drop in the immunity of bottlenose dolphin populations if they have not been exposed to the disease over time, and natural immunity wanes (NOAA 2013b). The last morbillivirus mortality event occurred in 1987–1988, when more than 740 bottlenose dolphins died along the mid-Atlantic coast from New Jersey to Florida (NOAA 2013b). During that UME, fungal, bacterial, and mixed bacterial and fungal pneumonias were common in the lungs of 79 dolphins that were examined, and the frequent occurrence of the fungal and bacterial infections in dolphins that also were infected by morbillivirus was consistent with morbillivirus-induced immunosuppression resulting in secondary infections (Lipscomb et al. 1994). Dr. Teri Knowles of NOAA noted that if the current outbreak evolves like the one in 1987–1988, "we're looking at mortality being higher and morbillivirus traveling southwards and continuing until May 2014." In fact, since mid 2014, the UME appears to have ended in the northern states: in the 8 months between 17 August 2014 and 15 April 2015, there were 1, 4, 2, and 1 strandings in NY, NJ, DE, and MD, respectively, as compared to pre-UME (2007–2012) annual strandings of 6, 15, 10, and 5 strandings in NY, NJ, DE, and MD, respectively (NOAA 2015a). Dr. Knowles also speculated that environmental factors, such as heavy metal pollution and sea surface temperature changes, could also play a role in the current outbreak (National Geographic Daily News 2013). It seems unlikely that the short-term behavioral disturbance that could be caused by the proposed seismic survey, especially for dolphins, would contribute to the development or continuation of a morbillivirus outbreak. Although NMFS has informed the Greater Atlantic Stranding Network coordinators and the Coordinator of the Marine Mammal Health and Stranding Program (MMHSRP) on 8 January 2015 that an IHA application for the proposed activity had been received, strandings from the proposed activity would not be expected. Therefore, the proposed activity would not be expected to increase the level of coordination necessary for stranding networks and associated budgets or impact the New Jersey Animal Health Diagnostic Laboratory budget, which has been involved with funding efforts related to the recent bottlenose dolphin morbillivirus mortality event.

(d) Fisheries

The commercial and recreational fisheries in the general area of the proposed survey are described in § III. The number of fishing vessels equipped with AIS for June and July 2013 and 2014 was 21–27 per month, with only 4–6 of those spending more than a few hours in the proposed survey area. No fisheries activities except vessels in transit were observed in the survey area during the 13 days that the Langseth was there in July 2014. The primary contributions of fishing to potential cumulative impacts on marine mammals and sea turtles involve direct removal of prey items, noise, potential entanglement (Reeves et al. 2003), and the direct and indirect removal of prey items. In U.S. waters, numerous cetaceans (mostly delphinids) and pinnipeds suffer serious injury or mortality each year from fisheries; for example, for the species assessed by Waring et al. (2013), average annual fishery-related mortality during 2006–2010 in U.S. Atlantic waters included 164 common dolphins, 212 Atlantic white-sided dolphins, 791 harbor porpoises, and 1466 harbor, gray, and harp seals. There may be some localized avoidance by marine mammals of fishing vessels near the proposed seismic survey area. L-DEO's operations in the proposed survey area are also limited (duration of ~1 month), and the combination of L-DEO's operations with the existing commercial and recreational fishing operations in the region is expected to produce only a negligible increase in overall disturbance effects on marine mammals and sea turtles.

(e) Military Activity

The proposed survey is located within the U.S. Navy's Atlantic City Range Complex (ACRC). The Boston, Narragansett Bay, and Atlantic City range complexes are collectively referred to as the Northeast Range Complexes. The types of activities that could occur in the ACRC would include the use of active sonar, gunnery events with both inert and explosive rounds, bombing events with both inert and explosive bombs, and other similar events. The ACRC includes special use airspace, Warning Area W-107. The ACRC is an active area, but there is typically relatively limited activity that occurs there. There has only been limited activity in the past, and there were no conflicts during the 2014 survey. L-DEO and NSF are coordinating, and would continue to coordinate, with the U.S. Navy to ensure there would be no conflicts in 2015.

(f) Oil and Gas Activities

Oil and gas activities are managed by BOEM. If BOEM were interested in oil and gas development activities in the survey area, BOEM would need to prepare the appropriate analyses under NEPA, followed by other consultation processes under such federal statutes as the MMPA, ESA, EFH, and CZMA. The proposed survey site is outside of the BOEM Atlantic Outer Continental Shelf Proposed Geological and Geophysical (G&G) Activities in the Mid-Atlantic and South Atlantic Planning Areas (BOEM 2014). The current BOEM mid-Atlantic and South Atlantic activities would be the preliminary surveys that are necessary for BOEM and industry to determine resource potential, and to provide siting information for renewable energy and marine minerals activities; lease sales in those areas have not yet been considered. The final BOEM Record of Decision for the proposed action was issued in July 2014.

A number of seismic surveys have been proposed within the Mid-Atlantic and South Atlantic Planning Areas. At this time, the proposals are under various federal regulatory reviews and it is unclear if and when they would be approved to move forward; it would be highly unlikely they would go forward as early as summer 2015. It is unlikely that the proposed survey would overlap in time with any of the proposed G&G seismic surveys.

Whereas it is theoretically possible that the oil and gas industry may be interested in the architecture of the passive margin area in the survey region for application to other locations (see Appendix B, page C-15, of the 1 July 2014 Final EA), there are no known interests for G&G activities, including oil and gas exploration, in or around the proposed survey site. The proposed seismic survey is not related to nor would it lead to offshore drilling; the proposed activity would evaluate sea level change as described here and in the 2014 Final EA and there are no additional activities proposed beyond those by the PIs or NSF (i.e., there are no proposed oil and gas exploration activities associated with the proposed activity).

Seismic surveys in support of research activities have occurred in the survey area in the recent past (2002, 1998, 1995, 1990). Additionally, NJDEP conducted a seismic survey (boomer/sparker source) in 1985 off the coast of New Jersey (Waldner and Hall 1991). Oil and gas activities in the proposed survey area have not resulted from these similar research seismic surveys. The proposed rescheduled seismic survey is a research activity, and is completely unrelated to oil and gas development.

Given the potential distance from any future BOEM G&G activities in the region and separation in time with the proposed activity, no cumulative effects would be expected.

(7) Unavoidable Impacts

Unavoidable impacts to the species of marine mammals, sea turtles, seabirds, fish, and invertebrates occurring in the proposed survey area would be limited to short-term, localized changes in behavior of individuals. For cetaceans, some of the changes in behavior may be sufficient to fall within the MMPA definition of "Level B Harassment" (behavioral disturbance; no serious injury or mortality). TTS, if it occurs, would be limited to a few individuals, would be a temporary phenomenon that does not involve injury, and would be unlikely to have long-term consequences for the few individuals involved. No long-term or significant impacts would be expected on any of these individual marine mammals, sea turtles, seabirds, fish, and invertebrates or on the populations to which they belong. Effects on recruitment or survival would be expected to be (at most) negligible.

(8) Public Involvement and Coordination with Other Agencies and Processes

NSF posted the Draft Amended EA on the NSF website on 19 December 2014 for a 37-day public comment period. Because the comment period overlapped with several holidays, an extra 7 days were added to the NSF standard 30-day open public comment period for Draft EAs. During the open public comment period, a 30-day extension of the public comment period on the Draft Amended EA was requested based on an assertion that the document included the addition of 126 new published data and scientific literature. NSF compared the sources cited in the 2014 Final EA for the project issued on 1 July 2014 with the Draft Amended EA. The 2014 Final EA, which was issued nearly 6 months before the Draft Amended EA, contained all but 6 of the sources identified in "Section VI Literature Cited". Three of those sources were actually referenced in the 2014 Final EA document on page 32 but were inadvertently omitted from the Draft Amended EA. Of the remaining three additional sources, one was the 2014 Final EA for the "Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the US Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards" issued on August 21, 2014. Despite the addition of only a few sources of published data and scientific literature referenced in the Draft Amended EA, NSF decided to extend the public comment period by an additional 15 days above and beyond the 37 days it was planned to be open for comment. The public comment period was opened on 19 December 2014 and closed on 9 February 2015 11:59 PM Eastern Standard Time.

During the Draft Amended EA public comment period, nine comments were received from individuals and entities requesting an extension to the public comment period. At the close of the comment period, eight additional comments on the proposed activity were submitted from individuals and entities, one of which represented multiple organizations and individuals. After the close of the public comment period, one comment was resubmitted to add an additional signatory. Comments received related to a range of topics including, but not limited to, scuba diving safety, survey monitoring and mitigation, socioeconomic impacts, impacts on marine life and habitat, regulatory processes, take estimates and modeling, evaluation of alternatives, and general support and opposition to the proposed survey. The public comments received during the open comment period on the Draft Amended EA can be found in Appendix F and responses to the comments can be found in a response-comment matrix in Appendix G. After consideration of comments received during the public comment period and discussions during MMPA and ESA consultations with NMFS, refinements and additions to the information in the Draft Amended EA were made and included in this Final Amended EA; recent scientific literature was also incorporated since the Draft Amended EA was issued in December 2014. These changes are noted in this Final Amended EA where appropriate, and changes made in response to public comments are also identified in the response-comment matrix (Appendix G). The changes in the Final Amended EA include the addition of

- recommended diving distances from the actively operating seismic vessel;
- GPS coordinates of the proposed survey area in degrees and decimal minutes;
- NAIS data on vessel activity in the proposed survey area during June and July 2013 and 2014;
- proposed changes to North Atlantic right whale Critical Habitat;
- the current status of oil and gas related seismic surveys;
- clarification on potential impacts on marine-related local business;
- identification of a recognized productive and historical fishing area overlapping the proposed survey area;
- identification of PSO monitoring and mitigation roles with respect to fish;
- incorporation of information on sea turtle sightings off New Jersey;
- updated information on consultation processes;
- discussion of the difference in approach for calculating take estimates between the Draft Amended EA and the IHA/NMFS EA and BO/ITS (2014 and 2015); and
- changes to mitigation measures (shot interval for mitigation source and shutdowns for groups of large whales.

The new information included in this Final Amended EA, however, did not alter the overall conclusions of the Draft Amended EA and remained consistent with the PEIS and the 2014 Final EA.

This Final Amended EA was prepared by LGL on behalf of L-DEO and NSF pursuant to NEPA. Potential impacts to endangered species and critical habitat were also assessed in the document; therefore, it was used to coordinate and support other consultations with federal agencies as required and noted below.

(a) Endangered Species Act (ESA)

For 2014 and 2015 survey activity, NSF engaged in formal consultation with NMFS and informal consultation with USFWS pursuant to Section 7 of the ESA. As in 2014, NSF received confirmation on 14 January 2015 from USFWS that the proposed rescheduling of the survey from 2014 to 2015 would not change the effect of the action on the species under their jurisdiction and their concurrence on the action remained the same as in 2014. In 2014, USFWS concluded that, "the proposed 3-D activity "may affect" but "are not likely to adversely affect" the roseate tern or piping plover." (Appendix H). Mitigation measures would include power-downs/ shutdowns for foraging endangered or threatened seabirds.

NMFS issued a Biological Opinion and an Incidental Take Statement (Appendix C of the 1 July 2014 Final EA) on 1 July 2014 for the 2014 survey and consultation was concluded. Because of the proposed rescheduling of the survey, NSF submitted a formal consultation request on 19 December 2014. On 7 May 2015, NMFS issued a Biological Opinion and an Incidental Take Statement (Appendix C) for the proposed activity. In the 2014 and 2015 Biological Opinions, NMFS concluded that the proposed seismic survey was not likely to jeopardize the continued existence of endangered species and would have no effect on their critical habitat. In 2014, NMFS determined that for operational purposes and coordination with monitoring and mitigation measures required under the IHA, the Exclusion Zone for cetaceans, sea turtles, and foraging seabirds would be expanded to the 177-db isopleth. For the proposed 2015 activity, however, based on analysis conducted by Crone et al. (2014) and Crone (2015, pers. comm.), NMFS determined that this mitigation measure was unnecessary and not required. Other differences between the 2014 and 2015 Biological Opinion and between the 2015 Biological Opinion and the NSF Final Amended EA have been noted throughout the Final Amended EA where appropriate.

(b) Marine Mammal Protection Act (MMPA)

As noted previously, although an IHA had been issued (Appendix D of the 1 July 2014 Final EA) and the survey commenced in 2014, NMFS required a new IHA to conduct the same survey during a rescheduled time in 2015. L-DEO, on behalf of LDEO, Rutgers, and NSF, submitted to NMFS an IHA application pursuant to the MMPA on 23 December 2014. On 17 March 2015, NMFS issued in the Federal Register a notice of intent to issue an IHA for the survey and 30-day public comment period. NMFS prepared a separate EA for its federal action of issuing an IHA; NMFS' EA (Appendix E) is incorporated by reference in this NSF Final Amended EA as appropriate and where indicated. NMFS issued an IHA on 7 May 2015 (Appendix D) for the proposed activity. As part of the IHA process, NMFS received public comments, which are summarized in their EA and will be made available on their website at http://www.nmfs.noaa.gov/pr/permits/incidental/research.htm#nj2015. Many of the comments received during the IHA process were similar to those received during the open comment period for NSF's Draft Amended EA.

The Draft Amended EA identified where there were slight differences between the 2014 Final EA and the 2014 IHA and 2014 NMFS EA issued for the 2014 survey; similarly, differences between the IHA and NMFS EA issued for the 2015 survey and the Final Amended EA have been noted throughout the Final Amended EA where appropriate. As noted above, in 2014, NMFS determined that for operational purposes and coordination with monitoring and mitigation measures required under the IHA, the Exclusion Zone for sea turtles and foraging seabirds would be expanded to the 177-db isopleth. For the proposed 2015 activity, however, based on analysis conducted by Crone et al. (2014) and Crone (2015, pers. comm.), NMFS determined that this mitigation measure was unnecessary and not required. Differences between the IHA issued for the 2015 survey and the Draft Amended EA included, but were not limited to, a 1.25 turnover rate for animals in the take estimate calculation, a one-minute shot interval for the 40-in^3 mitigation airgun, and power downs for groups (6 or more) of large whales. NSF, Rutgers, and LDEO would adhere to the IHA requirements for the proposed action.

(c) NMFS Marine Mammal Stranding Program

Although marine mammal strandings were not expected as a result of the 2015 survey activity, NMFS Protected Resources Division informed the Greater Atlantic Stranding Network coordinators and the Coordinator for the Marine Mammal Health and Stranding Program (MMHSRP) on 8 January 2015 that an IHA application for the proposed activity had been received. Per the IHA, should any marine mammal strandings occur during the survey, NMFS and the NMFS Greater Atlantic Regional Fisheries Office Marine Mammal Response Coordinator would be contacted. No marine mammal strandings attributable to the 2014 survey were reported to NSF.

(d) Magnuson-Stevens Act—Essential Fish Habitat (EFH)

The Magnuson-Stevens Act requires that a federal action agency consult with NMFS for actions that "may adversely affect" EFH. On 22 December 2014, NSF contacted the EFH Regional Coordinator of the NOAA Greater Atlantic Regional Fisheries Office regarding consultation for the proposed activity. The EFH Regional Coordinator concluded in a letter dated 11 February 2015 that some level of adverse effects to EFH might occur as a result of the proposed activity (Appendix I). Additional research and monitoring to gain a better understanding of the potential effects that seismic surveys may have on EFH, federal managed species, their prey, and other NOAA trust resources was recommended for future NSF activities. NSF has provided federal funding in part for the "Fourth International Conference on Effects of Noise on Aquatic Life" (AN2016), and for previous such international meetings held in Nyborg, Denmark (2007), Cork, Ireland (2010), and Budapest, Hungary (2013). The major goal of AN2016 will be to define the current state of knowledge on the impact of underwater noise and, in particular, explore the progress made in this field in the three years since the previous conference. The meeting will bring together researchers, regulators/policy makers, and industry with an interest in different animal groups, including marine mammals, turtles, fish, and invertebrates. No project-specific EFH conservation recommendations, however, were provided for the proposed survey, and consultation was concluded. NSF also consulted for EFH for the 2014 survey, which resulted in the same consultation conclusion as for the 2015 proposed survey.

(e) Coastal Zone Management Act (CZMA)

New Jersey.—Per the requirements of the CZMA, NSF reviewed the New Jersey Coastal Management Program (CMP) Federal Consistency Listings and determined that the proposed activity was unlisted. The following formal letters and documents are included as Appendix J. On 8 October 2014, NSF contacted NJDEP about NSF's interest in rescheduling the proposed survey for June/July/August 2015. On 15 October 2014, NSF and NJDEP held a teleconference during which the proposed survey was discussed and NJDEP's interest in reviewing the proposed survey under the CZMA was confirmed. Per CFR 15 930.34, NSF requested that NJDEP identify relevant enforceable policies applicable to the project, but none were identified. Although no enforceable policies were identified, on 22 December 2014, NSF submitted to NJDEP, "NSF Coastal Zone Management Act (CZMA) Consistency Determination" (CD), with the Draft Amended EA appended as Attachment 1. On 6 March 2015, after requesting a 15-day extension of time to respond, NJDEP provided its response to NSF's CD, which concluded that, contrary to NSF's determination, the proposed survey was inconsistent with three enforceable policies of New Jersey's federally approved CMP.

On 6 April 2015, NSF received a request from NJDEP for informal mediation facilitated by OCM pursuant to 15 CFR Part 930.111; NSF agreed to informal mediation on 9 April 2015. On April 21, 2015, NJDEP sent a request to NOAA's Office for Coastal Management (OCM) to initiate and facilitate informal mediation between NJDEP and NSF. On 27 April 2015, NSF received a letter from NJDEP also dated 21 April 2015, submitted to OCM, Rutgers, L-DEO, and NSF notifying the letter recipients of their position that the proposed survey required consistency review under 15 C.F.R. Part 930, subparts D and F. At no time prior to 21 April 2015, however, did NJDEP notify Rutgers, L-DEO, or NSF of its position. On 30 April 2015, OCM sent a letter to NJDEP denying the request to review the proposed activity under Subparts D and F (Appendix J). OCM noted that, as NJDEP had acknowledged in their letter, "...the CZMA regulations make clear that a project cannot be treated as *both* a federal agency activity under Subpart C and also an activity under Subpart D or F. Here, the Department [NJDEP] performed its review of the Project under Subpart C and having completed that review, additional, parallel, or redundant reviews under other Subparts of the regulations are now precluded." In its letter, OCM also indicated, "...that even if the reviews the Department is requesting were not otherwise precluded, it is not clear the request would meet the technical requirements set forth in the CZMA rules for reviews under Subpart D or F, including timeliness, proper notice, etc." On 1 May 2015, NSF sent a letter to OCM concurring with OCM's findings and providing additional comments for OCM's consideration regarding NJDEP's request (Appendix J). On 5 and 11 May, Rutgers University and L-DEO, respectively, sent letters to OCM concurring with OCM's findings and the additional comments provided in NSF's letter to OCM dated 1 May 2015. Despite NJDEP's inconsistent finding, NSF has determined that the proposed activity is consistent to the maximum extent practicable with New Jersey's CMP; this determination is set forth in the document titled "Final Determination of Federal Consistency by the National Science Foundation for the Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off New Jersey, Summer 2015 (Appendix J). Mediation efforts by NSF and NJDEP are ongoing, and NSF remains hopeful that an agreement will ultimately be reached.

New York.—Per the requirements of the CZMA, NSF reviewed the New York CMP Federal Consistency Listings and determined that the proposed activity was unlisted. On 1 August 2014, New York Department of State (NYDOS) submitted a letter to NSF stating that the survey area was within their off shore planning area of interest and requested review of all current and future proposed actions so that NYDOS could review them for federal consistency. Because of the substantial distance of the survey site from New York state waters, no effects would be expected on New York coastal uses or resources. Although under the CZMA unlisted review requests are required to go through OCM, in light of NYDOS' 1 August 2014 letter, NSF contacted NYDOS on 30 October 2014 to confirm the State's interest in reviewing the unlisted activity. On 9 January 2015, NYDOS confirmed interest in reviewing the project. Per CFR 15 930.34, NSF, both in October 2014 and in subsequent contacts, requested that NYDOS identify relevant enforceable policies applicable to the project, but none were identified.

On 16 January 2015, NSF submitted to NYDOS, "NSF Coastal Zone Management Act (CZMA) Consistency Determination" (CD), with the Draft Amended EA appended as Attachment 1 (Appendix K). The following correspondence is also included in Appendix K. On 17 February 2015, NSF received from NYDOS a letter (dated 3 February 2015) that acknowledged receipt of the CD, informed of the initiation of the State's review process, and included a request for additional data and information. On 19 February 2015, NSF responded to NYDOS's data request, providing the requested data. On 13 March 2015, NYDOS requested a 15-day extension of time to review the CD and NSF acknowledged NYDOS's request the same day. NYDOS provided its response to NSF's CD on 31 March 2015, which concurred with NSF's CD that the proposed survey was consistent with the enforceable policies of New York's federally approved CMP. NYDOS included, however, several recommendations to modify the proposed activity to reduce the likelihood of reasonably foreseeable effects on New York's coastal resources and uses. NYDOS's concurrence with NSF's CD was not conditional on NSF adhering to these recommendations.

One recommendation suggested by NYDOS was that because of the location of the survey and potential overlap with New York's commercial fishing use, the survey should avoid overlap to the maximum extent practicable. NYDOS suggested this could be achieved through consultation with the New York fishing industry to identify when and where commercial fishers would be in the area to avoid entangling fishing gear or displacing them. As noted in Chapter IV, based on past experience at the survey site and evaluation of NAIS data, few fishing vessels would be expected at the survey site during the proposed survey time. Regardless, L-DEO would issue Notice to Mariners to avoid space-use conflicts with fishing vessels in the survey area. Fishing activities could occur within the survey area; however, a safe distance would need to be kept from the *Langseth* and the towed seismic equipment. A second recommendation suggested by NYDOS was that the proposed activity be confined to operation during the fall months to reduce the likelihood of reasonably foreseeable effects on fish stocks commercially important to New York. The supporting exemplary graphics provided were for fall and spring; graphics for summer, the proposed survey timing, however, were not provided. Based on the supporting information provided, it would appear that conducting the survey in spring or fall would make little difference based on seasonal presence of some species. NYDOS suggested that some species would be migrating through the survey area during the proposed survey period, but again, supporting graphics for summer were not provided.

Alternative Action: Alternative Survey Timing

An alternative to issuing the IHA for the period requested, and to conducting the Project then, is to issue the IHA for another time, and to conduct the project at that alternative time. The proposed dates for the cruise (~34 days in June–August) are the dates when the personnel and equipment essential to meet the overall project objectives are available; if the date of the cruise were changed, for example to late spring or early fall, it is likely that the scientific personnel (lead PI and collaborating PIs) and *Langseth* would not be available and, therefore, the purpose and need of the proposed activities could not be met. A recommendation was made during the public comment period on the Draft Amended EA that the survey be conducted in September–October 2015, or September–October of a future year, to reduce the impact to fisheries and marine mammals. In the comment, it was suggested that the geologic formations at the target depths of interest are static and not likely to change if the proposed activity were rescheduled to September– October in a future year in which the personnel and equipment essential to meet the overall project objectives were available. This suggestion, however, does not take into account that the research was proposed by researchers and students whose professional and academic careers depend upon the timely collection of these data and successful completion of the survey. In other words, there is a timeliness factor involved with the Proposed Activity, as well as a desire to have the scientific results incorporated into the broader scientific community in the near term. If the IHA were issued for another period, it could result in significant delay and disruption not only of this cruise, but also of additional studies that are planned on the *Langseth* for 2015 and beyond.

The weather in the mid-Atlantic Ocean was also taken into consideration when planning the proposed activity. The mid-Atlantic Ocean off New Jersey can be challenging to operate during certain times of year, precluding the ability to safely tow seismic gear. Whereas conducting the survey at an alternative time is a viable alternative if the *Langseth*, personnel, and essential equipment are available, because of the weather conditions, it would not be viable to conduct a seismic survey in winter months off the coast of New Jersey. Whereas hurricanes can occur in the summer, peak hurricane season starts in mid August and extends until mid October (http://climate.rutgers.edu/stateclim/?section=menu&%20 target=nj_hurricane_history); some of New Jersey's deadliest recorded storms have occurred during September/October. The most recent deadly hurricane that hit the New Jersey shoreline was Hurricane Sandy, which impacted the state from 26 October 2012 to 8 November 2012. It was declared a major disaster on October 30, 2012 (http://www.fema.gov/disaster/4086). Hurricane Sandy was responsible for 73 deaths in the United States and cost billions of dollars in assistance (http://www.fema.gov/sandy-recovery-office). The rough weather encountered by the *Langseth* during the 2014 survey demonstrates the challenges of conducting oceanographic research even during optimal weather periods (summer), and similarly, highlights the potential safety hazards of operating during suboptimal weather periods.

Marine mammals and sea turtles are expected to be found throughout the proposed survey area and throughout the time during which the project would occur. 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 (see § III, above). In particular, migration of the North Atlantic right whale occurs mostly between November and April, and the survey is timed to avoid those months. Accordingly, the alternative action would likely result in either a failure to meet the purpose and need of the proposed activity or it would raise the risk of causing impacts to species such as the North Atlantic right whale.

No Action Alternative

An alternative to conducting the proposed activity is the "No Action" alternative, i.e. do not issue an IHA and do not conduct the operations. If the research were not conducted, the "No Action" alternative would result in no disturbance to marine mammals or sea turtles attributable to the proposed activities; however, valuable data about the marine environment would be lost. Research that would contribute to the understanding of the response of nearshore environments to changes in elevation of global sea level would be lost and greater understanding of Earth processes would not be gained. The "No Action" alternative could also, in some circumstances, result in significant delay of other studies that would be planned on the *Langseth* for 2015 and beyond, depending on the timing of the decision. Not conducting this cruise (no action) would result in less data and support for the academic institutions involved. Data collection would be an essential first step for a much greater effort to analyze and report information for the significant topics indicated. The field effort would provide material for years of analyses involving multiple professors, students, and technicians. The lost opportunity to collect valuable scientific information would be compounded by lost opportunities for support of research infrastructure, training, and professional career growth. The research goals and objectives cannot be achieved using existing scientific data. Existing seismic profiles occur at intervals too coarse to achieve the proposed scientific goals of this project. Both the larger spacing and the limitations inherent in processing 2-D seismic data preclude identification of key features of the past margin such as river or delta channels and shoreline adjustments. Only dense and 3-D seismic acquisition and processing can provide continuity of imaging to enable confident identification of these features, whose distributions are expected to evolve throughout the time period recorded in the sediments targeted. Dense 3-D data have not been collected previously at the survey site, which is why it was proposed by the PI and collaborators. The "No Action" Alternative would not meet the purpose and need for the proposed activities, but was carried through for analysis as required under CEQ regulations (40 C.F.R. 1502.14[d]).

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