Draft Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September–October 2014

Prepared for

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ABSTRACT

Lamont-Doherty Earth Observatory (L-DEO), with funding from the U.S. National Science Foundation (NSF), proposes to conduct a high-energy, 3-D seismic survey from the R/V *Langseth* in the Atlantic Ocean ~6–430 km from the coast of Cape Hatteras in September–October 2014. The proposed seismic survey would use a towed array of 36 airguns with a total discharge volume of ~6600 in^3 or 18 airguns with a total discharge volume of ~3300 in^3. The seismic survey would take place outside of U.S. state waters, mostly within the U.S. Exclusive Economic Zone (EEZ) and partly in International Waters, in water depths 30–4300 m.

NSF, as the funding and action 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 seismic survey would collect data in support of a research proposal that has been reviewed under the NSF merit review process and identified as an NSF program priority. It would provide data necessary to study how the continental crust stretched and separated during the opening of the Atlantic Ocean, and what the role of magmatism was during continental breakup.

This Draft Environmental Assessment (EA) addresses NSF's requirements under the National Environmental Policy Act (NEPA) and Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions", for the proposed NSF federal action. L-DEO is requesting an Incidental Harassment Authorization (IHA) from the U.S. National Marine Fisheries Service (NMFS) to authorize the incidental, i.e., not intentional, harassment of small numbers of marine mammals should this occur during the seismic survey. The analysis in this document also supports the IHA application process and provides information on marine species that are 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, this document will also be used to support ESA Section 7 consultations with NMFS and U.S. Fish and Wildlife Service (USFWS). Alternatives addressed in this Draft 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 document 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.

Numerous species of marine mammals inhabit the northwest Atlantic Ocean. Several of these species are listed as ***endangered*** under the U.S. Endangered Species Act (ESA): the sperm, North Atlantic right, humpback, sei, fin, and blue whales. Other marine ESA-listed species that could occur in the area are the ***endangered*** leatherback, hawksbill, green, and Kemp's ridley turtles, roseate tern, and Bermuda petrel, 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 Nassau grouper, dusky shark, and great hammerhead shark. Terrestrial ESA-listed species that could occur around the land drill sites are the red-cockaded woodpecker, the wood stork, Saint Francis' satyr butterfly, seabeach amaranth, golden sedge, pondberry, rough-leaved loosestrife, harperella, Michaux's sumac, American chaffseed, and Cooley's meadowrue. The northern long-eared bat, proposed for listing, could also occur.

Potential impacts of the seismic survey on the environment would be primarily a result of the operation of the airgun array. A multibeam echosounder, sub-bottom profiler, and acoustic Doppler current profiler would also be operated. Impacts would be associated with increased underwater noise, which could result in avoidance behavior by 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 activities 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 to be used. However, a precautionary approach would still be taken and the planned monitoring and mitigation measures would reduce the possibility of any effects.

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 one airgun has been operating; passive acoustic monitoring (PAM) via towed hydrophones during both 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 marine mammals or sea turtles are detected in or about to enter designated exclusion zones. L-DEO and its contractors are committed to applying these measures in order to minimize 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.

An associated land-based program would consist of passive and active components under permitting authorized by state and local agencies. Small, passive seismometers would be placed primarily alongside state roads in two 200-km SE-NW transects at or just under the soil surface, and at three coastal locations. No impact to the environment would be expected from this activity. The active source component would be limited to 14 small detonations along the transects, buried ~25 m deep and sealed over the upper 15 m. This component would be carried out by the University of Texas-El Paso (UTEP), which would obtain all permits and licenses required for these activities. No activities would occur in any protected lands, preserves, or sanctuaries, and because the holes would be sealed, negligible impact to the environment would be expected from the detonations. ESA-listed species would be avoided, thus no impacts would be anticipated. The closest approach to the ocean would be more than 2 km, so no impact to water column would be expected from vibrations on land.

LIST OF ACRONYMS

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ADCP	Acoustic Doppler current profiler
AMVER	Automated Mutual-Assistance Vessel Rescue
BOEM	Bureau of Ocean Energy Management
CETAP	Cetacean and Turtle Assessment Program
CITES	Convention on International Trade in Endangered Species
dB	decibel
DoN	Department of the Navy
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENAM	East North American Margin
EO	Executive Order
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
HAPC	Habitat Areas of Particular Concern
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
MAFMC	Mid-Atlantic Fishery Management Council
MBES	Multibeam Echosounder
MFA	Mid-frequency Active (sonar)
min	minute
MMPA	(U.S.) Marine Mammal Protection Act
ms	millisecond
n.mi.	nautical mile
NEPA	(U.S.) National Environmental Policy Act
NJ	New Jersey

NEFSC	Northeast Fisheries Science Center
NMFS	(U.S.) National Marine Fisheries Service
NRC	(U.S.) National Research Council
NSF	National Science Foundation
OAWRS	Ocean Acoustic Waveguide Remote Sensing
OBIS	Ocean Biogeographic Information System
OCS	Outer Continental Shelf
OEIS	Overseas Environmental Impact Statement
p or pk	peak
PEIS	Programmatic Environmental Impact Statement
PI	Principal Investigator
PTS	Permanent Threshold Shift
PSO	Protected Species Observer
PSVO	Protected Species Visual Observer
RL	Received level
rms	root-mean-square
R/V	research vessel
s	second
SAFMC	South Atlantic Fishery Management
SAR	U.S. Marine Mammal Stock Assessment Report
SBP	Sub-bottom Profiler
SEFSC	Southeast Fisheries Science Center
SEL	Sound Exposure Level (a measure of acoustic energy)
SPL	Sound Pressure Level
TTS	Temporary Threshold Shift
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 Draft Environmental Assessment (EA) is to provide the information needed to assess the potential environmental impacts of a collaborative research project entitled, "A community seismic experiment targeting the pre-, syn-, and post-rift evolution of the Mid Atlantic US margin", which includes both marine and land-based geophysical survey components. The Draft EA was prepared under the National Environmental Policy Act (NEPA) and Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions" (EO 12114). This Draft EA tiers to the Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (NSF and USGS 2011) and Record of Decision (NSF 2012), referred to herein as the PEIS. The Draft EA provides details of the proposed action at the site-specific level and addresses potential impacts of the proposed seismic surveys on marine mammals, as well as other species of concern in the area, including sea turtles, seabirds, fish, and invertebrates. The Draft and Final EAs will also be used in support of an application for an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS), and Section 7 consultations under the Endangered Species Act (ESA). The requested IHA would, if issued, allow the non-intentional, non-injurious "take by harassment" of small numbers of marine mammals during the proposed seismic survey by L-DEO in the Atlantic Ocean off Cape Hatteras during September–October 2014.

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.

Mission of NSF

The National Science Foundation (NSF) was established by Congress with 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 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 has a continuing need to fund seismic surveys that enable scientists to collect data essential to understanding the complex Earth processes beneath the ocean floor. The purpose of the proposed action is to collect data along the mid-Atlantic coast of East North American Margin (ENAM). The study area covers a portion of the rifted margin of the eastern U.S., from unextended continental lithosphere onshore to mature oceanic lithosphere offshore. The data set would therefore allow scientists to investigate how the continental crust stretched and separated during the opening of the Atlantic Ocean, and what the role of magmatism was during continental breakup. The study also covers several features representing the post-rift modification of the margin by slope instability and fluid flow. The proposed activities would continue to meet NSF's critical need to foster a better 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.

Regulatory Setting

The regulatory setting of this Draft EA is described in § 1.8 of the PEIS, including the

- National Environmental Protection Act (NEPA);
- Marine Mammal Protection Act (MMPA); and
- Endangered Species Act (ESA).

II. ALTERNATIVES INCLUDING PROPOSED ACTION

In this Draft EA, three alternatives are evaluated: (1) the proposed 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) 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 L-DEO's planned seismic survey are described in the following subsections.

(1) Project Objectives and Context

L-DEO proposes to conduct a 3-D seismic survey using the R/V *Marcus G. Langseth* (*Langseth*) along the mid-Atlantic coast (Fig. 1). As noted previously, the goal of the proposed research is to collect and analyze data along the mid-Atlantic coast of the East North American Margin (ENAM). The study area covers a portion of the rifted margin of the eastern U.S., from unextended continental lithosphere onshore to mature oceanic lithosphere offshore. The data set would therefore allow scientists to investigate how the continental crust stretched and separated during the opening of the Atlantic Ocean, and what the role of magmatism was during continental breakup. The study also covers several features representing the post-rift modification of the margin by slope instability and fluid flow. To achieve the project's goals, the Principal Investigators (PIs), Drs. H. Van Avendonk and G. Christeson (University of Texas at Austin), D. Shillington and A. Bécel (L-DEO), B. Magnani and M. Hornbach (Southern Methodist University), B. Dugan (Rice University), and S. Harder (University of Texas at El Paso), propose to use a 2-D marine seismic reflection and refraction survey to map sequences off Cape Hatteras and land seismometers along two 200-km SE–NW trending transects from the coast into North Carolina and southern Virginia. Arrays of small, passive seismometers placed along land-based extensions of two of the marine transects as well as limited active source work on land would allow for obtaining critical information on continental crust extension.

Additional objectives that would be met from conducting the proposed research include gaining insight in slope stability and the occurrence of past landslides. Slope stability is important for estimating the risk of future landslides. Landslides can result in tsunamis; such as the tsunami that occurred offshore eastern Canada in the early 20th century, and resulted in the loss of lives. The risk for landslides off the eastern U.S. is not known.

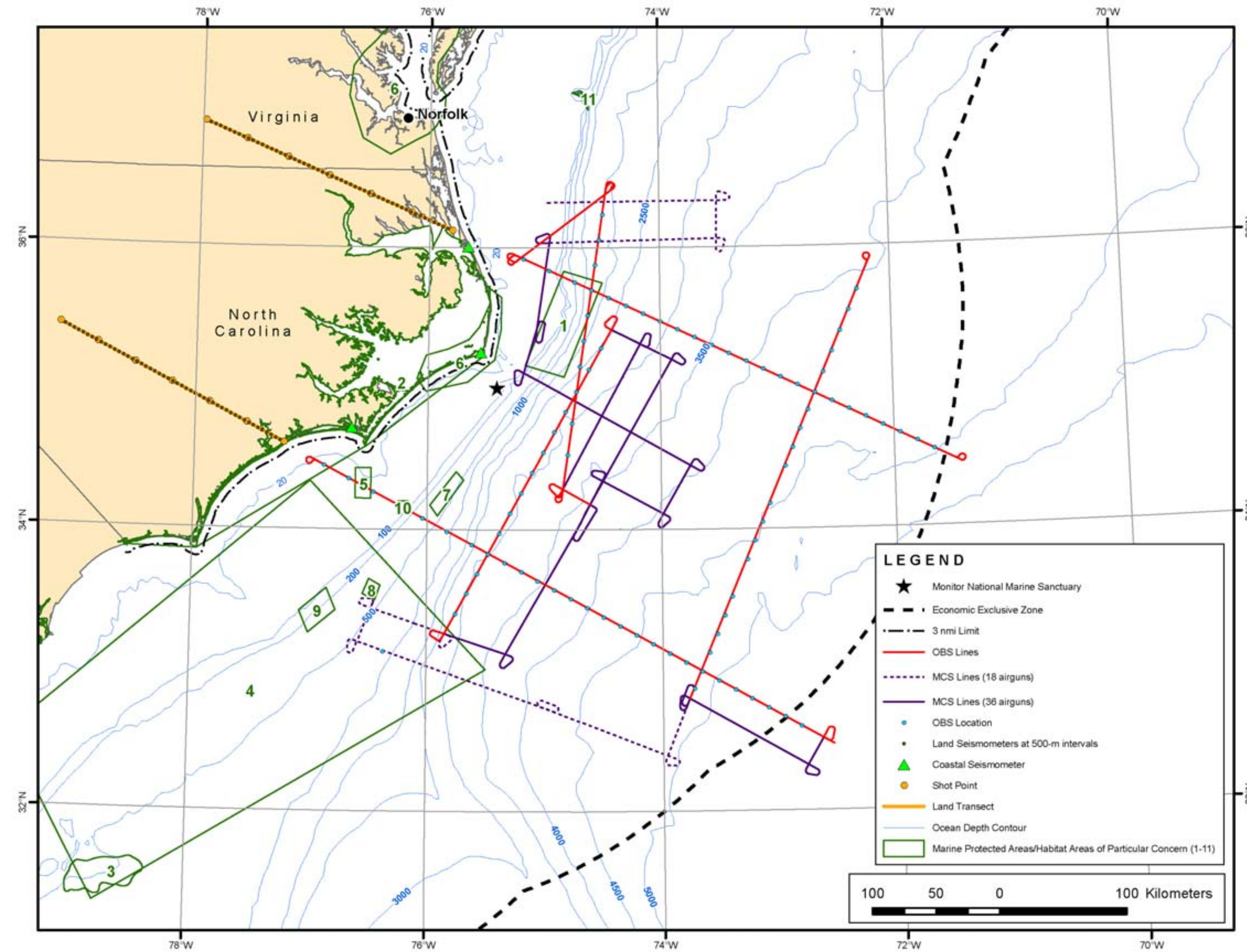


Figure 1. Location of the proposed seismic survey at the proposed survey site in the Atlantic Ocean off Cape Hatteras during September–October 2014. Also shown are a National Marine Sanctuary, one marine protected area, and 10 habitat areas of particular concern (see text).

(2) Proposed Activities

(a) Location of the Activities

The proposed survey area is located between ~32–37°N and ~71.5–77°W in the Atlantic Ocean ~6–430 km off the coast of Cape Hatteras (Fig. 1). The two land-based transects are between ~34.5–37°N and ~76–79.5°W (Fig. 1). Water depths in the survey area are 30–4300 m. The seismic survey would be conducted outside of state waters and mostly within the U.S. EEZ, and partly in International Waters, and is scheduled to occur for ~38 days during 15 September–22 October 2014. Some minor deviation from these dates is possible, depending on logistics and weather. Proposed activities, however, would avoid the North Atlantic right whale migration period.

(b) Description of the Activities

The procedures to be used for the marine geophysical survey would be similar to those used during previous surveys by L-DEO and would use conventional seismic methodology. The survey would involve one source vessel, the *Langseth*, which is owned by NSF and operated on its behalf by Columbia University's L-DEO. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3 or an array of 18 airguns with a total discharge volume of ~3300 in^3. The receiving system would consist of an 8-km hydrophone streamer or 94 ocean bottom seismometers (OBSs). The OBSs would be deployed and retrieved by a second vessel, the R/V *Endeavor*. As the airgun array is towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system. The OBSs record the returning acoustic signals internally for later analysis.

A total of ~5000 km of 2-D survey lines, including turns (~3650 km MCS and ~1350 km OBS lines) are oriented perpendicular to and parallel to shore (Fig. 1). The OBS lines would be shot a second time with the streamer, for a total of ~6350 km. There would be additional seismic operations in the survey area associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations [see § IV(3)], 25% has been added for those additional operations.

In addition to the operations of the airgun array, a multibeam echosounder (MBES), a sub-bottom profiler (SBP), and an acoustic Doppler current profiler (ADCP) would also be operated from the *Langseth* continuously throughout the survey. All planned geophysical data acquisition activities would be conducted by L-DEO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel with some personnel transfer on/off the *Langseth* by a small vessel.

(c) Schedule

The *Langseth* would depart from Norfolk, Virginia, on 15 September and spend one day in transit to the proposed survey area. Setup, deployment, and streamer ballasting would take ~3 days. The seismic survey would take ~33 days, and the *Langseth* would spend one day for gear retrieval and transit back to Norfolk, arriving on 22 October.

(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 R/V *Endeavor* has a length of 56.4 m, a beam of 10.1 m, and a maximum draft of 5.6 m. The *Endeavor* has been operated by the University of Rhode Island's Graduate School of Oceanography for over thirty years to conduct oceanographic research throughout U.S. and world marine waters. The ship is powered by one GM/EMD diesel engine, producing 3050 hp, which drives the single propeller directly at a maximum of 900 revolutions per minute (rpm). The vessel also has a 320-hp bowthruster. The *Endeavor* can cruise at 18.5 km/h and has a range of 14,816 km.

Other details of the *Endeavor* include the following:

Owner:	National Science Foundation
Operator:	University of Rhode Island
Flag:	United States of America
Date Built:	1976 (Refit in 1993)
Gross Tonnage:	298
Accommodation Capacity:	30 including ~17 scientists

The chase 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 survey, two energy source configurations would be used: the *Langseth* full array consisting of four strings with 36 airguns (plus 4 spares) and a total volume of ~6600 in^3, or a two-string array consisting of 18 airguns and a total volume of 3300 in^3. The airgun arrays are described in § 2.2.3.1 of the PEIS, and the airgun configurations are illustrated in Figures 2-11 to 2-13 of the PEIS. The 4-string array would be towed at a depth of 9 m for the OBS and MCS lines of the survey, and the 2-string array would be towed at a depth of 6 m. Shot intervals would be 65 s (~150 m) during OBS seismic, and ~22 s (50 m) during MCS seismic.

(f) OBS and Land-based Operations Description and Deployment

For the study, 47 OBSs would be deployed by the *Endeavor* before the first half of the OBS survey then retrieved, redeployed for the second half of the OBS survey, and retrieved thereafter. The OBSs that would be used during the cruise are Woods Hole Oceanographic Institute (WHOI) or Scripps Institution of Oceanography (SIO) OBSs. The WHOI OBSs have a height of ~1 m and a maximum diameter of 50 cm. The anchor is made of hot-rolled steel and weighs 23 kg. The anchor dimensions are 2.5 × 30.5 × 38.1 cm. The SIO OBSs have a height of ~0.9 m and a maximum diameter of 97 cm. The anchors are 36-kg iron grates with dimensions 7 × 91 × 91.5 cm.

Once an OBH/S is ready to be retrieved, an acoustic release transponder interrogates the instrument at a frequency of 9–11 kHz, and a response is received at a frequency of 10–12 kHz. The burn-wire release assembly is then activated, and the instrument is released from the anchor to float to the surface.

On land, wide-angle reflection and refraction seismic data would be acquired along two 200 km-long dip profiles trending SE–NW and by the passive EarthScope Transportable Array, providing detailed regional-scale data. EarthScope, an NSF-funded earth science program to explore the 4-D structure of the entire North American continent, has been moving thousands of passive seismometers across North America over a period of years. The ENAM land deployment of seismometers would consist of three components: 1) 400 "Reftek 125" seismometers (~12 cm × 6 cm diameter) deployed at the surface along each profile at 500-m intervals along roadsides, 2) 80 "Reftek 130" seismometers (~30 cm × 6 cm diameter) deployed on both profiles at 5-km intervals, buried about 45 cm deep along roadsides in small boxes, and 3) 3 Trillium Compact Post-hole sensors (~17.5 cm x 9.5 cm diameter), a solar panel, and a case (~89 cm x 53 cm x 43 cm) containing two marine-cell deep-cycle 12-volt batteries, a charge controller connected to the solar panel, and a Reftek RT130 data logger deployed at 3 separate coastal community sites. Reftek seismometer installation would involve digging with hand tools a small trench about six inches deep and wide and about 18 inches long and would take ~5 min each. Because installation would involve digging and placement along roads, seismometer sites would be cleared by 811 services and county road, bridge departments, and state Department of Transportation offices. Trillium seismometer installation would involve digging using hand tools postholes ~1 m deep for the seismometers and holes ~ 1 m x 1 m x 1 m for the battery case.

All of these passive units would record continuously throughout the offshore shooting of the main OBS/MCS profiles by the *Langseth*, the coastal Trillium sensors would be left in place for ~1 y, and all of the passive units would also record 14 planned land shots at 7 points along each 200-km profile, performed by the UTEP NSF National Seismic Source Facility. UTEP would obtain all licenses and permitting required for the land shot points. The drill rig would be a 30-tonne, tandem-axle truck ~10.5m long, 2.6 m wide, and 4 m high, with a mast-up height of 12 m. The water truck that accompanies it would be a 20-tonne, tandem-axle truck. The size of these vehicles constrains them from operating in areas such a forests and wetlands. Land shots would be located in pre-disturbed areas with easy access, such as along the edges of agricultural fields and along logging roads; safe distances would be maintained from any structures such as houses, wells, or pipelines. One site may be coordinated to occur within Marine Corps Base Camp Lejeune. Location of shotpoints would be done in conjunction with 811 (call before you dig) services. Local county fire marshals and sheriffs would be informed of explosive use within their jurisdictions and any requirements followed. All sensitive environmental areas and ESA-listed species would be avoided (see further in § III and § IV[5]).

Each land shot would consist of detonating ~450 kg of emulsion explosives at the bottom of 20-cm diameter, 25-m deep holes sealed over the upper 15 m so little sound would be emitted to the atmosphere. Shot holes would be drilled with mud rotary drilling techniques using bentonite drilling mud to lift cuttings out of the hole and cool the drill bit. Bentonite is a naturally occurring clay. The drilling mud would be recirculated through a steel tank on the surface and disposed of in accordance with state regulations. The drilled holes would be charged with emulsion blasting agent: a mixture of ammonium, calcium, and sodium nitrates, and diesel fuel. It would be designed to be waterproof and would be packaged in cartridges to keep it from mixing with drilling mud or groundwater. Once charged, the hole would be plugged first with angular crushed gravel to contain the detonation, followed by drill cuttings and bentonite chips. Plugging of the hole would be done in accordance with state regulations. Drilling, charging, and stemming at each shot site would take approximately a half-day.

Once shots have been charged and seismographs deployed, shots would be detonated one at a time. This would be done by a licensed shooter who would ensure the shot site was clear of people and animals before shooting. The sound of the detonation would be comparable to distant thunder without the rolling coda. Ground vibration would only be felt within a few hundred meters of the shot. Accidental and unauthorized detonation of shots would be prevented by use of electronic detonators, which must receive a coded signal at the time of detonation. If material were ejected from shot holes after detonation, it would be plugged again in accordance with state regulations. The nominal charge size would be 450 kg of emulsion, which would detonate with the energy of ~35 L of diesel fuel. The benign byproducts of the explosion would be carbon dioxide, water, and nitrogen, so negligible impact to the environment would be expected. The closest approach to the ocean would be more than 2 km, so no impact to the ocean water column would be expected from vibrations on land.

(f) Additional Acoustical Data Acquisition Systems

Along with the airgun operations, three additional acoustical data acquisition systems would be operated from the *Langseth* during the survey: a multibeam echosounder (MBES), sub-bottom profiler (SBP), and an acoustic Doppler current profiler (ADCP). 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.

Currents would be measured with a Teledyne OS75 75-kHz ADCP. The ADCP is configured as a 4-beam phased array with a beam angle of 30°. The source level is proprietary information. The PEIS stated that ADCPs (make and model not specified) had a maximum acoustic source level of 224 dB re 1 µPa · m.

Three acoustical data acquisition systems would be operated from the *Endeavor* during OBS deployment: a Teledyne OS75 75-kHz ADCP (see above), a Teledyne WH300 300-kHz ADCP, which is configured as a 4-beam phased array with a beam angle of 20°, and a Knudsen 320BR 12-kHz depth sounder.

(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. Mitigation for land based operational activities would include inspection, identification, and avoidance, as described in this document in § II.2(f) and IV.5.

(a) Planning Phase

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

***Energy Source.*—**Part of the considerations for the proposed marine seismic 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 for most of the survey could not be met using a smaller source because of the need to image the crust-mantle boundary at a depth of 30 km beneath the continental shelf and slope. For some lines of the survey, the target of interest is at a shallower depth, and it was decided that the 18-airgun, 3300-in^3 subarray would be adequate to image it.

***Survey Timing.*—**The PIs worked with L-DEO and NSF to identify potential times to carry out the survey taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals, sea turtles, and seabirds), weather conditions, equipment (including the EarthScope Transportable Array), 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, such as the North Atlantic right whale, are expected to be farther north at the time of the survey, so the survey timing is beneficial for those species.

***Mitigation Zones.*—**During the planning phase, mitigation zones for the proposed marine seismic survey were calculated based on modeling by L-DEO for both the exclusion and the safety zones.

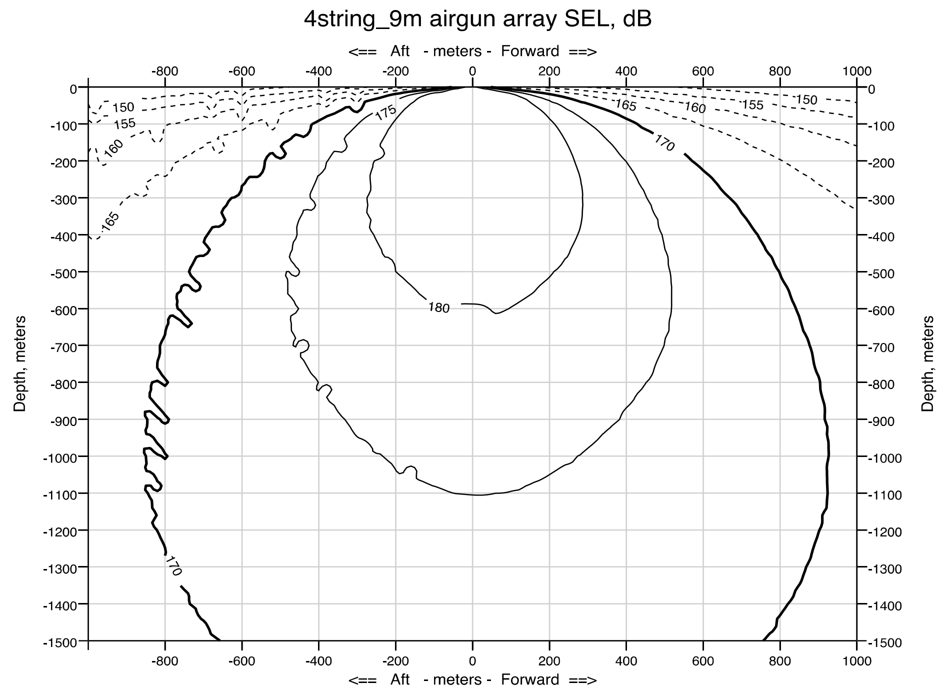
Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010, provided as Appendix H in the PEIS), as a function of distance from the airguns, for the 36-airgun array at any tow depth and for a single 1900LL 40-in^3 airgun, which would be used during power downs. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (~1600 m), intermediate water depth on the slope (~600–1100 m) and shallow water (~50 m) in the Gulf of Mexico (GoM) in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

For deep and intermediate-water cases, the field measurements cannot be used readily to derive mitigation radii, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 meters, which may not intersect all the sound pressure level (SPL) isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of ~2000 m. Figures 2 and 3 in Appendix H of the PEIS show how the values along the maximum SPL line that connects the points where the isopleths attain their maximum width (providing the maximum distance associated with each sound level) may differ from values obtained along a constant depth line. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep and slope sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At larger ranges, the comparison with the mitigation model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant. The results are summarized below.

In deep and intermediate water depths, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (Figs. 12 and 14 in Appendix H of the PEIS). As a consequence, isopleths falling within this domain can be reliably predicted by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At larger distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (Figs. 11, 12, and 16 in Appendix H of the PEIS). Aside from local topography effects, the region around the critical distance (~5 km in Figs. 11 and 12, and ~4 km in Fig. 16 in Appendix H of the PEIS) is where the observed levels rise very close to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Figs. 11, 12, and 16 in Appendix H of the PEIS). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for estimating mitigation radii.

In shallow water (<100 m), the depth of the calibration hydrophone (18 m) used during the GoM calibration survey was appropriate to sample the maximum sound level in the water column, and the field measurements reported in Table 1 of Tolstoy et al. (2009) for the 36-airgun array at a tow depth of 6 m can be used to derive mitigation radii.

The proposed survey on the ENAM off Cape Hatteras would acquire data with the 36-airgun array at a tow depth of 9 m, and the 18-airgun array at a tow depth of 6 m. For deep water (>1000 m), we used the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m (Figs. 2 and 3). The radii for intermediate water depths (100–1000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 in Appendix H of the PEIS). For the 18-airgun array, the shallow-water radii are the empirically derived measurements from the GoM calibration survey



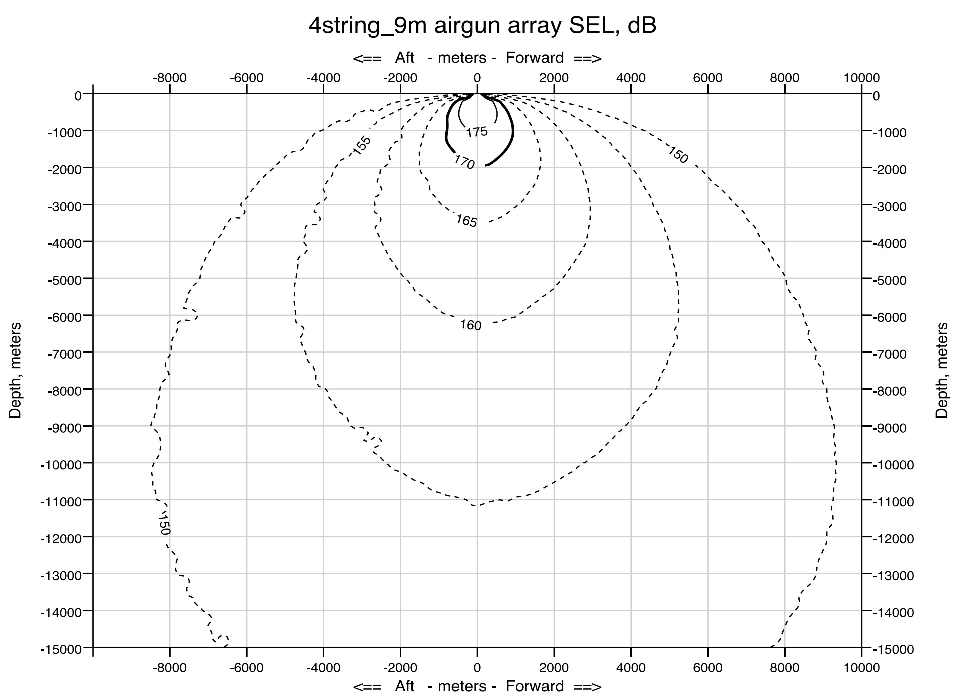


FIGURE 2. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the survey off Cape Hatteras, at a 9-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

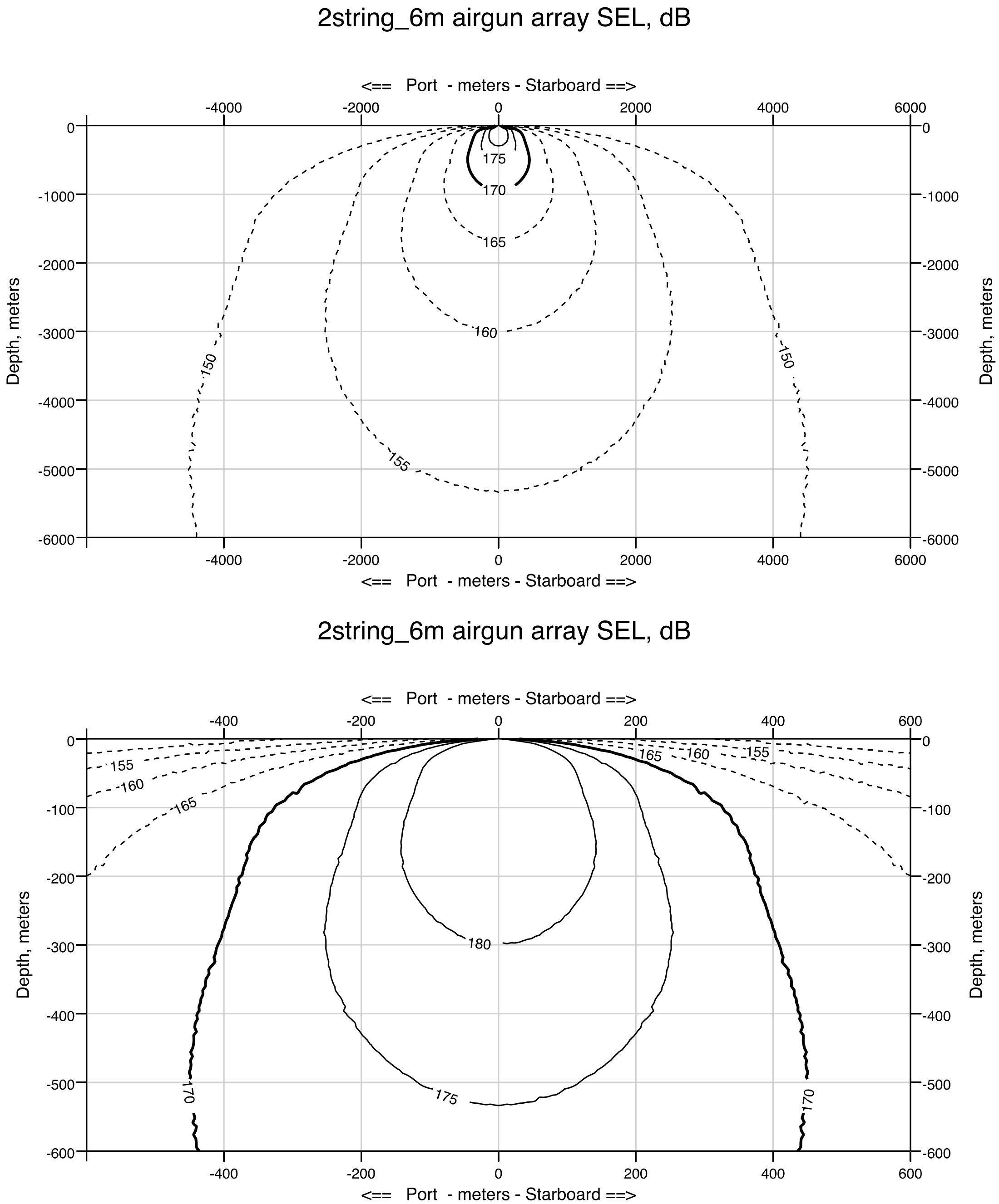


FIGURE 3. Modeled deep-water received sound levels (SELs) from the 18-airgun array planned for use during the survey off Cape Hatteras, at a 6-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

(Fig. 5a in Appendix H of the PEIS), which are 1097 m for 170 dB SEL (proxy for 180 dB RMS) and 15.28 km for 150 dB SEL (proxy for 160 dB RMS), respectively. For the 36-airgun array, the shallow-water radii are obtained by scaling the empirically derived measurements from the GoM calibration survey to account for the difference in tow depth between the calibration survey (6 m) and the proposed survey (9 m). A simple scaling factor is calculated from the ratios of the isopleths calculated by the deep-water L-DEO model, which are essentially a measure of the energy radiated by the source array: the 150-decibel (dB) Sound Exposure Level (SEL)[1] corresponds to a deep-water radius of 9334 m for 9-m tow depth (Fig. 2) and 7244 m for 6-m tow depth (Fig. 4), yielding a scaling factor of 1.29 to be applied to the shallow-water 6-m tow depth results. Similarly, the 170 dB SEL corresponds to a deep-water radius of 927 m for 9-m tow depth (Fig. 2) and 719 m for 6-m tow depth (Fig. 4), yielding the same 1.29 scaling factor. Measured 160 and 180 dB re 1µPa_{rms} distances in shallow water for the 36-gun array towed at 6 m depth were 17.5 km and 1.6 km, respectively, based on a 95th percentile fit (Tolstoy et al. 2009, Table 1). Multiplying by 1.29 to account for the tow depth difference yields distances of 22.6 km and 2.1 km, respectively.

Measurements have not been reported for the single 40-in^3 airgun. The 40-in^3 airgun fits under the PEIS low-energy sources. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applies a 180 dB_{rms} exclusion zone (EZ) of 100 m for all low-energy acoustic sources in water depths >100 m. This approach is adopted here for the single Bolt 1900LL 40-in^3 airgun that would be used during power downs. L-DEO model results are used to determine the 160-dB radius for the 40-in^3 airgun in deep water (Fig.5). For intermediate-water depths, a correction factor of 1.5 was applied to the deep-water model results. For shallow water, a scaling of the field measurements obtained for the 36-gun array is used: the 150-dB SEL level corresponds to a deep-water radius of 388 m for the 40-in^3 airgun at 9-m tow depth (Fig. 4) and 7244 for the 36-gun array at 6-m tow depth (Fig. 2), yielding a scaling factor of 0.0536. Similarly, the 170-dB SEL level corresponds to a deep-water radius of 39 m for the 40-in^3 airgun at 9-m tow depth (Fig. 4) and 719 m for the 36-gun array at 6-m tow depth (Fig. 2), yielding a scaling factor of 0.0542. Measured 160- and 180-dB re 1µPa_{rms} distances in shallow water for the 36-gun array towed at 6-m depth were 17.5 km and 1.6 km, respectively, based on a 95th percentile fit (Tolstoy et al. 2009, Table 1). Multiplying by 0.0536 and 0.0542 to account for the difference in array sizes and tow depths yields distances of 938 m and 86 m, respectively.

Table 1 shows the distances at which the 160- and 180- dB re 1µPa_{rms} sound levels are expected to be received for the 36-airgun array, the 18-airgun array, and the single (mitigation) airgun. The 180-dB re 1 µPa_{rms} distance is the safety criterion as specified by NMFS (2000) for cetaceans. Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals(NOAA 2013a), although at the time of preparation of this Draft EA, the date of release of the final guidelines and how they will be implemented are unknown. As such, this Draft 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), and Nowacek et al. (2013).

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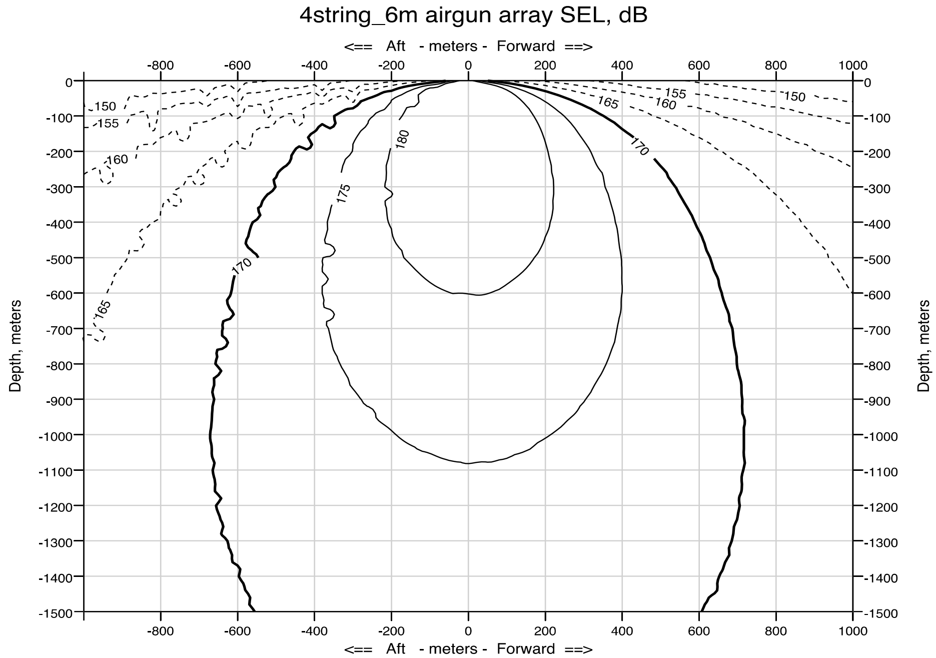
[1] SEL (measured in dB re 1 µ$Pa^2 \cdot s$) is a measure of the received energy in the pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period. Because actual seismic pulses are less than 1 s in duration in most situations, this means that the SEL value for a given pulse is usually lower than the SPL calculated for the actual duration of the pulse. In this EA, we assume that rms pressure levels of received seismic pulses would be 10 dB higher than the SEL values predicted by L-DEO's model.



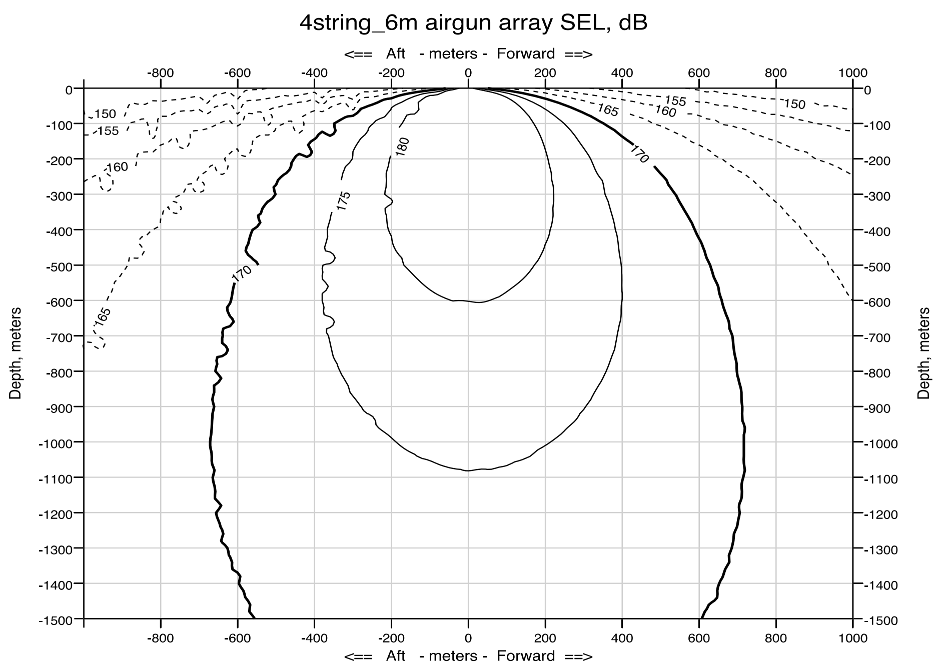
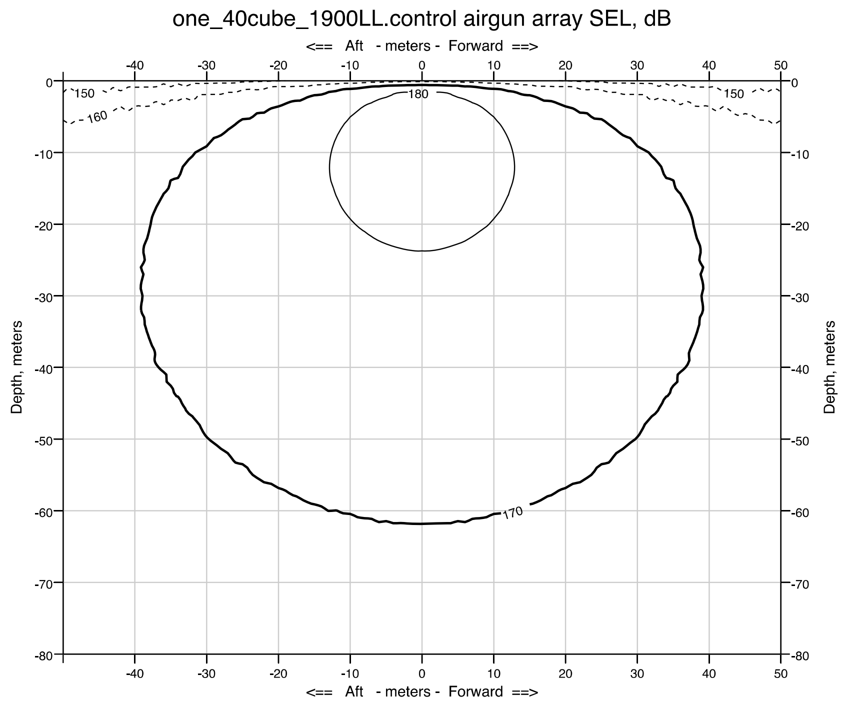


FIGURE 4. Modeled deep-water received sound levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.



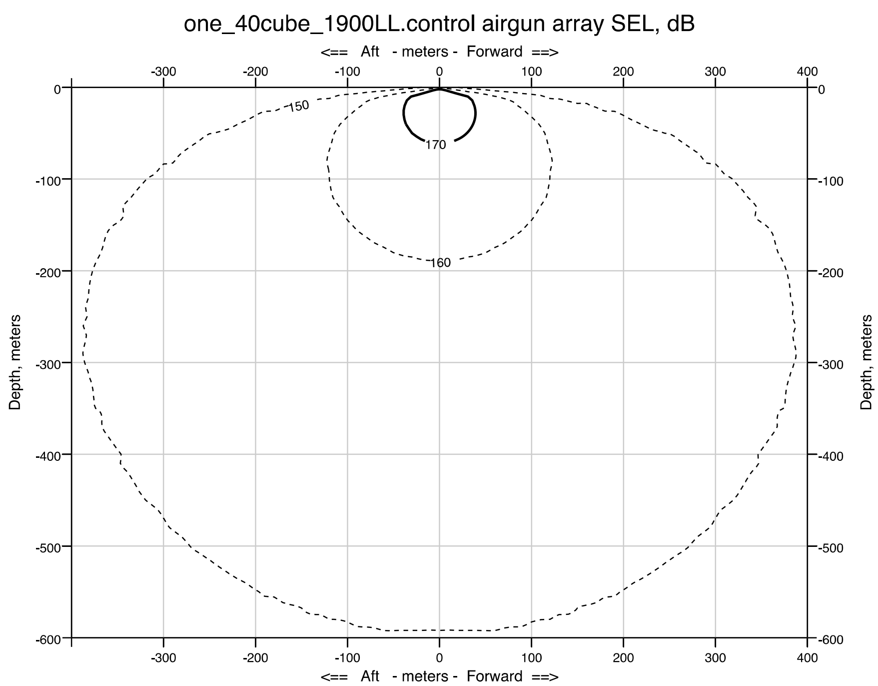


FIGURE 5. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9 m depth, which is planned for use as a mitigation gun during the proposed survey off Cape Hatteras. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleths as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

TABLE 1. Predicted distances to which sound levels ≥180- and 160-dB re 1 μPa_{rms} are expected to be received during the proposed survey off Cape Hatteras in September–October 2014. For the single mitigation airgun, the EZ is the conservative EZ for all low-energy acoustic sources in water depths >100 m defined in the PEIS.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted rms Radii (m)	
			180 dB	160 dB
Single Bolt airgun, 40 in³	6 or 9	>1000 m	100	388[1]
		100–1000 m	100	582[2]
		<100 m	86[3]	938[3]
4 strings, 36 airguns, 6600 in³	9	>1000 m	927[1]	5780[1]
		100–1000 m	1391[2]	8670[2]
		<100 m	2060[3]	22,600[3]
2 strings, 18 airguns, 3300 in³	6	>1000 m	450[1]	3760[1]
		100-1000 m	675[2]	5640[2]
		<100 m	1097[4]	15,280[4]

[1] Distance is based on L-DEO model results
[2] Distance is based on L-DEO model results with a 1.5 x correction factor between deep and intermediate water depths
[3] Distance is based on empirically derived measurements in the GoM with scaling applied to account for differences in tow depth
[4] Distance is based on empirically derived measurements in the GoM

The 180-dB distance would also be used as the exclusion zone for sea turtles, as required by NMFS in most other seismic projects (e.g., Smultea et al. 2004; Holst et al. 2005a,b; Holst and Beland 2008; Holst and Smultea 2008; Hauser et al. 2008; Holst 2009; Antochiw et al. n.d.). Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase.

(b) Operational Phase

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 activities 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 activities, which are consistent with the PEIS and past IHA requirements, include

1. monitoring by protected species visual observers (PSVOs) for marine mammals and sea turtles;
2. passive acoustic monitoring (PAM);
3. PSVO data and documentation; and
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 cruises, per the PEIS, and therefore are not discussed further here. Special mitigation measures were considered for this cruise. 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 its rarity and conservation status. It is also unlikely that concentrations of large whales would be encountered, but if so, they would be avoided.

With the proposed monitoring and mitigation provisions, potential effects on most if not all individuals would be expected to be limited to minor behavioral disturbance. 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, implementing the same monitoring and mitigation measures as under the Proposed Action, and requesting an IHA to be issued for that alternative time. The proposed time for the cruise in September–October 2014 is the most suitable time logistically for the *Langseth* and the participating scientists, and coincides with the availability of the EarthScope Transportable Array. The EarthScope Transportable Array is scheduled to leave the survey area in 2015. If the IHA is 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 2014 and beyond. An evaluation of the effects of this Alternative is given in § IV.

Alternative 2: No Action Alternative

An alternative to conducting the proposed activities is the "No Action" alternative, i.e., do not issue an IHA and do not conduct the research operations. If the research was not conducted, the "No Action" alternative would result in no disturbance to marine mammals due to the proposed activities.

The "No Action" alternative could also, in some circumstances, result in significant delay of other studies that would be planned on the *Langseth* for 2014 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 provides 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. An evaluation of the effects of this Alternative is given in § IV.

Alternatives Considered but Eliminated from Further Analysis

(1) Alternative E1: Alternative Location

The survey location has been specifically identified because the Cape Hatteras area represents a discontinuity in the margin of the eastern U.S., with the Carolina Trough to the south and the Baltimore Canyon Trough to the north. One of the purposes of this study is to understand how a step in the margin is formed during the breakup of a continent.

There are many seismic data sets available for the continental shelf and slope of the eastern U.S. However, the quality of these data is not sufficient to meet the goals of this project. 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. NSF currently owns the *Langseth*, and its primary capability is to conduct seismic surveys.

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

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 activities have the potential to impact marine biological resources within the Project area. These resources are identified in § III, and the potential impacts to these resources are discussed in § IV. Initial review and analysis of the proposed Project activities determined that the following resource areas did not require further analysis in this Draft EA:

- *Air Quality/Greenhouse Gases*—Project vessel and vehicle emissions would result from the proposed activities; 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*—The majority of activities are proposed to occur in the marine environment. Marine and land-based activities, however, have been coordinated with the EarthScope Transportable Array, further extending data collection capabilities. No changes to current land uses or activities within the Project area would result from the proposed Project;
- *Safety and Hazardous Materials and Management*—No hazardous materials would be generated during proposed marine activities. Small amounts of emulsion explosives materials would be used for the 14 land based active shot points. Each land shot would consist of detonating ~450 kg of emulsion blasting agent in holes with a minimum of 15 m of stemming above the charge. In cases where shots would be in close proximity to houses (< 800 m), charges would be divided into three separate charges and detonated individually. The benign byproducts of the explosion would be carbon dioxide, water, and nitrogen, so negligible impact to the environment would be expected. Materials would be handled by experienced and licensed personnel of UTEP, following all federal, state, and local requirements. All Project-related wastes would be disposed of in accordance with state, Federal, and international requirements;

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

Proposed Action	Description
Proposed Action: Conduct a marine geophysical survey and associated activities in the Atlantic Ocean off Cape Hatteras	Under this action, a 2-D seismic reflection and refraction survey is proposed with associated land-based activities. When considering transit; equipment deployment, maintenance, and retrieval; weather; marine mammal activity; and other contingencies, the proposed activities would be expected to be completed in ~38 days. The affected environment, environmental consequences, and cumulative impacts of the proposed activities are described in § III and IV. The standard monitoring and mitigation measures identified in the NSF PEIS would apply, along with any additional requirements identified by regulating agencies. All necessary permits and authorizations, including an IHA, would be requested from regulatory bodies.
Alternatives	Description
Alternative 1: Alternative Survey Timing	Under this Alternative, L-DEO would conduct survey operations with associated land-based activities at a different time of the year to reduce impacts on marine resources and users, and improve monitoring capabilities. Some marine mammal species are probably year-round residents in the survey area and others would be farther north at the time of the survey, so altering the timing of the proposed project likely would not result in net benefits. Further, consideration would be needed for constraints for vessel operations and availability of equipment (including the vessel and EarthScope Transportable Array) and personnel. Limitations on scheduling the vessels include the additional research studies planned on the vessels for 2014 and beyond. 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 activities conducted during an alternative survey time period, along with any additional requirements identified by regulating agencies as a result of the change. All necessary permits and authorizations, including an IHA, would be requested from regulatory bodies.
Alternative 2: No Action	Under this Alternative, no proposed activities would be conducted and seismic data would not be collected. Whereas this alternative would avoid impacts to marine resources, it would not meet the purpose and need for the proposed action. Geological data of scientific value and relevance increasing our understanding of how the continental crust stretched and separated during the opening of the Atlantic Ocean, and what the role of magmatism was during continental breakup would not be collected. The collection of new data, interpretation of these data, and introduction of new results into the greater scientific community and applicability of these data to other similar settings would not be achieved. No permits and authorizations, including an IHA, would be needed 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 the Cape Hatteras area represents a discontinuity in the margin of the eastern U.S., with the Carolina Trough to the south and the Baltimore Canyon Trough to the north. One of the purposes of this study is to understand how a step in the margin is formed during the breakup of a continent. The proposed science underwent the NSF merit review process, and the science, including the site location, was determined to be meritorious.
Alternative E2: Alternative Survey Techniques	Under this alternative, L-DEO would use alternative survey techniques, such as marine vibroseis, that 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.

- *Geological Resources (Topography, Geology and Soil)*—The proposed Project would result in only a minor displacement of soil and seafloor sediments. Proposed marine or land-based activities would not adversely affect geologic resources, thus no significant impacts would be anticipated;

- *Water Resources*—Land activities are no closer than 2 km from the coast, and no discharges to the marine environment are proposed within the Project area that would adversely affect marine water quality. Terrestrial water resources and wetlands would be avoided. Therefore, there would be no impacts to water resources resulting from the proposed Project activities;
- *Visual Resources*—No visual resources would be anticipated to be negatively impacted by marine activities as the area of operation is significantly outside of the land and coastal view shed. Land-based activities would be short-term, primarily along roadsides, and would not be anticipated to affect the local view shed; and
- *Socioeconomic and Environmental Justice*—Implementation of the proposed Project would not affect, beneficially or adversely, socioeconomic resources, environmental justice, or the protection of children. Land-based activities would be short term. No changes in the population or additional need for housing or schools would occur. Human activities in the area around the survey vessel would be limited to commercial and recreational fishing activities and other vessel traffic. Fishing, vessel traffic, and potential impacts are described in further detail in § III and IV. No other socioeconomic impacts would be anticipated as result of the proposed activities.

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, where they are entrained between the Gulf Stream and slope waters. 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 outflow from rivers and estuaries.

Slope waters in the mid Atlantic are a mixture zone of water from the shelf and the Gulf Stream. 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 has a mean speed of 1 m/s, and the surface speed is higher in summer than in winter. It turns seaward near Cape Hatteras and moves northeast into the open ocean.

The continental shelf off the U.S. east coast is very narrow off Cape Hatteras, broadening to form the mid-Atlantic Bight to the north and the Florida-Hatteras Shelf to the south. South of Cape Hatteras, the shelf gives way to the relatively steep Florida-Hatteras Slope at 100–500 m depths, the Blake Plateau, 700−1000 m deep and extending ~300–500 km offshore, and the Blake Escarpment, which slopes steeply to the abyssal plain at 400–5000 m. North of Cape Hatteras, the continental slope is steep from 200 to 2000 m deep extending <200 m offshore, then sloping gradually to 5000-m depth.

Protected Areas

Several federal Marine Protected Areas (MPAs) or sanctuaries have been established along the east coast of the U.S., primarily with the intention of preserving cetacean habitat (Hoyt 2005; CetaceanHabitat 2013). A number of these are located to the north of the proposed survey area off New England or south of the proposed survey area. The Monitor National Marine Sanctuary, a sanctuary established to preserve a cultural resource (the wreck of the Civil War ironclad USS *Monitor*), is located in ~70 m of water to the southeast of Cape Hatteras, in the proposed survey area (Fig. 1). The sanctuary consists of the column of water 1.6 km in diameter from the bottom to the surface centred on the wreck. Regulations prohibit a number of activities in the sanctuary, including "Detonating below the surface of the water any explosive or explosive mechanism" (NOAA 2013b). One of the proposed transect lines would approach the sanctuary within ~24 km, but the vessel would not enter the sanctuary.

The South Atlantic Fishery Management Council (SAFMC) established eight deep-water MPAs to protect a portion of the long-lived, "deep water" snapper grouper species such as snowy grouper, speckled hind, and blueline tilefish (SAFMC 2013). One of the eight MPAs, the Snowy Grouper Wreck, is just west of the southwest corner of the proposed survey area (MPA/HAPC #9 in Fig. 1). SAFMC regulations prohibit the fishing for or possession of any snapper-grouper species, and the use of shark bottom longline gear within the MPAs. There are also 10 HAPC shown in Figure 1; those are described in the section dealing with fish, below.

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 2010). 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. Bryde's whale (*Balaenoptera brydei*) likely would not occur near the proposed survey area, because its distribution generally does not extend as far north as ~32–37°N. An additional three cetacean species, although present in the wider western North Atlantic Ocean, likely would not be found near the proposed survey area because their ranges generally do not extend as far south (northern bottlenose whale, *Hyperoodon ampullatus*; Sowerby's beaked whale, *Mesoplodon bidens*; and white-beaked dolphin, *Lagenorhynchus albirostris*).

Similarly, no pinnipeds are included; harp seals (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*) are rare in the proposed survey area, and gray (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) have a more northerly distribution during the summer (DoN 2005) and are not expected to occur there during the survey.

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 general distributions of mysticetes and odontocetes in this region of the Northwest Atlantic Ocean are discussed in § 3.6.2.1 and § 3.7.2.1 of the PEIS, respectively. Additionally, information on marine mammals in this region is included in § 4.2.2.1 of the Bureau of Ocean Energy Management (BOEM) draft PEIS for Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas (BOEM 2012), and in § 3.7.2 of the Final EIS/OEIS for the Virginia Capes and the Cherry Point Range Complexes (DoN 2009a,b). The rest of this section focuses on species distribution in and near the proposed survey area off the coasts of Virginia and North Carolina.

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.

Species	Habitat	Occurrence in survey area in fall	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 nearshore, banks; pelagic	Uncommon	11,600[6] / 823[7]	EN	LC	I
Minke whale	Mainly coastal	Uncommon	138,000[8] / 20,741[9]	NL	LC	I
Sei whale	Mainly offshore	Rare	10,300[10] / 357[11]	EN	EN	I
Fin whale	Slope, pelagic	Uncommon	26,500[12] / 3522[5]	EN	EN	I
Blue whale	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[5]	NL	LC	II
True's beaked whale	Pelagic	Rare	N.A. / 7092[17]	NL	DD	II
Gervais' beaked whale	Pelagic	Rare	N.A. / 7092[17]	NL	DD	II
Blainville's beaked whale	Pelagic	Rare	N.A. / 7092[17]	NL	DD	II
Rough-toothed dolphin	Mainly pelagic	Uncommon	N.A. / 271[5]	NL	LC	II
Bottlenose dolphin	Coastal, offshore	Common	N.A. / 86,705[18]	NL^	LC	II
Pantropical spotted dolphin	Mainly pelagic	Common	N.A. / 3333[5]	NL	LC	II
Atlantic spotted dolphin	Shelf, slope, pelagic	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	Common	N.A. / 54,807[5]	NL	LC	II
Clymene dolphin	Pelagic	Uncommon	N.A. / N.A.	NL	DD	II
Short-beaked common dolphin	Shelf, pelagic	Common	N.A. / 173,486[5]	NL	LC	II
Atlantic white-sided dolphin	Shelf and slope	Rare	10s to 100s of 1000s[19] / 48,819[5]	NL	LC	II
Fraser's dolphin	Pelagic	Rare	N.A. / N.A.	NL	LC	II
Risso's dolphin	Mainly shelf, slope	Common	N.A. /18,250[5]	NL	LC	II
Melon-headed whale	Mainly pelagic	Rare	N.A. / N.A.	NL	LC	II
False killer whale	Pelagic	Rare	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	Common	780K[20] / 26,535[5]	NL†	DD	II
Short-finned pilot whale	Mainly pelagic	Common	780K[20] / 21,515[5]	NL	DD	II
Harbor porpoise	Coastal	Rare	~500K[21] / 79,883[22]	NL	LC	II

N.A. = Data not available

[1] SAR (stock assessment report) abundance estimates are from the 2012 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments (Waring et al. 2013) 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. 2013)

[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. 2013)
[8] Best estimate for the North Atlantic in 2002–2007 (IWC 2013)
[9] Estimate for the Canadian East Coast Stock (Waring et al. 2013)
[10] Estimate for the Northeast Atlantic in 1989 (Cattanach et al. 1993)
[11] Estimate for the Nova Scotia Stock (Waring et al. 2013)
[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. 2013)
[16] Combined estimate for pygmy and dwarf sperm whales (Waring et al. 2013)
[17] Combined estimate for *Mesoplodon* spp. (Waring et al. 2013)
[18] Combined estimate for the Western North Atlantic Offshore Stock and the Southern Migratory Coastal Stock (Waring et al. 2013)
[19] Tens to low hundreds of thousands in the North Atlantic (Reeves et al. 1999)
[20] Estimate for both long- and short-finned pilot whales in the central and eastern North Atlantic in 1989 (IWC 2013)
[21] Estimate for the North Atlantic (Jefferson et al. 2008)
[22] Estimate for the Gulf of Maine/Bay of Fundy Stock (Waring et al. 2013)
* 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

The main sources of information used here are the 2010 and 2012 U.S. Atlantic and Gulf of Mexico marine mammal stock assessment reports (SARs: Waring et al. 2010, 2012), 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.

(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 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 a peak abundance during August, September, and early October (Gaskin 1987). Morano et al. (2012) and Mussoline et al. (2012) indicated that right whales are present in the southern Gulf of Maine year-round and that they occur there over longer periods than previously thought.

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

Knowlton et al. (2002) provided an extensive and detailed analysis of survey data, satellite tag data, whale strandings, and opportunistic sightings along State waters of the mid-Atlantic migratory corridor[2], from the border of Georgia/South Carolina to south of New England, spanning the period from 1974 to 2002. The majority of sightings (94%) along the migration corridor were within 56 km of shore, and more than half (64%) were within 18.5 km of shore (Knowlton et al. 2002). Water depth preference was for shallow waters; 80% of all sightings were in depths <27 m, and 93% were in depths <45 m (Knowlton et al. 2002). Most sightings farther than 56 km from shore occurred at the northern end of the corridor, off New York and south of New England. North of Cape Hatteras, most sightings were reported for March–April; south of Cape Hatteras, most sightings occurred during February–April (Knowlton et al. 2002). Similarly, sighting data analyzed by Winn et al. (1986) dating back to 1965 showed that the occurrence of North Atlantic right whales in the Cape Hatteras region, including the proposed survey area, peaked in March; in the mid-Atlantic area, it peaked in April.

A review of the mid-Atlantic whale sighting and tracking data archive from 1974 to 2002 showed North Atlantic right whale sightings off the coasts of Virginia and North Carolina during fall, winter, and spring; there were no sightings for July–September (Beaudin Ring 2002). Three sightings were reported for the month of October near the coast of North Carolina; there were no sightings off Virginia during October (Beaudin Ring 2002). Right whale sighting data mapped by DoN (2008a,b) showed the greatest

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

occurrence off Virginia and North Carolina during the winter (December–April), with many fewer sightings during spring and fall.

The Interactive North Atlantic Right Whale Sighting Map showed 30 sightings in the shelf waters off Virginia and North Carolina between 2005 and 2013, and one sighting seaward of the shelf off Virginia (NEFSC 2013b). All sightings were made from December through July, and six sightings were made within the proposed survey area during 2013. There are 69 sightings of right whales off Virginia/ North Carolina in OBIS (IOC 2013) including sightings made during the 1978–1982 CETAP surveys (CETAP 1982); none of the OBIS sightings were made during September or October.

Palka (2006) reviewed North Atlantic right whale density in the U.S. Navy Northeast Operating Area based on summer abundance surveys conducted during 1998–2004. One of the lowest whale densities (including right whales) was found in the mid-Atlantic stratum, which included the waters off Virginia. 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 from November to January. 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.

North Atlantic right whales likely would not be encountered at the time of the proposed survey.

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

A number of other actions have been taken to protect North Atlantic right whales, including establishing the Right Whale Sighting Advisory System designed to reduce collisions between ships and right whales by alerting mariners to the presence of the whales (see NEFSC 2012); a Mandatory Ship Reporting System implemented by the U.S. Coast Guard in the right whale nursery and feeding areas (USCG 1999, 2001; Ward-Geiger et al. 2005); recommended shipping routes in key right whale aggregation areas (NOAA 2006, 2007, 2013c); and regulations to implement seasonal mandatory vessel speed restrictions in specific locations (Seasonal Management Areas) during times when whales are likely present, including ~37 km around points near the mouth of Chesapeake Bay (37.006ºN, 75.964ºW) and the Ports of Morehead City and Beaufort, NC (34.962ºN, 76.669ºW) during 1 November–30 April (NMFS 2008). Furthermore, the Bureau of Ocean Energy Management (BOEM) proposed that no seismic surveys would be authorized within right whale critical habitat areas in its draft PEIS (BOEM 2012). The proposed survey area is not in any of these areas.

Humpback Whale (*Megaptera novaeangliae*)

Although considered to be mainly a coastal species, humpback whales often traverse deep pelagic areas while migrating (e.g., Calambokidis et al. 2001). 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 spring and summer, the greatest concentrations of humpback whales occur in the southern Gulf of Maine and east of Cape Cod, with a few sightings ranging south to North Carolina (Clapham et al. 1993; DoN 2005). Similar distribution patterns are seen in fall, although with fewer sightings. Off Virginia and North Carolina, most sightings mapped by DoN (2008a,b) are in winter, mostly nearshore; there were fewer in spring, most along the shelf break or in deep, offshore water; none in summer, and five in fall, mostly nearshore. During CETAP surveys, three sightings of humpbacks where made off Virginia: one each during spring, fall, and winter (CETAP 1982). There are 63 OBIS sighting records of humpback whales in and near the proposed survey area off the coasts of Virginia and North Carolina; most sightings were made over the continental shelf (IOC 2013).

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; DoN 2005). Seasonal movements in the northwest Atlantic are apparent, with animals moving south and offshore from New England waters during winter (DoN 2005; Waring et al. 2013). Sightings off Virginia and North Carolina are less common; 15 sightings were mapped by DoN (2008a,b), most in winter and spring with 1 in summer and 1 in fall, and most on the shelf or near the shelf break. There are ~17 OBIS sighting records of minke whales for the shelf waters off Virginia and North Carolina and another two sightings in deep offshore waters (IOC 2013); half the sightings were made during spring and summer CETAP surveys (CETAP 1982).

Sei Whale (*Balaenoptera borealis*)

Two stocks of the sei whale are recognized in the North Atlantic: the Labrador Sea Stock and the Nova Scotia Stock; the latter has a distribution that includes continental shelf waters from the northeastern U.S. to areas south of Newfoundland (Waring et al. 2013). The southern portion of the Nova Scotia stock's range includes the Gulf of Maine and Georges Bank during spring and summer (Waring et al. 2013). Peak sightings occur in spring and are concentrated along the eastern edge of Georges Bank into the Northeast Channel and the southwestern edge of Georges Bank (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 (DoN 2005). DoN (2008a) reported only six sightings off Virginia and North Carolina, all during winter and spring, and all north of Cape Hatteras. There are two OBIS sightings of sei whales off North Carolina (IOC 2013), including one in deep offshore water that was made during a CETAP survey in 1980 (CETAP 1982) and one on the shelf. Sei whales likely would not be encountered during the proposed survey.

Fin Whale (*Balaenoptera physalus*)

The fin whale is present in U.S. shelf waters during winter, and is sighted more frequently than any other large whale at this time (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 (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 (DoN 2005), or begin a southward migration (Clark 1995).

The occurrence of fin whales off Virginia and North Carolina appears to be highest during winter and spring, with more sightings close to shore during winter and farther offshore, mostly on the outer shelf and along the shelf break, during spring; only a few sightings were made in summer and fall (DoN 2008a,b). There are ~100 OBIS sightings of fin whales in and near the proposed survey area off Virginia and North Carolina, mainly in shelf waters (IOC 2013); some of these sightings were made during the CETAP surveys (CETAP 1982). Three fin whale sightings were made near the shelf break off Virginia and North Carolina during NEFSC and SEFSC summer surveys between 1995 and 2011 (Waring et al. 2013).

Blue Whale (*Balaenoptera musculus*)

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

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

During the 1978–1982 CETAP surveys, the only two sightings of blue whales were made just south of Nova Scotia (CETAP 1982). Two offshore sightings of blue whales during spring have been reported just to the northeast of the proposed survey area: one off the coast of North Carolina and the other off Virginia (IOC 2013). DoN (2008a) also reported one blue whale sighting to the northeast of the proposed survey area in deep water off North Carolina during spring. Blue whales likely would not be encountered during the proposed 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 (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 (DoN 2005; Waring et al. 2013).

Sperm whales occur in deep, offshore waters of Virginia and North Carolina throughout the year, on the shelf, along the shelf break, and offshore, including in and near the proposed survey area; the lowest number of sightings was in fall (DoN 2008a,b). There are several hundred OBIS records of sperm whales in deep waters off Virginia and North Carolina (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; 11 strandings of *Kogia* spp. were reported for Virginia and 48 for North Carolina (Waring et al. 2013). There are eight OBIS sightings of pygmy or dwarf sperm whales in offshore waters off Virginia and North Carolina (IOC 2013). DoN (2008a,b) mapped 22 sightings of *Kogia* spp. off Virginia and North Carolina, most in winter and spring with 2 in summer and 1 in fall, and most near the shelf break or offshore. Several sightings of *Kogia* sp. (either pygmy or dwarf sperm whales) were also reported by DoN (2008a) and Waring et al. (2013) in deep, offshore waters off Virginia and North Carolina, all in summer.

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; DoN 2005; Waring et al. 2001, 2013).

Off North Carolina, 14 sightings of Cuvier's beaked whales were mapped by DoN (2008a,b), most along the shelf break or offshore; there were 7 in spring, 4 in winter, 2 in summer, and 1 in fall. Several sightings were made along the shelf break off North Carolina in the spring and summer during the 1978–1982 CETAP surveys (CETAP 1982). Palka (2012) reported one Cuvier's beaked whale sighting in deep offshore waters off Virginia during June–August 2011 surveys. There are four and nine OBIS sighting records of Cuvier's beaked whale in offshore waters off Virginia and North Carolina, respectively, including the CETAP sightings (IOC 2013).

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. One sighting was reported on the shelf break off North Carolina during spring (DoN 2008a,b), and there are three stranding records of True's beaked whale for North Carolina (DoN 2008a,b). Macleod et al. (2006) reported numerous other stranding records for the east coast of the U.S. Several sightings of unidentified beaked whales were reported off Virginia and North Carolina during summer NEFSC and SEFSC surveys between 1995 and 2011 (Waring et al. 2013). True's beaked whales likely would not be encountered during the proposed survey.

Gervais' Beaked Whale (*Mesoplodon europaeus*)

Based on stranding records, Gervais' beaked whale appears to be more common in the western Atlantic than in the eastern Atlantic (Macleod et al. 2006; Jefferson et al. 2008). Off the U.S. east coast, it occurs from Cape Cod Bay, Massachusetts (Moore et al. 2004) to Florida, with a few records in the Gulf of Mexico (Mead 1989). Numerous strandings were mapped by DoN (2008a,b) in North Carolina during all seasons, but there were no sightings. DoN (2005) also reported numerous other sightings along the shelf break off the northeast coast of the U.S. Palka (2012) reported one sighting in deep offshore waters off Virginia during June–August 2011 surveys. There are four OBIS stranding records of Gervais' beaked whale for Virginia (IOC 2013).

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 stranding records along the east coast of the U.S. (Macleod et al. 2006). DoN (2008a,b) mapped a number of strandings but no sightings of Blainville's beaked whale off Virginia or North Carolina; however, numerous sightings of unidentified beaked whales were mapped off Virginia and North Carolina by DoN (208a.b) and during summer NEFSC and SEFSC surveys between 1995 and 2011 (Waring et al. 2013). There is one OBIS sighting record in offshore waters off Virginia (IOC 2013). Blainville's beaked whales likely would not be encountered during the proposed survey.

Rough-toothed Dolphin (*Steno bredanensis*)

The rough-toothed dolphin is distributed worldwide in tropical, subtropical, and warm temperate waters (Miyazaki and Perrin 1994). It is generally seen in deep, oceanic water, although it 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). There are eight OBIS sighting records of rough-toothed dolphins off North Carolina (IOC 2013), including four sightings made during SEFSC surveys during 1992–1999 (Waring et al. 2010). Five of the OBIS sightings were made on the shelf, and three were made in deep, offshore water. DoN (2008a,b) reported two sightings off North Carolina, one in summer and one in fall. In addition, Palka (2012) reported three sightings in deep offshore waters off Virginia during June–August 2011 surveys.

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; and 1219 as of 13 April 3014) have washed up on the mid-Atlantic coast from New York to Florida (NOAA 2013d). NOAA declared an unusual mortality event (UME), the tentative cause of which is thought to be cetacean morbillivirus. As of 8 December 2013, 163 of 174 dolphins tested (203 of 212 as of 14 April 2014) were confirmed positive or suspect positive for morbillivirus. NOAA personnel observed that the dolphins affected live 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 2013d). In addition to morbillivirus, the bacteria *Brucella* was confirmed in 11 of 43 dolphins tested (NOAA 2013d). The NOAA web site is updated frequently, and it is apparent that the strandings have been extending south; in the 4 November update, dead or dying dolphins had been reported only as far south as South Carolina, in the 8 December update, strandings were also reported in Georgia and Florida, whereas as of 13 April, there have been no reported strandings in New York or New Jersey in 2014.

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 from 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 (DoN 2005, 2008a,b).

Palka (2012) reported several sightings off Virginia in water depths >2000 m during June–August 2011 surveys. There are also several thousand OBIS records for waters off Virginia and North Carolina, including sightings in the proposed survey area on the shelf, slope, and in offshore waters (IOC 2013).

Pantropical Spotted Dolphin (*Stenella attenuata*)

Pantropical spotted dolphins generally occur in deep offshore waters between 40°N and 40°S (Jefferson et al. 2008). Very few sightings were mapped by DoN (2008a,b) off Virginia and North Carolina: four in spring, one in winter, one in summer, and none in fall, although there were numerous sightings of unidentified spotted dolphins. Waring et al. (2010) reported one sighting off North Carolina and one off South Carolina during NEFSC and SEFSC surveys in the summer during 1998–2004. In addition, there are 91 OBIS sighting records for waters off Virginia and North Carolina, mostly in shelf waters, including the proposed survey area (IOC 2013).

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. 1994a; Rice 1998). Numerous Atlantic spotted dolphin sightings off Virginia and North Carolina were mapped by DoN (2008a,b), especially in spring and summer, mainly near the shelf edge but also in shelf waters, on the slope, and offshore. Also mapped were numerous sightings of unidentified spotted dolphins. Numerous sightings were reported during summer NEFSC and SEFSC surveys between 1998 and 2011 on the shelf off North Carolina and seaward of the shelf break off Virginia and North Carolina (Waring et al. 2013). Palka (2012) also reported several sightings for offshore waters off Virginia during June–August 2011 surveys. There are 162 OBIS sighting records for the waters off Virginia and North Carolina, mostly in shelf waters, including the proposed survey area (IOC 2013).

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). Five sightings off Virginia and North Carolina were mapped by DoN (2008a,b), all just outside the shelf break in winter, spring, and summer; there were also sightings of unidentified *Stenella* in all seasons, near the shelf break, on the slope, and in offshore waters. There are two OBIS sighting records of spinner dolphins (IOC 2013): one at the shelf break off North Carolina and one in deep, offshore waters off Virginia, made during CETAP surveys (CETAP 1982). Spinner dolphins likely would not be encountered during the proposed survey.

Striped Dolphin (*Stenella coeruleoalba*)

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

Off Virginia and North Carolina, striped dolphin sightings are made year-round, with the fewest number of sightings during fall (DoN 2008a,b). All were north of Cape Hatteras and almost all were in deep, offshore water. There are 126 OBIS sighting records of striped dolphins off Virginia and North Carolina, at the shelf break and in deep, offshore water, including the proposed survey area (IOC 2013). Several sightings were also reported off the shelf break during summer NEFSC and SEFSC surveys between 1998 and 2011 (Waring et al. 2013). Palka (2012) also reported several sightings for offshore waters off Virginia during June–August 2011 surveys.

Clymene Dolphin (*Stenella clymene*)

The Clymene dolphin only occurs in tropical and subtropical waters of the Atlantic Ocean (Jefferson et al. 2008). In the western Atlantic, it occurs from New Jersey to Florida, the Caribbean Sea, the Gulf of Mexico, and south to Venezuela and Brazil (Würsig et al. 2000; Fertl et al. 2003). It is generally sighted in deep waters beyond the shelf edge (Fertl et al. 2003). There are a few sightings for waters off the coast of Virginia and North Carolina, including in fall, and almost all in deep, offshore water (Fertl et al. 2003; DoN 2008a,b). There are also six OBIS sighting records for shelf and deep waters off North Carolina (IOC 2013).

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin occurs from Cape Hatteras to Georges Bank during mid January–May, moves onto Georges Bank and the Scotian Shelf during mid summer and fall, and has been observed in large aggregations on Georges Bank in fall (Selzer and Payne 1988; Waring et al. 2013). Sightings off Virginia and North Carolina were made during all seasons, with most sightings during winter and spring; in winter and spring, sightings were on the shelf, near the shelf break, and in offshore water, whereas in summer and fall, sightings were close to the shelf break (DoN 2008a,b). There are several hundred OBIS sighting records off the coasts of Virginia and North Carolina, including within the proposed survey area, with sightings on the shelf, near the shelf edge, and in offshore waters (IOC 2013).

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). Along the northeastern coast of the U.S., it ranges south to ~37ºN (CETAP 1982). There are seasonal shifts in its distribution off the northeastern U.S. coast, with low numbers in winter from Georges Basin to Jeffrey's Ledge and high numbers in spring in the Gulf of Maine (CETAP 1982; DoN 2005). In summer, Atlantic white-sided dolphins are mainly distributed northward from south of Cape Cod (DoN 2005). Sightings south of ~40ºN are infrequent during all seasons (CETAP 1982; DoN 2005). DoN (2008a) mapped 10 sightings off Virginia and North Carolina in all seasons, with most (4) in winter and fewest (1) in fall. During the CETAP surveys, two sightings were made during summer off Virginia, but no sightings were made off North Carolina (CETAP 1982). There is one OBIS sighting record in shelf waters off North Carolina and nine for Virginia just north of the proposed survey area, in shelf and deep, offshore waters (IOC 2013). White-sided dolphins likely would not be encountered during the proposed survey.

Fraser's Dolphin (*Lagenodelphis hosei*)

Fraser's dolphin is a tropical species distributed between 30ºN and 30ºS (Dolar 2009). It only rarely occurs in temperate regions, and then only in relation to temporary oceanographic anomalies such as El Niño events (Perrin et al. 1994b). The distribution of this species in the Atlantic is poorly known, but it is believed to be most abundant in the deep waters of the Gulf of Mexico (Dolar 2009). The only sighting during NMFS surveys was one off-transect sighting of an estimated 250 Fraser's dolphins in 1999 off Cape Hatteras, in waters 3300 m deep (NMFS 1999 *in* Waring et al. 2010); this sighting occurred within the proposed survey area. Fraser's dolphins likely would not be encountered during the proposed survey.

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). According to Payne et al. (1984 *in* Waring et al. 2013), Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras to Georges Bank during spring, summer, and autumn, but they range in the North Atlantic Bight and into oceanic waters during winter (Waring et al. 2013). Mapping of Risso's dolphin sightings off the U.S. east coast suggests that they could occur year-round from the Scotian Shelf to the coast of the southeastern U.S. in waters extending from the continental shelf to the continental rise (DoN 2005). DoN (2008a,b) mapped numerous sightings throughout the year off the coasts of Virginia and North Carolina, most in spring, and almost all on the shelf break or in deeper water. Palka (2012) also made several sightings of Risso's dolphins in deep, offshore waters off Virginia. Several sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2011 for the shelf break off Virginia and North Carolina (Waring et al. 2013). There are 199 OBIS records off the coasts of Virginia and North Carolina, including shelf and shelf break, and offshore waters within the proposed survey (IOC 2013).

Melon-headed Whale (*Peponocephala electra*)

The melon-headed whale is a pantropical species usually occurring between 40ºN and 35ºS (Jefferson et al. 2008). Occasional occurrences in temperate waters are extralimital, likely associated with warm currents (Perryman et al. 1994; Jefferson et al. 2008). Melon-headed whales are oceanic and occur in offshore areas (Perryman et al. 1994), as well as around oceanic islands. Off the east coast of the U.S., sightings have been of two groups (20 and 80) of melon-headed whales off Cape Hatteras in waters >2500 m deep during vessel surveys in 1999 and 2002 (NMFS 1999, 2002 *in* Waring et al. 2010). Melon-headed whales likely would not be encountered during the proposed survey.

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 also two OBIS sighting records off Virginia, in deep, offshore water (Palka et al. 1991 *in* IOC 2013). DoN (2008a,b) mapped one sighting in deep water off North Carolina in winter, one stranding in spring, and one stranding in fall. Pygmy killer whales likely would not be encountered during the proposed survey.

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found worldwide in tropical and temperate waters generally between 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, 2008a,b): off Virginia and North Carolina, two sightings were made during summer and one during spring (DoN 2008a,b). There are five OBIS sighting records for the waters off Virginia and North Carolina, on the shelf, along the shelf edge, and in deep water (IOC 2013), including one sighting during the 1978–1982 CETAP surveys (CETAP 1982). False killer whales likely would not be encountered during the proposed survey.

Killer Whale (*Orcinus orca*)

In the western North Atlantic, the killer whale occurs 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 North Carolina. DoN (2008a,b) mapped eight sightings off Virginia and North Carolina, all during spring and almost all along the shelf break and in deep, offshore water. There are 39 OBIS sighting records for the waters off the eastern U.S., four of which were off North Carolina, on the shelf, along the shelf edge, and in deep water (IOC 2013). Killer whales likely would not be encountered during the proposed survey.

Long- and short-finned pilot whales (*Globicephala melas* and *G. macrorhynchus*)

There are two species of pilot whale, both of which could occur in the survey area. The long-finned pilot whale (*G. melas*) is distributed antitropically, whereas the short-finned pilot whale (*G. macrorhynchus*) is found in tropical, subtropical, and warm temperate waters (Olson 2009). In the northwest Atlantic, pilot whales often occupy areas of high relief or submerged banks and associated with the Gulf Stream edge or thermal fronts along the continental shelf edge (Waring et al. 1992). The ranges of the two species overlap in the shelf/shelf-edge and slope waters of the northeastern U.S. between New Jersey and Cape Hatteras, with long-finned pilot whales occurring to the north (Bernard and Reilly 1999).

Pilot whales are common off North Carolina and Virginia year-round, and almost all were along the shelf break or in deeper water (DoN 2008a,b). There are several hundred OBIS sighting records for pilot whales for shelf, slope, and offshore waters off Virginia and North Carolina, including within the proposed survey area; these sightings include *G. macrorhynchus* 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 North Carolina and Virginia (Waring et al. 2010). Palka (2012) reported two sightings of short-finned pilot whales and two sightings of *Globicephala* spp. off Virginia during June–August 2011 surveys.

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 sighting off Virginia (Waring et al. 2013). In summer, sightings mapped from numerous sources generally extended only as far south as Long Island, New York (DoN 2005). During October–December and April–June, harbor porpoises are dispersed and range from New Jersey to Maine, although there are lower densities at the northern and southern extremes (DoN 2005; Waring et al. 2013). Most animals are found over the continental shelf, but some are also encountered over deep water (Westgate et al. 1998). During January–March, harbor porpoises concentrate farther south, from New Jersey to North Carolina, with lower densities occurring from New York to New Brunswick (DoN 2005; Waring et al. 2013).

There are five OBIS sighting records for shelf waters off Virginia and North Carolina, and hundreds of stranding records (IOC 2013). Also for the waters off Virginia and North Carolina, DoN (2008a,b) mapped 7 sighting records and 10 bycatch records in winter, 1 sighting and 1 bycatch record in spring, and 1 sighting in fall. There were also numerous stranding records in winter and spring, and one in fall (DoN 2008a,b). Harbor porpoises likely would not be encountered during the proposed 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 eastern U.S. 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 discussed in § 3.4.2.1 of the

PEIS, § 4.2.3.1 of the BOEM Draft PEIS (BOEM 2012), and in § 3.8.2 of the Final EIS/OEIS for the Virginia Capes and the Cherry Point Range Complexes (DoN 2009a,b). The rest of this section focuses on their distribution off Virginia and North Carolina.

(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). 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 the 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.

Leatherback turtle sightings off Virginia and North Carolina mapped by (DoN 2008a,b) are most numerous during spring and summer, although sightings were reported for all seasons; most sightings were on the shelf, with fewer along the shelf break and in offshore waters. Palka (2012) reported one sighting off Virginia during June–August 2011 surveys. There are over 200 OBIS sighting records off Virginia and North Carolina, on the shelf, along the shelf edge, and in deep water (IOC 2013). During CETAP surveys, leatherback turtles were sighted off North Carolina during spring, summer, and fall, and off Virginia during summer.

(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). There are few sighting records in the northeastern U.S., but DoN (2005) suggested that small numbers could be found from spring to fall as far north as Cape Cod Bay. DoN (2008a,b) mapped 61 sightings off Virginia and North Carolina, mostly on the shelf, in all seasons with the highest number in spring and the lowest in winter. There are 31 OBIS sightings of green turtles off the coasts of Virginia and North Carolina, on the shelf, along the shelf edge, and in deep water (IOC 2013).

(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).

DoN (2008a,b) mapped numerous sightings of loggerheads off the coasts of Virginia and North Carolina, especially during spring and summer; most records are for shelf waters, but there are also sightings on the shelf break and farther offshore. Sightings of loggerhead turtles were by far the most numerous of any sea turtle. There are thousands of OBIS sighting records off the coasts of Virginia and

North Carolina, mostly on the shelf but also along the shelf edge and in deep water, including in the proposed survey area (IOC 2013).

In 2013, NMFS proposed 36 areas in the range of the Northwestern Atlantic Ocean Distinct Population Segment (DPS) of the loggerhead turtle, from Virginia to the Gulf of Mexico (NMFS 2013a). The areas contain one or more of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. In the proposed survey area, the inner end (20-100 m) of the southern on-offshore transect is in winter habitat, and there are a few transects north of Cape Hatteras that extend into migratory habitat, which extends from shore to 200 m depth.

(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). DoN (2008a,b) mapped 16 sightings of hawksbill turtles off the coasts of Virginia and North Carolina throughout the year, with fewest in fall and most on the shelf. There are five OBIS sighting records in shelf waters off Virginia and North Carolina (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). Virtually all sighting records of Kemp's ridley turtles off the northeastern U.S. were in summer in the shelf waters off the coast of New Jersey, with fewer sightings off Delaware, Maryland, and Virginia (DoN 2005). DoN (2008a,b) mapped numerous sightings off Virginia and North Carolina in all seasons, with most in winter and summer; numerous strandings occurred in all seasons but winter, mostly in spring and fall. There was one sighting off North Carolina during 1978–1982 CETAP surveys (CETAP 1982). There are 124 OBIS sighting records off the coast of Virginia and North Carolina, most in shelf waters with a few in deep offshore waters, including in the proposed survey area (IOC 2013).

Seabirds

Three ESA-listed seabird species could occur in or near the Project area: the ***Threatened*** piping plover and the ***Endangered*** roseate tern and Bermuda petrel. 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).

(3) Bermuda Petrel (*Pterodroma cahow*)

The Bermuda petrel is listed as ***Endangered*** under the U.S. ESA and ***Endangered*** on the IUCN Red List of Threatened Species (IUCN 2013). It was thought to be extinct by the 17th century until it was rediscovered in 1951, at which time the population consisted of 18 pairs; by 2011, the population had reached 98 nesting pairs (Birdlife International 2013b). Currently, all known breeding pairs breed on islets in Castle Harbour, Bermuda (Maderios et al. 2012). In the non-breeding season (mid June–mid October), it is though that birds move north into the Atlantic and following the warm waters on the western edges of the Gulf Stream. There are confirmed sightings off North Carolina Birdlife International 2013b). Small numbers of Bermuda petrels could be encountered over deep water at the eastern edge of the proposed survey area.

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 Carolina distinct population segment (DPS) of the Atlantic sturgeon, and the shortnose sturgeon. There are three species that are candidates for ESA listing: the Nassau grouper, the Northwest Atlantic and Gulf of Mexico DPS of the dusky shark, and the great hammerhead shark. There are no listed or candidate invertebrate species.

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 Carolina DPS, and the species is listed as ***Critically Endangered*** on the IUCN Red List of Threatened Species (IUCN 2013). 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 Carolina DPS primarily uses the Roanoke River, Tar and Neuse rivers, Cape Fear, and Winyah Bay 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 2012a).

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 2013). 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 2013e).

Nassau Grouper (*Epinephelus striatus*)

The Nassau grouper is an ESA ***Candidate Species*** throughout its range, and is listed as ***Endangered*** on the IUCN Red List of Threatened Species (IUCN 2013). It ranges from North Carolina south to Florida and throughout the Bahamas and Caribbean (Hall 2010). Nassau groupers occur to ~100 m depth and are usually found near high-relief coral reefs or rocky substrate (NMFS 2012). They are solitary fish except when they congregate to spawn in very large numbers (NMFS 2012).

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 2013). 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 201b).

Great Hammerhead Shark (*Carcharhinus mokarran*)

The great hammerhead shark is an ESA ***Candidate Species***, and has not been assessed for the IUCN Red List. It is a highly migratory species found in coastal, warm temperate and tropical waters throughout the World, usually in coastal waters and over continental shelves, but also adjacent deep waters. Along the U.S. east coast, the great hammerhead shark can be found in waters off Massachusetts, although it is rare north of North Carolina, and south to Florida and the Gulf of Mexico (NOAA 2013f).

(2) Essential Fish Habitat

Essential fish habitat 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 seaboard 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 South Atlantic Fishery Management Council (SAFMC). 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.

Several EFH areas in or near the proposed survey area have prohibitions in place for various gear types and/or possession of specific species/species groups: (1) Restricted areas designated to minimize impacts on juvenile and adult tilefish EFH from bottom trawling activity (see further under next section), (2) Prohibitions on the use of several gear types to fish for and retain snapper-grouper species from state waters to the limit of the EEZ, including roller rig trawls, bottom longlines, and fish traps; and on the harvesting of *Sargassum* (an abundant brown algae that occurs on the surface in the warm waters of the western North Atlantic), soft corals, and gorgonians (SAFMC 2013), and (3) Prohibitions on the possession of coral species and the use of all bottom-damaging gear (including bottom longline, bottom and mid-water trawl, dredge, pot/trap, and anchor/anchor and chain/grapple and chain) by all fishing vessels in Deepwater Coral HAPC (see further under next section).

(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. HAPC have been designated for seven species/species groups within the proposed survey area:

1. Juvenile and adult summer flounder: 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, which is demersal waters over the continental shelf north of Cape Hatteras and demersal waters over the continental shelf south of Cape Hatteras to a depth of 152 m (NOAA 2012b);
2. Juvenile and adult tilefish: four canyons with clay outcroppings ("pueblo habitats"; complex of burrows in clay outcrops, walls of submarine canyons, or elsewhere on the outer continental shelf) in 100–300 m depths (MAFMC and NMFS 2008), of which the Norfolk Canyon (HAPC # 11 in Fig. 1) is just north of the survey area;

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

	Life stage[1] and habitat[2]				
Species	E	L/N	J	A	SA
Atlantic herring *Clupea harengus*			P/D	P/D	
Bluefish *Pomatomus saltatrix*	P	P	P	P	P
Butterfish *Peprilus triacanthus*	P	P	P	P	P
Black sea bass *Centropristis striata*	P	D	D	D	D
Atlantic mackerel *Scomber scombrus*	P	P	P	P	P
King mackerel *Scomberomorus cavalla*	P[3]	P[3]	P[3]	P[3]	P[3]
Spanish mackerel *Scomberomorus maculatus*	P[3]	P[3]	P[3]	P[3]	P[3]
Cobia *Rachycentron canadum*	P[3]	P[3]	P[3]	P[3]	P[3]
Snapper-Grouper[4]	P/D	P/D	P/D	P/D	P/D
Offshore hake *Merluccius albidus*	P	P	D	D	D
Red hake *Urophycis chuss*	P	P	D	D	D
Silver hake *Merluccius bilinearis*	P	P	D	D	D
White hake *Urophycis tenuis*	P	P	P/D	D	D
Scup *Stenotomus chrysops*	P[5]	P/D[5]	D	D	D
Dolphin *Coryphaena hippurus,* wahoo *Acanthocybium solanderi*	P[6]	P[6]	P[6]	P[6]	P[6]
Tilefish *Lopholatilus chamaeleonticeps*	P[7]	P[7]	B[7]	B[7]	B[7]
Monkfish *Lophius americanus*	P	P	B	B	B
Summer flounder *Paralichthys dentatus*	P	P	B	B	B
Window pane flounder *Scophthalmus aquosus*	P	P	B	B	B
Witch flounder *Glyptocephalus cynoglossus*	P	P	B	B	B
Yellowtail flounder *Limanda ferruginea*		P			
Albacore tuna *Thunnus alalunga*			P	P	
Bluefin tuna *Thunnus thynnus*		P	P	P	
Bigeye tuna *Thunnus obesus*			P	P	
Yellowfin tuna *Thunnus albacres*			P	P	
Skipjack tuna *Katsuwonus pelamis*			P	P	
Swordfish *Xiphias gladius*		P	P	P	
Blue marlin *Makaira nigricans*			P	P	
White marlin *Tetrapturus albidus*			P	P	
Sailfish *Istiophorus platypterus*	P	P	P	P	P
Longbill spearfish *Tetrapturus pfluegeri*			P	P	
Roundscale spearfish *Tetrapturus georgii*			P	P	
Clearnose skate *Raja eglanteria*			B[8]	B[8]	
Little skate *Leucoraja erinacea*			B[9]	B[9]	
Rosette skate *Leucoraja garmani*			B[10]	B[10]	
Winter skate *Leucoraja ocellata*			B[11]	B[11]	
Angel shark *Squatina dumeril*			B	B	
Atlantic sharpnose shark *Rhizoprionodon terraenovae*		B	B	B	
Basking shark *Cetorhinus maximus*			P	P	
Bigeye thresher shark *Alopias superciliosus*		P	P	P	
Common thresher shark *Alopias vulpinus*		P	P	P	
Blue shark *Prionace glauca*			P	P	
Porbeagle shark *Lamna nasus*		P	P	P	
Longfin mako shark *Isurus paucus*		P	P	P	
Shortfin mako shark *Isurus oxyrinchus*		P	P	P	
Smooth (spiny) dogfish *Squalus acanthias*		P	P	P	
Tiger shark *Galeocerdo cuvier*		P	P	P	
Sand tiger shark *Carcharias taurus*		P	P	P	
White shark *Carcharodon carcharias*		P	P	P	
Bonnethead shark *Sphyrna tiburo*				B	
Great hammerhead shark *Sphyrna mokarran*		P	P	P	
Scalloped hammerhead shark *Sphyrna lewini*		P	P	P	
Bignose shark *Carcharhinus altimus*			B	B	

TABLE 4. (Concluded).

Species	Life stage[1] and habitat[2]				
	E	L/N	J	A	SA
Blacknose shark *Carcharhinus acronotus*		B	B	B	
Blacktip shark *Carcharhinus limbatus*		P	P	P	
Dusky shark *Carcharhinus obscurus*		P	P	P	
Finetooth shark *Carcharhinus isodon*			P	P	
Night shark *Carcharhinus signatus*		P	P	P	
Oceanic whitetip shark *Carcharhinus longimanus*		P	P	P	
Sandbar shark *Carcharhinus plumbeus*		B	B	B	
Silky shark *Carcharhinus falciformis*		P	P	P	
Spinner shark *Carcharhinus brevipinna*		P	P	P	
Atlantic sea scallop *Placopecten magellanicus*	B	P	B	B	B
Atlantic surfclam *Spisula solidissima*	P[12]	P[12]	B[12]	B[12]	B[12]
Ocean quahog *Arctica islandica*	P[13]	P[13]	B[13]	B[13]	B[13]
Golden crab *Chaceon fenneri*	P[6]	P/B[6]	B[6]	B[6]	B[6]
Red crab *Chaceon quinquedens*	P[14]	P/B[14]	B[14]	B[14]	B[14]
Spiny lobster *Panulirus argus*		P[6]	B[6]	B[6]	
Shrimp	P/D[6]	P/D[6]	P/D[6]	P/D[6]	P/D[6]
Northern shortfin squid *Illex illecebrosus*	P[15]	P[15]	D/P[15]	D/P[15]	D/P[15]
Longfin inshore squid *Loligo pealeii*	B[16]	P[16]	D/P[16]	D/P[16]	D/P[16]
Coral, coral reefs and live/hard bottom[17]		D/B[6]	B[6]	B[6]	B[6]

Source: NOAA 2012b

[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

References: [3] ESS 2013; [4] May include up to 70 species (NOAA 2012b); [5] Steimle et al. 1999a; [6] SAFMC 1998; [7] Steimle et al. 1999b; [8] Packer et al. 2003a; [9] Packer at al. 2003b; [10] Packer et al. 2003c; [11] Packer et al. 2003d; [12] Cargnelli et al. 1999a; [13] Cargnelli et al. 1999b; [14] Steimle et al. 2001; [15] Hendrickson and Holmes 2004; [16] Jacobson 2005

[17] May include black corals (*Antipatharia*) and Octocorals (including sea pens and sea pansies)

3. Species in the snapper-grouper management group: medium- to high-profile offshore hard bottoms where spawning normally occurs; localities of known or likely periodic spawning aggregations; nearshore hard-bottom areas; The Point (HAPC # 1 in Fig. 1), The 10- Fathom Ledge (HAPC # 5 in Fig. 1), and Big Rock (HAPC # 10 in Fig. 1); The Charleston Bump Complex (HAPC # 4 in Fig. 1); mangrove habitat; seagrass habitat; oyster/shell habitat; all coastal inlets (in and near the survey area, HAPC # 2 in Fig. 1); all state-designated nursery habitats of particular importance to snapper/grouper (e.g., Primary and Secondary Nursery Areas designated in North Carolina); and pelagic and benthic *Sargassum* (SAFMC and NMFS 2011);
4. Coastal migratory pelagics (including sharks, swordfish, billfish, and tunas) and dolphin and wahoo fish: within the proposed survey area, The Point, the Charleston Bump Complex, 10-Fathom Ledge, Big Rock, and pelagic *Sargassum* (SAFMC and NMFS 2009);
5. Deepwater Coral: Within the survey area, The Point, 10-Fathom Ledge, Big Rock, Cape Lookout *Lophelia* Banks (HAPC # 7 in Fig. 1), and Cape Fear *Lophelia* Banks (HAPC # 8 in Fig. 1) (SAFMC 2013); the use of specified fishing gear/methods and the possession of corals are prohibited (SAFMC 2013);
6. Sandbar shark: in and near the survey area region, important nursery and pupping grounds near Outer Banks (North Carolina), in areas of Pamlico Sound and adjacent to Hatteras and Ocracoke Islands (North Carolina), and offshore those islands (HAPC # 6 in Fig. 1; NOAA 2012b); and

7. *Sargassum*: HAPC for various fish species because of mutually beneficial relationship between the fishes and algae, and commercial harvest; the top 10 m of the water column in the South Atlantic EEZ, bounded by the Gulf Stream (SAFMC and NMFS 2011; SAFMC 2013).

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 2013g). Fisheries data from 2008 to 2012 (and 2013 where available) were used in the analysis of Virginia's and North Carolina's commercial and recreational fisheries. The latest year's available data are considered preliminary.

(1) Commercial Fisheries

Virginia

In the waters off Virginia, commercial fishery catches are dominated by menhaden, various finfish, and shellfish. Menhaden accounted for 84% of the catch weight, followed by blue crab (7%), sea scallop (2%), Atlantic croaker (2%), summer flounder (1%), unidentified finfish (1%), and northern quahog clam (1%). Numerous other fish and invertebrate species accounted for the remaining proportion of catch weight. Most fish and all shellfish and squid were captured within 5.6 km from shore, which would be outside of the proposed survey area. The average annual catch weights and values, fishing season, and gear types for major commercial species are summarized in Table 5. During 2002–2006 (the last year reported), commercial catch has only been landed by U.S. and Canadian vessels in the EEZ along the U.S east coast, with the vast majority of the catch (>99%) taken by U.S. vessels (Sea Around Us Project 2011). Typical commercial fishing vessels in the Virginia area include trawlers, gill netters, lobster/crab boats, dredgers, longliners, and purse seiners.

North Carolina

In North Carolina waters, commercial fishery catches are predominantly various shellfish and finfish. Blue crab accounted for 43% of the catch weight, followed by Atlantic croaker (8%), brown shrimp (6%), summer flounder (4%), bluefish (3%), southern flounder (3%), striped (liza) mullet (3%), spiny dogfish shark (3%), white shrimp (3%), menhaden (2%), smooth dogfish shark (2%), and Spanish mackerel (1%). Numerous other fish and invertebrate species accounted for the remaining proportion of catch weight. Fish were caught equally within 5.6 km from shore and between 5.6 and 370 km from shore, whereas the majority of shellfish were caught within 5.6 km from shore. The average annual catch weights and values, fishing season, and gear types for major commercial species are summarized in Table 6). Typical commercial fishing vessels in the North Carolina area include trawlers, gill netters, lobster/crab boats, dredgers, longliners, and purse seiners.

(2) Recreational Fisheries

Virginia

In 2012, marine recreational fishers in Virginia waters caught ~7.9 million fish for harvest or bait, and ~13.7 million fish in catch and release programs. These catches were taken by 684,022 recreational fishers during more than 2.5 million trips. The majority of the trips (99%) occurred within 5.6 km from

TABLE 5. Commercial fishery catches for major marine species for Virginia waters by weight, value, season, and gear type, averaged from 2008 to 2012.

Species	Average annual landings (mt)	% total	Average annual landings (1000$)	% total	Fishing season (peak season)	Gear Type: Fixed	Gear Type: Mobile
Menhaden	176,236	87	28,681	19	Year-round (May-Nov)	Gill nets, long lines, pots, traps, pound nets	Cast nets, seines, hand lines,
Blue crab	14,436	7	21,548	15	Year-round (Mar-Oct)	Gill nets, pots, traps, lines trot with bait, pound nets	Dip nets, dredge, fyke net, hand lines, picks, scrapes, tongs, grabs
Sea scallop	3,905	2	66,511	45	Year-round (Mar-Sept)	N/A	Dredge, trawls
Atlantic croaker	3,637	2	6,056	4	Year-round (Mar-Nov)	Gill nets, long lines, lines trot with bait, pots, traps, pound nets	Cast nets, dredge, fyke net, seines, hand lines, otter trawl
Summer flounder	1,306	1	4,705	3	Year-round (Mar; Dec)	Gill nets, long lines, lines trot with bait, pots, traps, pound nets	Dredge, fyke net, seines, hooks, hand lines, trawls, rakes
Unidentified finfish	1,297	1	737	<1	Year-round (May-Sept)	Gill nets, pots, traps, pound nets	Hand, cast nets, dip nets, fyke net, seines, hand lines, picks
Northern quahog clam	1,128	1	19,374	13	Year-round (spring-fall)	Pots, traps, pound nets	Hand, dredge, picks, scrapes, tongs, grabs
Total	201,945	100	147,612	100			

Source: NOAA 2013g

shore, outside of the survey area. The periods with the most boat-based trips (including charter, party, and private/rental boats) were July–August (430,733 trips or 29% of total), followed by May–June (407,783 or 28%), and September–October (344,787 or 23%). Similarly, most shore-based trips (from beaches, jetties, banks, marshes, docks, and/or piers; DoN 2008a), were in July–August (397,340 or 38%), and September–October (224,238 or 21%).

In 2007, there were two recreational fishing tournaments in Virginia, for tuna in July and for billfish in August, both based in Virginia Beach and within ~200 km from Virginia's shore (DoN 2008a). Of the "hotspots" (popular fishing sites commonly visited by recreational anglers) mapped by DoN (2008a), most are to the north of the proposed survey area; however, there is at least one hotspot ("Cigar") located in or very near the portion of the proposed survey area that is closest to the Virginia border.

In 2012, at least 77 species of fish were targeted by recreational fishers in Virginia waters. Species with 2012 recreational catch numbers exceeding one million include Atlantic croaker (40% of total catch), red drum (12%), spot (12%), striped mullet (6%), and summer flounder (5%). Other notable species or species groups representing at least 1% each of the total catch included black sea bass, white perch, spotted seatrout, blue catfish, oyster toadfish, northern kingfish, bluefish, Atlantic menhaden, striped bass, southern kingfish, pinfish, Atlantic spadefish, northern puffer, and weakfish. Virtually all (~99%) of these species/species groups were predominantly caught within 5.6 km from shore.

TABLE 6. Commercial fishery catches for major marine species for North Carolina waters by weight, value, season, and gear type, averaged from 2008 to 2012.

Species	Average annual landings (mt)	% total	Average annual landings (1000$)	% total	Fishing season (peak season)	Gear Type	
						Fixed	Mobile
Blue Crab	13,266	48	22,497	34	Year-round (May-Nov)	Gill nets, pots, traps, pound nets	Bag nets, hand, dredge, fyke nets, hoop nets, trawls
Atlantic Croaker	2,486	9	2,971	4	Year-round (Nov-Mar)	Gill nets, pots, traps, pound nets	Fyke nets, hoop nets, seines, hand lines, trawls, spears
Brown Shrimp	1,949	7	8,037	12	May-Dec (Jul-Aug)	Pots, traps	Bag nets, trawls, cast nets
Summer Flounder	1,136	4	5,414	8	Year-round (Winter)	Gill nets, pots, traps	Seines, hand lines, trawls, spears
Bluefish	922	3	764	1	Year-round (Jan-Apr)	Gill nets, long lines, pots, traps, pound nets	Seines, hand lines, troll lines, trawls, spears
Southern Flounder	869	3	4,232	6	Year-round (Apr-Nov)	Gill nets, pots, traps, pound nets	Bag nets, trawls, hand, cast nets, dredge, fyke nets, hoop nets, seines, hand lines, rakes, spears
Striped (Liza) Mullet	810	3	889	1	Year-round (Oct-Nov)	Gill nets, pots, traps, pound nets	Hand, cast nets, fyke nets, hoop nets, seines, hand lines, trawls, spears
Spiny Dogfish Shark	778	3	304	<1	Jan	Gill nets	N/A
White Shrimp	774	3	3,713	6	Year-round (Aug-Feb; May-Jun)	Gill nets	Bag nets, trawls, cast nets
Menhaden	738	3	166	<1	Year-round (Jan-Mar)	Gill nets, pots, traps, pound nets	Bag nets, cast nets, fyke nets, hoop nets, seines, hand lines, trawls, rakes
Smooth Dogfish Shark	534	2	386	1	Year-round (Mar-Apr)	Gill nets, long lines	Hand lines, trawls
Spanish Mackerel	370	1	1,013	2	Year-round (May-Oct)	Gill nets, pots, traps, pound nets	Bag nets, trawls, seines, hand lines, troll lines
Spot	340	1	527	1	Year-round (May-Nov)	Gill nets, pots, traps, pound nets	Bag nets, hand, seines, hand lines, trawls, spears
King Whiting	328	1	746	1	Year-round (Nov-Apr)	Gill nets, pots, traps, pound nets	Seines, hand lines, troll lines, trawls, spears
Eastern Oyster	301	1	3,427	5	Year-round (Oct-Mar)	Gill nets	Hand, dredge, trawls, rakes, tongs, grabs
Swordfish	298	1	1,995	3	Year-round (Dec-Jun)	Long lines	N/A
King and Cero Mackerel	258	1	1,134	2	Year-round (Oct-Apr)	Gill nets, long lines	Hand lines, troll lines
Yellowfin Tuna	254	1	1,100	2	Year-round (May-Oct)	Long lines	Hand lines, trawls, troll lines
Blue, Peeler Crab	216	1	1,098	2	Mar-Nov (Apr-Jun)	Gill nets, pots, traps, pound nets	Trawls
Catfishes and Bullheads	186	1	86	<1	Year-round (Feb-Apr)	Gill nets, lines trot with bait, pots, traps, pound nets	Fyke nets, hoop nets, hand lines
Back Sea Bass	184	1	964	1	Year-round (Dec-Feb; Jun-Aug)	Gill nets, long lines, pots, traps	Hand lines, troll lines, trawls
Pink Shrimp	173	1	685	1	Apr-Nov (May-Jul)	N/A	Bag nets, trawls

TABLE 6. (Concluded).

Species	Average annual landings (mt)	% total	Average annual landings (1000$)	% total	Fishing season (peak season)	Gear Type: Fixed	Gear Type: Mobile
Vermilion Snapper	170	1	1,123	2	Year-round (Jan; Jul-Sep)	Pots, traps	Hand lines
Blueline Tilefish	162	1	650	1	Year-round (May-Sep)	Gill nets, long lines, pots, traps	Hand lines, trawls
Quahog Clam	161	1	2,192	3	Year-round	Gill nets, pots, traps	Hand, dredge, trawls, rakes, tongs, grabs
Striped Bass	158	1	865	1	Oct-Apr (Jan-Apr)	Gill nets, pots, traps, pound nets	Fyke nets, hoop nets, seines, trawls
Total	27,820	100	27,820	100			

Source: NOAA 2013g

North Carolina

In 2012, marine recreational fishers in the waters of North Carolina caught ~8.5 million fish for harvest or bait, and over 18.5 million fish in catch and release programs. These catches were taken by over 1.6 million recreational fishers during more than 5.3 million trips. The majority of the trips (94%) occurred within 5.6 km from shore, outside of the survey area. The periods with the most boat-based trips (including charter, man-made, and private/rental boats) were July–August (949,950 trips or 26% of total), followed by September–October (923,650 or 25%), and May–June (857,356 or 23%). The majority of shore-based trips (from beaches, jetties, banks, marshes, docks, and/or piers; DoN 2008b) occurred in September–October (524,506 trips or 33%), then July–August (422,863 or 26%), and May–June (316,825 or 20%).

North Carolina also provides a recreational commercial gear license in addition to typical recreational fishing, which allows recreational anglers to use select amounts of commercial gear to harvest for personal, non-salable consumption (DoN 2008b).

In 2007, there were 35 recreational fishing tournaments around North Carolina, between May and November, all within ~200 km from shore (DoN 2008b). Eight tournaments were held in September or October. DoN (2008a,b) mapped numerous hotspots off North Carolina, many of which are located within or near the proposed survey area, mostly at or inshore of the shelf break. In 2014, 15 tournaments are currently (24 April 2014) scheduled for North Carolina ports of call (Table 7). No detailed information about locations is given in the sources cited.

In 2012, at least 190 species of fish were targeted by recreational fishers in the waters of North Carolina. Species with 2012 recreational catch numbers exceeding one million include pinfish (13% of total), black sea bass (8%), spotted seatrout (8%), bluefish (7%), red drum (6%), Atlantic croaker (6%), spot (6%), unidentified lefteye flounders (5%), unidentified kingfishes (5%), and unidentified mullets (5%). Other notable species or species groups representing at least 1% each of the total catch included pigfish, Spanish mackerel, Atlantic menhaden, northern puffer, unidentified sharks, southern kingfish, Florida pompano, dolphinfish, unidentified puffers, unidentified lizardfish, Gulf kingfish, black drum, weakfish, sheepshead, striped bass, and unidentified sea robins. Most of these species/species groups were predominantly caught within 5.6 km from shore (63% of total catch for black sea bass; ~98% for all others), with the exception of dolphinfish, which were almost entirely caught beyond 5.6 km.

Table 7. Fishing tournaments off North Carolina, mid September–mid October 2014.

Dates	Tournament name	Port	Marine species/groups targeted	Source
1 Jan–31 Dec	2014 North Carolina Saltwater Fishing Tournament	Statewide	False albacore tuna; amberjack; Atlantic bonito; barracuda; black sea/ striped bass; bluefish; cobia; croaker; dolphinfish; black/red drum; flatfish; grouper; crevalle jack; king/Spanish mackerel; blue/white marlin; sea mullet; Florida pompano; silver snapper (porgy); sailfish; shark; sheepshead; spearfish; spotfish; tarpon; gray tilefish; triggerfish; gray(weakfish)/speckled trout; bigeye/ blackfin/bluefin/yellowfin tuna; wahoo	1
20, 27 Sep; 4, 11 Oct	Kayak Wars	Statewide	Barred sand/calico/spotted bay/white sea bass; bonefish; bonito; cabezon; California barracuda; coho/king/pink salmon; corvina; dorado (mahi mahi); greenling; halibut; leopard/mako/ sevengill/thresher shark; lingcod; opaleye; rock sole; rockfish; saltwater perch; sanddab; sculpin; sheephead; spiny dogfish; starry flounder; sturgeon; cutthroat trout; whitefish; yellowtail	2
8 Aug–30 Nov	Onslow Bay Open King Mackerel Tournament	Swansboro	King mackerel	3
18–20 Sep	Atlantic Beach Saltwater Classic	Atlantic Beach	Unlisted	3
20 Sep	Military Appreciation Day	Morehead City	Wahoo; dolphinfish; triggerfish; grouper: snapper; sea bass; flounder; redfish; king/Spanish mackerel; bluefish; amberjack	4
20 Sep	Redfish Shootout Series #3	Surf City	Redfish	4
20 Sep	Carolina Fall Flatfish Tournament	Kure Beach	Flatfish	4
26–27 Sep	Newbridge Bank Spanish Mackerel Open	Wrightsville Beach	Spanish mackerel	4
27 Sep	Carolina Redfish Series	Atlantic Beach	Unlisted	3
27–28 Sep	Carolina Fall King Challenge	Kure Beach	King mackerel	4
2–4 Oct	U.S. Open King Mackerel Challenge	Southport	King mackerel	5
4–5 Oct	Ocean Crest Pier Fall Flounder Tournament	Oak Island	King/Spanish mackerel	4
10–12 Oct	Ocean Isle Fishing Centre Fall Brawl King Classic	Ocean Isle Beach	King/Spanish mackerel	3
11 Oct	Redfish Shootout Series Championship	Sneads Ferry	Redfish	4
11–12 Oct	Rumble on the Tee King Mackerel Tournament	Oak Island	King mackerel	4

Sources: 1: NCDMF (2014); 2: American Fishing Contests (2014); 3: SportFishermen (2014); 4: Fisherman's Post (2014); 5: U.S. OKMT (2014)

Recreational SCUBA Diving

Wreck diving is a popular recreation in the waters off North Carolina, an area nicknamed the "Graveyard of the Atlantic". A search for shipwrecks in and near the proposed survey area was made using NOAA's automated wreck and obstruction information system (NOAA 2014), and wreck use by divers and wreck locations were verified by searching various dive operators' web sites and other sources (especially DiveAdvisor [2014] and DiveBuddy [2014], and also NC [2014] and OBDC [2014]). Results of the searches in water depths <100 m, a depth considered to be the maximun for recreational diving, are plotted in Figure 6 together with the survey lines. Only dive sites within 25 km of the survey track lines are included in Table 8. The coordinates of any shipwrecks on survey track lines in water depths >100 m would be given to the crew conducting OBS deployment.

Terrestrial Species

A search for ESA-listed species was conducted using USFWS' Information, Planning, and Conservation System (IPAC) in 20 km x 20 km areas around the 14 nominal drill sites where explosives would be detonated. Three fish species (Roanoke logperch *Percina rex*, shortnose sturgeon *Acipenser brevirostrum*, and Cape Fear shiner *Notropis mekistocholas*) and one mussel (dwarf wedgemussel *Alasmidonta heterodon*) were identified in the search; these are not discussed further here, as drilling would not be conducted in or near water. Two bird species, one mammal, one insect, and eight species of vegetation found in the searches are described in the following sections. Marine species identified in the search (because the areas around the nominal drill sites included marine waters at coastal sites) are described in the appropriate sections above.

(1) Birds

Red-cockaded Woodpecker (*Picoides borealis*)

The red-cockaded woodpecker is listed as ***Endangered*** under the U.S. ESA, and as ***Near Threatened*** on the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the 20 km x 20 km areas around most of the nominal drill sites. The red-cockaded woodpecker is endemic to the southeastern United States, where it inhabits fire-sustained open pine-forest, dominated in half of its range by longleaf pine elsewhere by shortleaf, slash, or loblolly pine. It is a cooperative breeder (i.e., family groups typically consist of a breeding pair with or without one or two male helpers), and each group requires at least 80 ha of habitat. Nests are in cavities of living old-growth (100+ years) trees, and eggs are laid from late April to early June. Both adults and nestlings apparently forage more in shortleaf and loblolly pine habitats than in longleaf pine forest (BirdLife International 2014).

The red-cockaded woodpecker likely would not be encountered because its habitat is forest, and land-based operational activities would not occur there.

Wood Stork (*Mycteria americana*)

The U.S. breeding population of the wood stork was listed in Florida, Georgia, South Carolina, and Alabama is listed as ***Endangered*** under the U.S. ESA and as ***Least Concern*** on the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around only 2 of the 14 nominal drill sites, two sites near the middle of the southern line. Historically, the core of the wood stork breeding population was located in the Everglades of southern Florida. Populations there diminished because of habitat deterioration, but the breeding range has now almost doubled in extent and shifted

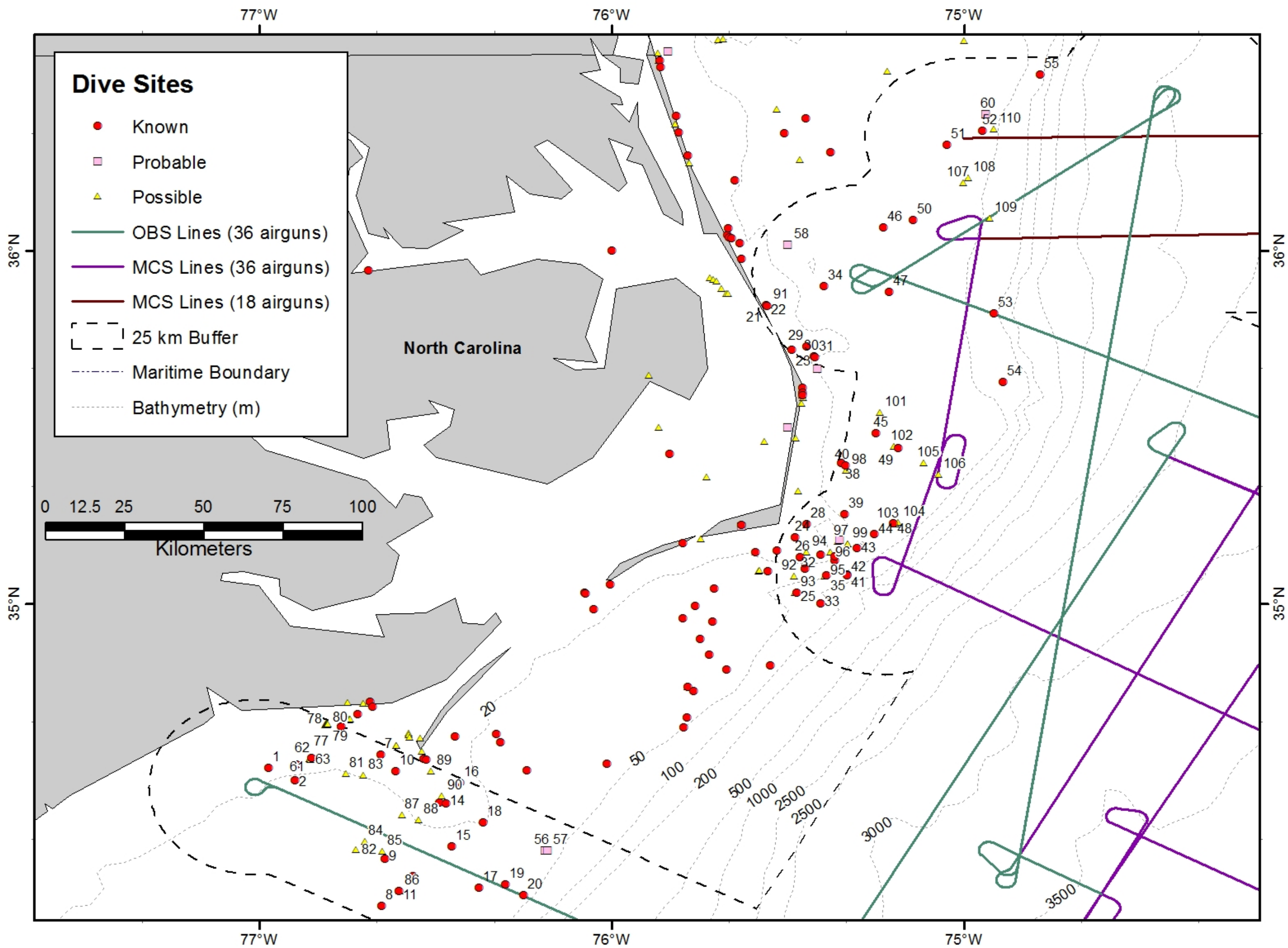

Figure 6. Recreational dive sites in water depths <100 m.

Table 8. North Carolina dive sites in <100 m depth and within 25 km of the proposed transect lines.

ID Number	Site ID	Latitude	Longitude	Source
Known Sites				
1	*Titan Tug (AR-345)* Shipwreck	34.535683	-76.97455	DiveBuddy 2014
2	*W.E. Hutton* Shipwreck	34.499833	-76.897983	DiveBuddy 2014
3	*Suloide* Shipwreck	34.544789	-76.895011	NOAA 2014
4	*Indra* Shipwreck	34.5623	-76.851517	DiveBuddy 2014
5	*Theodore Parker* Shipwreck	34.652189	-76.768341	DiveBuddy 2014
6	*Dorothy B* Shipwreck	34.3585	-76.677983	DiveAdvisor 2014; NOAA 2014
7	*Senateur Duhamel* Shipwreck	34.57149	-76.655045	DiveBuddy 2014
8	*Papoose* Shipwreck	34.143883	-76.652567	DiveBuddy 2014
9	*SCGC Spar (AR-305)* Shipwreck	34.277716	-76.64475	DiveBuddy 2014
10	*USS Aeolus* Shipwreck	34.52637	-76.613423	DiveBuddy 2014
11	*Schurz* Shipwreck	34.186167	-76.602833	DiveBuddy 2014
12	*U-352* Shipwreck	34.228033	-76.565117	DiveBuddy 2014
13	*Fenwick Island* Shipwreck	34.437111	-76.489919	DiveAdvisor 2014; NOAA 2014
14	*EA* Shipwreck	34.4335	-76.469639	DiveAdvisor 2014; NOAA 2014
15	*Ario (1)* Shipwreck	34.313503	-76.453139	DiveAdvisor 2014; NOAA 2014
16	*Portland* Shipwreck	34.492592	-76.429961	NOAA 2014
17	Box Wreck	34.194417	-76.376067	DiveBuddy 2014
18	*Ashkabad* Shipwreck	34.380669	-76.365467	DiveAdvisor 2014; NOAA 2014
19	*HMS Bedfordshire* Shipwreck	34.204534	-76.302795	DiveBuddy 2014
20	*Yancy* Shipwreck	34.175048	-76.250746	NOAA 2014
21	*Oriental* Shipwreck	35.847342	-75.561611	DiveAdvisor 2014; NOAA 2014
22	*Laura A. Barnes* Shipwreck	35.845175	-75.559944	DiveAdvisor 2014; NOAA 2014
23	*Oriental* Shipwreck	35.7189	-75.48905	NOAA 2014
24	*Kassandra Louloudis* Shipwreck	35.187678	-75.480148	DiveBuddy 2014
25	*Empire Gem* Shipwreck	35.030456	-75.475978	NOAA 2014
26	*Brewster* Shipwreck	35.131844	-75.466258	DiveAdvisor 2014; NOAA 2014
27	*Glanayron* Shipwreck	35.100178	-75.451256	DiveAdvisor 2014; NOAA 2014
28	*Central America* Shipwreck	35.226844	-75.447922	DiveAdvisor 2014; NOAA 2014
29	*Zane Grey* Shipwreck	35.730283	-75.446117	DiveBuddy 2014
30	*Mirlo* Shipwreck	35.700178	-75.424603	DiveAdvisor 2014; NOAA 2014
31	*Marlyn* Shipwreck	35.698789	-75.422658	DiveAdvisor 2014; NOAA 2014
32	*Veturia* Shipwreck	35.138917	-75.4075	DiveBuddy 2014
33	*Monitor* Shipwreck	35.001992	-75.406703	DiveAdvisor 2014; NOAA 2014
34	*Advance II* Shipwreck	35.900283	-75.397783	DiveBuddy 2014
35	*Tenas* Shipwreck	35.081289	-75.389864	DiveAdvisor 2014; NOAA 2014
36	*Australia* Shipwreck	35.121844	-75.367086	DiveAdvisor 2014; NOAA 2014
37	*Lancing* Shipwreck	35.133511	-75.366253	DiveAdvisor 2014; NOAA 2014
38	*Ciltvaira* Shipwreck	35.400178	-75.349592	DiveAdvisor 2014; NOAA 2014
39	*H.C. Drewer* Shipwreck	35.254622	-75.338753	DiveAdvisor 2014; NOAA 2014
40	*City of Atlanta* Shipwreck	35.391289	-75.336811	DiveAdvisor 2014; NOAA 2014
41	*Norlavore* Shipwreck	35.083511	-75.332919	DiveAdvisor 2014; NOAA 2014
42	*Diamond Shoal No. 71* Shipwreck	35.080178	-75.332917	DiveAdvisor 2014; NOAA 2014
43	*British Splendour* Shipwreck	35.156844	-75.303472	DiveAdvisor 2014; NOAA 2014
44	*Empire Thrush* Shipwreck	35.196847	-75.254583	DiveAdvisor 2014; NOAA 2014
45	*Bedloe* Shipwreck	35.483514	-75.249589	OBDC 2012; NOAA 2014
46	*York* Shipwreck	36.066839	-75.227936	DiveAdvisor 2014; NOAA 2014
47	*Jackson* Shipwreck	35.8846	-75.213089	DiveBuddy 2014
48	*Merak* Shipwreck	35.228792	-75.201247	DiveAdvisor 2014; NOAA 2014
49	*Moriana 200* Shipwreck	35.441847	-75.187919	DiveAdvisor 2014; NOAA 2014
50	*Byron D. Benson* Shipwreck	36.086841	-75.143738	NOAA 2014
51	*Baurque* Shipwreck	36.300167	-75.0496	DiveAdvisor 2014; NOAA 2014
52	*Snoopy* Shipwreck	36.340317	-74.947722	DiveAdvisor 2014; NOAA 2014
53	*U-85* Shipwreck	35.822267	-74.915771	DiveBuddy 2014

Table 8. (Continued).

54	*San Delfino* Shipwreck	35.628511	-74.889856	DiveAdvisor 2014; NOAA 2014
55	*Nordhav* Shipwreck	36.500161	-74.782925	DiveAdvisor 2014; NOAA 2014
Probable Sites				
56	*Irene* Shipwreck	34.299753	-76.188394	NOAA 2014
57	*Irene* Shipwreck	34.300172	-76.182958	NOAA 2014
58	*Olympic* Shipwreck	36.016836	-75.499611	NOAA 2014
59	*Virginia* Shipwreck	35.181844	-75.352919	NOAA 2014
60	*Sea Hawk* Shipwreck	36.387608	-74.937842	NOAA 2014
Possible Sites				
61	Unidentified Obstruction	34.560611	-76.856561	NOAA 2014
62	Unidentified Obstruction	34.560656	-76.856425	NOAA 2014
63	Unidentified Obstruction	34.558547	-76.854247	NOAA 2014
64	Unidentified Obstruction	34.657817	-76.811317	NOAA 2014
65	Unidentified Obstruction	34.662389	-76.810111	NOAA 2014
66	Unidentified Obstruction	34.656778	-76.81	NOAA 2014
67	Unidentified Obstruction	34.658306	-76.809806	NOAA 2014
68	Unidentified Obstruction	34.658972	-76.809472	NOAA 2014
69	Unidentified Obstruction	34.657861	-76.80925	NOAA 2014
70	Unidentified Obstruction	34.656722	-76.808889	NOAA 2014
71	Unidentified Obstruction	34.658194	-76.8085	NOAA 2014
72	Unidentified Obstruction	34.658833	-76.808194	NOAA 2014
73	Unidentified Obstruction	34.655861	-76.808194	NOAA 2014
74	Unidentified Obstruction	34.659361	-76.808056	NOAA 2014
75	Unidentified Obstruction	34.658444	-76.807861	NOAA 2014
76	Unidentified Obstruction	34.656778	-76.807528	NOAA 2014
77	Unidentified Obstruction	34.657194	-76.80725	NOAA 2014
78	Unidentified Obstruction	34.655561	-76.807056	NOAA 2014
79	Unidentified Obstruction	34.657556	-76.806417	NOAA 2014
80	Unidentified Obstruction	34.660056	-76.8055	NOAA 2014
81	Unidentified Obstruction	34.518544	-76.754314	NOAA 2014
82	Unidentified Shipwreck	34.301833	-76.72465	NOAA 2014
83	Unidentified Shipwreck	34.514856	-76.705392	NOAA 2014
84	Unidentified Shipwreck	34.326833	-76.69965	NOAA 2014
85	Unidentified Obstruction	34.2985	-76.651314	NOAA 2014
86	Unidentified Shipwreck	34.186836	-76.601311	NOAA 2014
87	Unidentified Obstruction	34.40085	-76.594725	NOAA 2014
88	Unidentified Obstruction	34.386667	-76.548333	NOAA 2014
89	Unidentified Obstruction	34.525164	-76.511586	NOAA 2014
90	Unidentified Shipwreck	34.455167	-76.481306	NOAA 2014
91	Unidentified Shipwreck	35.845675	-75.555444	NOAA 2014
92	Unidentified Shipwreck	35.077633	-75.480853	NOAA 2014
93	Unidentified Shipwreck	35.031708	-75.478703	NOAA 2014
94	Unidentified Shipwreck	35.146844	-75.446256	NOAA 2014
95	Unidentified Shipwreck	35.078511	-75.394586	NOAA 2014
96	Unidentified Shipwreck	35.146844	-75.379586	NOAA 2014
97	Unidentified Shipwreck	35.177219	-75.358017	NOAA 2014
98	Unidentified Shipwreck	35.379075	-75.333317	NOAA 2014
99	Unidentified Shipwreck	35.170178	-75.330142	NOAA 2014
100	Unidentified Shipwreck	35.170178	-75.328753	NOAA 2014
101	Unidentified Shipwreck	35.542672	-75.237867	NOAA 2014
102	Unidentified Shipwreck	35.444836	-75.19955	NOAA 2014
103	Unidentified Shipwreck	35.225181	-75.194581	NOAA 2014
104	Unidentified Shipwreck	35.230181	-75.186247	NOAA 2014
105	Unidentified Shipwreck	35.398236	-75.115136	NOAA 2014
106	Unidentified Shipwreck	35.365375	-75.0727	NOAA 2014

Table 8. (Concluded).

107	Unidentified Shipwreck	36.192947	-75.002372	NOAA 2014
108	Unidentified Shipwreck	36.206414	-74.987028	NOAA 2014
109	Unidentified Shipwreck	36.093519	-74.926639	NOAA 2014
110	Unidentified Shipwreck	36.344969	-74.914458	NOAA 2014

northward to wetland complexes along the Atlantic coast as far as southeastern North Carolina (USFWS 2007).

Throughout its range, the wood stork is dependent upon wetlands for breeding and foraging. It has a unique feeding method and requires higher prey concentrations than other wading birds. Optimal water regimes involve periods of flooding, during which prey (fish) populations increase, alternating with dryer periods, during which receding water levels concentrate fish at higher densities coinciding with the stork's nesting season (USFWS 2014). In north and central Florida, Georgia, and South Carolina, storks lay eggs during March–late May, with fledging occurring in July and August. Nests are frequently located in the upper branches of large cypress trees or in mangroves on islands (USFWS 2014).

The wood stork likely would not be encountered because its habitat is wetlands, and land-based operational activities would not occur there.

(2) Mammals

Northern Long-eared Bat (*Myotis septentrionalis*)

In October 2013, USFWS published a proposal to list the northern long-eared bat as ***Endangered***; it is listed as ***Least Concern*** on the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the area around only 1 of the 14 nominal drill sites, near the middle of the northern line. The range of the northern long-eared bat includes much of the eastern and north central United States, and all Canadian provinces.

During winter, northern long-eared bats hibernate in caves and mines called hibernacula. During summer, they roost singly or in colonies underneath bark, in cavities, or in crevices of live or dead trees. Breeding begins in late summer or early fall, when males swarm near hibernacula. After copulation, females store sperm during hibernation; in spring, they emerge from their hibernacula, ovulate, and the stored sperm fertilizes an egg. After fertilization, pregnant females migrate to summer areas where they roost in small colonies and give birth to a single pup. Maternity colonies, with young, generally have 30–60 bats, although larger maternity colonies have been observed. Most females in a colony give birth from late May or early June to late July. Young bats start flying within 18–21 days of birth (USFWS 2013a).

The northern long-eared bat likely would not be encountered because its habitat is forest and hibernacula, and land-based operational activities would not occur there.

(3) Insects

Saint Francis' Satyr Butterfly (*Neonympha mitchellii francisci*)

Saint Francis' satyr (SFS) butterfly is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around only 2 of the 14 nominal drill sites, the sites on the southern line that are farthest inshore. There is currently only one known population of SFS butterfly, found in a range that is

~10 km x 10 km at Ft. Bragg, NC. The population consists of a number of small inactive (formerly occupied) and active sites (subpopulations), 0.2–2.0 ha in size; most active sites are found in artillery impact areas that are restricted in access (USFWS 2013b).

The distribution of SFS butterfly at the local subpopulation level is most closely tied to grassy wetlands with numerous sedges that are created and maintained through a regular disturbance regime, especially by beavers or fire. The most influential disturbances are beaver impoundments, which create inundated regions highly favorable to sedge growth. Most subpopulations are found in abandoned beaver dams or along streams with active beaver complexes. SFS cannot survive in sites that either are inundated by flooding or succeed to riparian forest. Fire may also be a type of disturbance of importance; fire resets succession, where grassy wetlands naturally succeed to shrub lands and then hardwood forest. The host plant for SFS butterfly larvae is *Carex mitchelliana*, a sedge that grows in swampy woods and wet meadows. The butterfly's adult lifespan averages 3–4 days (USFWS 2013b).

Saint Francis' satyr butterfly likely would not be encountered because its habitat is wetlands, and land-based operational activities would not occur there.

(4) Plants

Seabeach Amaranth (*Amaranthus pumilus*)

Seabeach amaranth is listed as ***Threatened*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around only 3 of the 14 nominal drill sites, areas on both lines that are closest to shore and include some coastline. It is native to the barrier island beaches of the Atlantic coast. An annual plant, to grow it appears to need extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner, allowing it to move around in the landscape, occupying suitable habitat as it becomes available. It often grows in the same areas selected for nesting by shorebirds such as plovers, terns, and skimmers (Weakley et al. 1996). Seabeach amaranth is a classic example of a fugitive species: "an inferior competitor which is always excluded locally under interspecific competition, but which persists in newly disturbed habitats by virtue of its high dispersal ability; a species of temporary habitats" (Lincoln et al. 1982 *in* Weakley et al. 1996).

Seabeach amaranth likely would not be encountered because its habitat is barrier island beaches, and land-based operational activities would not occur there.

Golden Sedge (*Carex lutea*)

Golden sedge is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around only 2 of the 14 nominal drill sites, areas on the southern line that are closest to shore. It is a perennial member of the sedge family that is endemic to Onslow and Pender Counties, NC. Eight populations are recognized made up of 17 distinct locations or element occurrences all occurring within a 26 km x 8 km area, extending southwest from the community of Maple Hill. Golden sedge generally occurs on fine sandy loam, loamy fine sands, and fine sands that are moist to saturated to periodically inundated (USFWS 2011a). Critical habitat has been designated for the golden sedge (see maps in USFWS 2011); none of those areas is in the 20 km x 20 km areas around the nominal drill sites.

Golden sedge likely would not be encountered because its habitat is wetlands, and land-based operational activities would not occur there.

Pondberry *(Lindera melissifolia*)

Pondberry is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around 5 of the 14 nominal drill sites, all on the southern line. As of 1993, there were 36 populations of pondberry distributed in Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina (LeDay et al. 1993). There are two known populations in North Carolina, one in Cumberland County and one in Sampson County (USFWS 2011b). Pondberry occurs in seasonally flooded wetlands, sandy sinks, pond margins, and swampy depressions. In the coastal sites of North and South Carolina, pondberry is associated with the margins of sinks, ponds, and depressions in the pinelands (LeDay et al. 1993).

Pondberry likely would not be encountered because its habitat is wetlands, and land-based operational activities would not occur there.

Rough-leaved Loosestrife (*Lysimachia asperulaefolia*)

Rough-leaved loosestrife is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around 5 of the 14 nominal drill sites, all on the southern line. Rough-leaved loosestrife is a rare perennial herb, endemic to the coastal plain and sandhills of North Carolina and South Carolina. North Carolina populations are known from the following counties: Bladen, Brunswick, Carteret, Cumberland, Harnett, Hoke, New Hanover, Onslow, Pamlico, Pender, Richmond and Scotland. Most of the populations are small, both in extent of area covered and in number of stems (USFWS 2011c). As of 1995 (Frantz 1995), nearly all sites were on publicly owned land, with the majority on federally owned land (e.g., 33 on military bases).

It is associated with sandy or peaty soils and moist open habitat that was more abundant prior to the development of the coastal region of the Carolinas (Frantz 1995). This species generally occurs in the ecotones or edges between longleaf pine uplands and pond pine pocosins (areas of dense shrub and vine growth usually on a wet, peaty, poorly drained soil) on moist to seasonally saturated sands and on shallow organic soils overlaying sand. Rough-leaf loosestrife has also been found on deep peat in the low shrub community of large Carolina bays (shallow, elliptical, poorly drained depressions of unknown origin). The grass-shrub ecotone, where rough-leaf loosestrife is found, is fire-maintained, as are the adjacent plant communities. Several populations are known from roadsides and power line rights of way where regular maintenance mimics fire and maintains vegetation so that herbaceous species are open to sunlight (USFWS 2011c).

Rough-leaved loosestrife could be encountered because its habitat includes roadsides, where land activities would occur.

Harperella (*Ptilimnium nodosum*)

Harperella is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the area around only 1 of the 14 nominal drill sites, the site on the southern line that is farthest inshore. Harperella is a perennial herb that typically occurs on rocky or gravel shoals and sandbars and along the margins of clear, swift-flowing stream sections. It is known from only two locations in North Carolina: one population in the Tar River in Granville County and another in the Deep River in Chatham County (USFWS 2011d).

Harperella likely would not be encountered because its habitat is riverine, and land-based operational activities would not occur in or near water.

Michaux's Sumac (*Rhus michauxii*)

Michaux's sumac is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around 3 of the 14 nominal drill sites, sites on the southern line that are farthest inshore. Michaux's sumac is endemic to the coastal plain and piedmont (the plateau region located between the coastal plain and the main Appalachian Mountains) from Virginia to Florida. Most populations are located in the North Carolina piedmont and sandhills. Currently, the plant occurs in the following counties: Cumberland, Davie, Durham, Franklin, Hoke, Moore, Nash, Richmond, Robeson, Scotland, and Wake.

Michaux's sumac grows in sandy or rocky, open woods with basic soils, apparently surviving best in areas where some form of disturbance has provided an open area. Several populations in North Carolina are on highway rights-of way, roadsides, or on the edges of artificially maintained clearings. Others are in areas with periodic fires and on sites undergoing natural succession, and one is in a natural opening on the rim of a Carolina bay (USFWS 2011e).

Michaux's sumac could be encountered because its habitat includes roadsides and the edges of artificially maintained clearings, where land-based operational activities would occur.

American Chaffseed (*Schwalbea americana*)

American chaffseed is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around 6 of the 14 nominal drill sites, sites on both northern and southern lines. American chaffseed occurs in New Jersey and from North Carolina to Florida. It is found in sandy, acidic, seasonally moist to dry soils, and "is generally found in habitats described as open, moist pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems." (USFWS 2011f). Chaffseed is dependent on factors such as fire, mowing, or fluctuating water tables to maintain open to partly-open conditions. Most surviving populations are in areas that are subject to frequent fire, including plantations where burning is part of management for quail and other game, army base impact zones that burn regularly because of artillery shelling, forest management areas burned to maintain habitat for wildlife, and private lands burned to maintain open fields (USFWS 2011f).

American chaffseed could be encountered because its habitat includes private lands burned to maintain open fields, where land-based operational activities could occur.

Cooley's Meadowrue (*Thalictrum cooleyi*)

Cooley's meadowrue is listed as ***Endangered*** under the U.S. ESA, and it has not yet been assessed for the IUCN Red List of Threatened Species (IUCN 2013). It was found in the IPAC search of the areas around only 2 of the 14 nominal drill sites, areas on the southern line that are closest to shore. Currently, Cooley's meadowrue is known from North Carolina, Georgia, and Florida. In North Carolina, populations are located in Brunswick, Columbus, Onslow, and Pender counties, including several sites protected by The Nature Conservancy and NC Division of Parks and Recreation. It occurs in grass-sedge bogs and wet pine savannahs and savannah-like areas, and can also occur along fire plow lines, in roadside ditches, woodland clearings, and powerline rights-of-way, where some type of disturbance such as fire or mowing maintains an open habitat (USFWS 2011g).

Cooley's meadowrue could be encountered because its habitat includes roadsides, where land-based operational activities would occur.

IV. ENVIRONMENTAL CONSEQUENCES

Proposed Action

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

The material in this section includes a brief summary of the anticipated 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.

This section also includes estimates of the numbers of marine mammals that could be affected by the proposed seismic surveys scheduled to occur during September–October 2014. 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} is also provided.

(a) Summary of Potential Effects of Airgun Sounds

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 project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term.

***Tolerance.*—**Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers (e.g., 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), 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 as a result of reverberation at ranges of 50 km from the seismic source. Based on measurements in deep water of the Southern Ocean, Gedamke (2011) estimated that the slight elevation of background levels during intervals between pulses reduced blue and fin whale communication space by as much as 36–51% when a seismic survey was operating 450–2800 km away. Based on preliminary modeling, Wittekind et al. (2013) reported that airgun sounds could reduce the communication range of blue and fin whales 2000 km from the seismic source. Klinck et al. (2012) also found reverberation effects between airgun pulses. Nieukirk et al. (2012) and Blackwell et al. (2013) noted the potential for masking effects from seismic surveys on large whales.

Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses (e.g., Cerchio et al. 2010; Nieukirk et al. 2012). 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 that 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 faecal hormone metabolites decreased in North Atlantic right whales with a 6-dB decrease in underwater noise from vessels. Wright et al. (2011) also reported that sound could be a potential source of stress for marine mammals.

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

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

A multivariate analysis of factors affecting the distribution of calling bowhead whales during their fall migration in 2009 noted that the southern edge of the distribution of calling whales was significantly closer to shore with increasing levels of airgun sound from a seismic survey a few hundred kilometers to the east of the study area (i.e., behind the westward-migrating whales; McDonald et al. 2010, 2011). It was not known whether this statistical effect represented a stronger tendency for quieting of the whales farther offshore in deeper water upon exposure to airgun sound, or an actual inshore displacement of whales.

Reactions of migrating and feeding (but not wintering) *gray whales* to seismic surveys have been studied. Off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 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 versus without airgun sounds (Castellote et al. 2012).

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

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year, and bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years.

Toothed Whales

Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal observers on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (e.g., Stone and Tasker 2006; Moulton and Holst 2010; Barry et al. 2012). In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance.

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

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

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

Most studies of *sperm whales* exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses; in most cases the whales do not show strong avoidance (e.g., Stone and Tasker 2006; Moulton and Holst 2010), but foraging behavior can be altered upon exposure to airgun sound (e.g., Miller et al. 2009). There are almost no specific data on the behavioral reactions of *beaked whales* to seismic surveys. Most beaked whales tend to avoid approaching vessels of other types (e.g., Würsig et al. 1998) and/or change their behavior in response to sounds from vessels (e.g., 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 $\mu Pa^2 \cdot s$); however, animals returned to the area within a few hours. The apparent tendency for greater responsiveness in the harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson et al. 1995; Southall et al. 2007).

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

Sea Turtles

The limited available data indicate that sea turtles will hear airgun sounds and sometimes exhibit localized avoidance (see PEIS, § 3.4.4.3). 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 are likely to have the greatest impact. 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 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, although there is recent evidence that auditory effects in a given animal are not a simple function of received acoustic energy. Frequency, duration of the exposure, and occurrence of gaps within the exposure can also influence the auditory effect (Finneran and Schlundt 2010, 2011; Finneran et al. 2010a,b; Finneran 2012; Ketten 2012; Finneran and Schlundt 2011, 2013; Kastelein et al. 2013a).

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

Recent data have shown that the SEL required for TTS onset to occur increases with intermittent exposures, with some auditory recovery during silent periods between signals (Finneran et al. 2010b; Finneran and Schlundt 2011). Schlundt et al. (2013) reported that the potential for seismic surveys using airguns to cause auditory effects on dolphins could be lower than previously thought. Based on behavioral tests, Finneran et al. (2011) and Schlundt et al. (2013) reported no measurable TTS in bottlenose dolphins after exposure to 10 impulses from a seismic airgun with a cumulative SEL of ~195 dB re 1 $\mu Pa^2 \cdot s$; 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). Popov et al. (2013b) also reported that TTS produced by exposure to a fatiguing noise was larger during the first session (or naïve subject state) with a beluga whale than TTS that resulted from the same sound in subsequent sessions (experienced subject state). Therefore, Supin et al. (2013) reported that SEL may not be a valid metric for examining fatiguing sounds on beluga whales. Similarly, Nachtigall and Supin (2013) reported that false killer whales are able to change their hearing sensation levels when exposed to loud sounds, such as warning signals or echolocation sounds.

It is inappropriate to assume that onset of TTS occurs at similar received levels in all cetaceans (*cf.* Southall et al. 2007). Some cetaceans could incur TTS at lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin. Based on the best available information, Southall et al. (2007) recommended a TTS threshold for exposure to single or multiple pulses of 183 dB re 1 $\mu Pa^2 \cdot s$. Tougaard et al. (2013) proposed a TTS criterion of 165 dB re 1 $\mu Pa^2 \cdot s$ for porpoises based on data from two recent studies. Gedamke et al. (2011), based on preliminary simulation modeling that attempted to allow for various uncertainties in assumptions and variability around population means, suggested that some baleen whales whose closest point of approach to a seismic vessel is 1 km or more could experience TTS.

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al. 1995, p. 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. At the time of preparation of this Draft EA, the date of release of the final guidelines and how they would be implemented are unknown.

Nowacek et al. (2013) concluded that current scientific data indicate that seismic airguns have a low probability of directly harming marine life, except at close range. Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see § 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 may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong transient sounds.

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

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

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.

The PSVOs 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, Knudsen Chirp 3260 SBP, and Teledyne OS75 75-kHz ADCP would be operated from the source vessel during the proposed survey. Information about this equipment was provided in § 2.2.3.1 of the PEIS (MBES, SBP) or § II of this Draft EA (ADCP). A review of the anticipated potential effects (or lack thereof) of MBESs, SBPs, and pingers on marine mammals and sea turtles appears in § 3.4.4.3, § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.

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

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

Despite the aforementioned information that has recently become available, this Draft EA is in agreement with the assessment presented in § 3.4.7, 3.6.7, and 3.7.7 of the PEIS that operation of MBESs, SBPs, and pingers is not likely to impact mysticetes or odontocetes 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 the proposed 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.

Entanglement of sea turtles in seismic gear is also a concern; whereas 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 then 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 that was the only case of sea turtle entanglement in seismic gear for the *Langseth*, which has been conducting seismic surveys since 2008, or for its predecessor, R/V *Maurice Ewing*, during 2003–2007. Towing the hydrophone streamer or other equipment during the proposed survey is not expected to significantly interfere with sea turtle movements, including migration.

(d) Mitigation Measures

Several mitigation measures are built into the proposed seismic survey as an integral part of the planned activities. 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 during the day and at night; 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 airgun array, because of its design, directs the majority of the energy downward, and less energy laterally, is also 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 activities without mitigation, as the mitigation (and associated monitoring) measures are a basic part of the activities, and would be implemented under the Proposed Action or Alternative Action.

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

All anticipated 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 ~6350 km of seismic surveys off Cape Hatteras. 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 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-SEFSC and NMFS-NEFC vessel-based and aerial surveys conducted between 1998 and 2005; most (seven) surveys that included the proposed survey area were conducted in summer (between June and August), one vessel-based survey extended to the end of September, and one vessel-based and two aerial surveys were conducted in winter–spring (between January and April). Density estimates were derived using density surface modelling 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 polygons for the survey area separated into three depth strata (<100 m, 100–1000 m, and >1000 m) for the 20 cetacean species in the model. The GIS provides minimum, mean, and maximum estimates for four seasons, and we used the mean estimates for fall. Mean densities were used because the minimum and maximum estimates are for points within the polygons, whereas the mean estimate is for the entire polygons.

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 9 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 9.

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

TABLE 9. Densities and estimates of the possible numbers of individuals that could be exposed to ≥160 dB re 1 μPa$_{rms}$ during L-DEO's proposed seismic survey in the Atlantic Ocean off Cape Hatteras during September–October 2014. The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in^3 or an 18-airgun array with a total discharge volume of ~3300 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.

	Reported density[1] (#/1000 km^2) in depth range (m)			Ensonified area (1000 km^2) in depth range (m)			Calculated Take[2] in depth range (m)				% Regional pop'n[3]	Requested Level B Take Authorization
Species	<100	100-1000	>1000	<100	100-1000	>1000	<100	100-1000	>1000	All		
Mysticetes												
North Atlantic right whale	*0*	*0*	*0*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*0*	***0***
Humpback whale	*0.73*	*0.56*	*1.06*	*15.17*	*6.65*	*42.90*	*11*	*4*	*46*	*60*	*0.52*	***60***
Minke whale	0.03	0.02	0.04	*15.17*	*6.65*	*42.90*	0	0	2	2	0.01	**2**
Sei whale	*0*	*0*	*0*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*0*	***0***
Fin whale	*<0.01*	*0.01*	*0.01*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*<0.01*	***1***
Blue whale	*0*	*0*	*0*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*0*	***1***
Odontocetes												
Sperm whale	*0.03*	*0.68*	*3.23*	*15.17*	*6.65*	*42.90*	*1*	*4*	*139*	*144*	*1.09*	***144***
Pygmy/dwarf sperm whale	0.64	0.49	0.93	*15.17*	*6.65*	*42.90*	10	3	40	53	1.39	**53**
Beaked whales[4]	0.01	0.14	0.58	*15.17*	*6.65*	*42.90*	0	1	25	26	0.19	**26**
Rough-toothed dolphin	0.30	0.23	0.44	*15.17*	*6.65*	*42.90*	5	2	19	25	9.23	**25**
Bottlenose dolphin	70.4	331.0	49.4	*15.17*	*6.65*	*42.90*	1068	2200	2120	5388	6.21	**5388**
Pantropical spotted dolphin	14.0	10.7	20.4	*15.17*	*6.65*	*42.90*	213	71	874	1158	34.74	**1158**
Atlantic spotted dolphin	216.5	99.7	77.4	*15.17*	*6.65*	*42.90*	3285	663	3322	7270	16.26	**7270**
Spinner dolphin[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Striped dolphin	0	0.4	3.53	*15.17*	*6.65*	*42.90*	0	2	151	154	0.28	**154**
Clymene dolphin	6.70	5.12	9.73	*15.17*	*6.65*	*42.90*	102	34	418	553	N/A	**553**
Common dolphin	5.8	138.7	26.4	*15.17*	*6.65*	*42.90*	88	922	1132	2142	1.23	**2142**
Atlantic white-sided dolphin	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Fraser's dolphin[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Risso's dolphin	1.18	4.28	2.15	*15.17*	*6.65*	*42.90*	18	28	92	139	0.76	**139**
Melon-headed whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Pygmy killer whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
False killer whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Killer whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Pilot whale	3.74	58.9	19.1	*15.17*	*6.65*	*42.90*	57	392	820	1268	0.16	**1268**
Harbor porpoise	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**

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

[2] Calculated take is reported density multiplied by the 160-dB ensonified area (including the 25% contingency); calculated take for the fin whale was 0.49 so requested take is 1.

[3] 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), SAR population estimates were used. This results in overestimates, particularly for the pantropical and Atlantic spotted dolphins, as SAR estimates are based on surveys only in U.S. waters rather than in their full ranges. N/A means not available

[4] May include Cuvier's, True's, Gervais', or Blainville's beaked whales

[5] Atlantic waters not included in the SERDP model of Read et al. (2009), only Gulf of Mexico

the shut down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 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.

Consideration should be given to the hypothesis that delphinids are less responsive to airgun sounds than are mysticetes, as referenced in both the PEIS and "Summary of Potential Airgun Effects" of this document. The 160-dB (rms) criterion currently applied by NMFS, on which the following estimates are based, was developed based primarily on data from gray and bowhead whales. The estimates of "takes by harassment" of delphinids given below are thus considered precautionary. 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 Draft 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 2013d). 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 2013d).

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 widely spaced relative to the 160-dB distance. Thus, the area including overlap is 1.79 times the area excluding overlap, so a marine mammal that stayed in the survey area during the entire survey could be exposed slightly less than twice, 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 anticipated area to be ensonified to that level during airgun operations excluding overlap. The area expected to be ensonified was determined by entering the planned survey lines into a MapInfo GIS, using the GIS to identify the relevant areas by "drawing" the applicable 160-dB buffer (see Table 1) around each seismic line, and then calculating the total area within the buffers.

Applying the approach described above, ~51,775 km^2 (~64,720 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 in response to increasing sound levels before the levels reach 160 dB as the *Langseth* approaches. 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 18,382 (Table 9). That total includes 204 cetaceans listed as ***Endangered*** under the ESA, including 60 humpback whales (0.52% of the regional population) and 144 sperm whales (1.09%). It also includes 26 beaked whales (0.19%), probably mostly Cuvier's whale. Most (98.5%) of the cetaceans potentially exposed are delphinids; the Atlantic spotted dolphin, bottlenose dolphin, short-beaked common dolphin, short- and long-finned pilot whales, and pantropical spotted dolphin are estimated to be the most common delphinid species in the area, with estimates of 7270 (16.26% of the regional population), 5388 (6.21%), 2142 (1.23%), 1268 (0.16%), and 1158 (34.74%) exposed to ≥160 dB re 1 μPa_{rms}, respectively. All percentage estimates for delphinids except for the pilot whales are very likely overestimates, in some cases considerable overestimates, because the population sizes are very likely underestimates. This is because there are no truly regional population size estimates (e.g., for the northwest Atlantic) for most delphinids, most of which are at least partly pelagic; rather, the population sizes are based on surveys in U.S. waters, which represent only a small fraction of northwest Atlantic waters.

(f) Conclusions for Marine Mammals and Sea Turtles

The proposed seismic project would involve towing a 36-airgun array with a total discharge volume of 6600 in^3 or an 18-airgun array with a total discharge volume of 3300 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, and that Level A effects were highly unlikely. 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 EA, 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". For most species predicted to be exposed to sound levels sufficient to cause appreciable disturbance, including all ESA listed species, the estimated numbers of animals potentially exposed are low percentages of the regional population sizes (Table 9). For some delphinid species, the estimated numbers potentially exposed are higher percentages of the populations in the NMFS SARs; as discussed above, we believe that those percentages are overestimates because the "regional" population sizes—in fact, the estimated population sizes in U.S. waters—underestimate true regional population sizes, in some cases considerably. The estimates of exposures are also 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 anticipated from the proposed activities.

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 monitoring and mitigation measures, no significant impacts on sea turtles would be anticipated.

(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 Fish and Invertebrates

Morley et al. (2013) considered invertebrates important when examining the impacts of anthropogenic noise. Although their review focused on terrestrial invertebrates, they noted that invertebrates, because of their short life cycle, can provide model systems for evaluating the effects of noise on individual fitness and physiology, thereby providing data that can be used to draw stronger, ecologically valid conclusions.

Solé et al. (2013) exposed four cephalopod species to low-frequency sound (50–400 Hz sweeps) 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 the shore crab *Carcinus maenas* was initially exposed to ship-noise playbacks, it consumed more oxygen, indicating a higher metabolic rate and potentially more stress; however, there were no changes in physiological responses to repeated exposure (Wale et al. 2013). Heavier crabs were more responsive than lighter crab (Wale et al. 2013). Celi et al. (2013) exposed red swamp crayfish (*Procambarus clarkia*) to linear sweeps with a frequency range of 0.1 to 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.

Fewtrell and McCauley (2012) exposed squid (*Sepioteuthis australis*), 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 squid and fish at SELs >147–151 dB re 1 $\mu Pa^2 \cdot s$; the fish swam faster and formed more cohesive groups in response to the airgun sounds, and squid were seen to discharge ink or change their swimming pattern or vertical position in the water column.

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. This study contrasts the findings of Løkkeborg et al. (2012). Study results 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, while longline catches decreased overall (Løkkeborg et al. 2012).

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 prior to 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, which reduced the impacts of seismic sounds on the fish communities by exposing them to relatively low SELs (<187 dB re 1 $\mu Pa^2 \cdot s$).

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 $\mu Pa^2 \cdot s$.

(b) 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. 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.

(c) 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. Most commercial and recreational fishing off Virginia and North Carolina occurs in State waters (within 5.6 km from shore), whereas the proposed survey is not in State waters, so interactions between the proposed survey and the fisheries would be relatively limited. Two possible conflicts are the *Langseth*'s streamer entangling with fixed fishing gear and displacement of fishers from the survey area. If fishing activities were occurring within the survey area, 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 during the survey and publication of a Notice to Mariners about operations in the area. A chase boat would also be employed to assist the *Langseth* by identifying, locating, and/or removing obstacles as required.

Ninety-four OBS instruments would be deployed during the 2-D survey. All OBSs would be recovered after the proposed survey. The OBS anchors either are 23-kg pieces of hot-rolled steel that have a footprint of 0.3×0.4 m or 36-kg iron grates with a footprint of 0.9×0.9 m. OBS anchors would be left behind upon equipment recovery. Although OBS placement would disrupt a very small area of seafloor habitat and could disturb benthic invertebrates, the impacts are expected to be localized and transitory. Only three OBSs would be deployed in HAPC in the survey area (Fig. 1, HAPC #1 and possibly #5 and #10).

Given the proposed activities, no significant impacts on marine invertebrates, marine fish, their EFH or HAPC, and their fisheries would be anticipated.

(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 activities, no significant impacts on seabirds would be anticipated. Terrestrial activities would not affect seabirds because the only activities within 2 km of the coast would only involve burying passive seismometers.

(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 activities 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. Thus, 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 significant indirect impacts on marine mammals or seabirds would be anticipated.

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

No significant impacts on dive sites, including shipwrecks, would be anticipated. Airgun sounds would have no effects on solid structures, and the *Endeavor* would avoid deploying OBSs on any wrecks along the survey track lines. 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 during the survey within 25 km of the track lines would be contacted directly. Only a small percentage of the recreational dive sites (wrecks in water depths <100 m) are within 25 km of the survey track lines.

(6) Direct Effects on Terrestrial Species and Their Significance

Effects of the terrestrial component of the project would be very limited because of the nature of the activities. Small, passive Reftek seismometers would be placed at or just under the soil surface along two 200-km SE-NW transects, primarily beside state roads. Trillium sensors deployed at coastal sites would be buried in three coastal communities, well above the high-tide line and not on the beach. No impact to the environment would be expected from this activity. The active source component would be limited to 14 small detonations along the 200-km transects in pre-disturbed areas with easy access, such as along the edges of agricultural fields and along logging roads, buried ~25 m deep and sealed over the upper 15 m. Because the holes would be sealed, negligible impact to the environment would be expected from the detonations.

No activities would occur in any protected lands, preserves, sanctuaries, or Critical Habitat for ESA-listed species. All required permits and licenses required for the activities would be obtained. Many of the ESA-listed species that were identified using IPAC in the general areas (20 km x 20 km) around the nominal drill sites would not be encountered because their habitat is not conducive to the methods required to do the work. For example, the large drill rig and water truck cannot operate in wetlands or forests; see further in § II(2)(f). Some of the ESA-listed plant species could occur at potential drill sites (e.g., along road sides), and they would be avoided by inspection, identification, and locating the actual (vs. nominal) drill sites away from them. Detailed information on the listed species given in § III is summarized below.

ESA-listed species that would not be encountered because of their habitat are as follows:

- The red-cockaded woodpecker, found in the IPAC search of the areas around most of the 14 nominal drill sites, inhabits fire-sustained open pine forest, nesting in cavities of living old-growth (100+ years) trees;
- The wood stork, found in the areas around only 2 of the 14 nominal drill sites, is dependent on wetlands for breeding and foraging, and nests are frequently located in the upper branches of large cypress trees or in mangroves on islands;
- The northern long-eared bat, found in the area around only 1 of the 14 nominal drill sites, roosts underneath bark, in cavities, or in crevices of live or dead trees in summer. Breeding begins in late summer or early fall near the caves and mines where they hibernate for the winter;
- Saint Francis' satyr butterfly, found in the areas around only 2 of the 14 nominal drill sites, is found only in a range that is ~10 km x 10 km at Ft. Bragg, NC. Its distribution is closely tied to grassy wetlands with numerous sedges that are created and maintained through a regular disturbance regime, especially by beavers or fire; most subpopulations are found in abandoned beaver dams or along streams with active beaver complexes;
- Seabeach amaranth, found in the areas around 3 of the 14 nominal drill sites (all near the coast), is native to the barrier island beaches of the Atlantic coast;
- Golden sedge, found in the areas around only 2 of the 14 nominal drill sites (both near the coast), found only within an area 26 km x 8 km, generally occurs on sandy ground that is moist to saturated to periodically inundated;
- Pondberry, found in the areas around 5 of the 14 nominal drill sites, occurs in seasonally flooded wetlands, sandy sinks, pond margins, and swampy depressions; and
- Harperella, found in the area around only 1 of the 14 nominal drill sites, typically occurs on rocky or gravel shoals and sandbars and along the margins of clear, swift-flowing stream sections.

ESA listed species that could be encountered are as follows:

- Rough-leaved loosestrife, found in the areas around 5 of the 14 nominal drill sites, is found in grass-shrub areas that are fire-maintained, and on roadsides and powerline rights-of-way where regular maintenance mimics fire and maintains vegetation so that herbaceous species are open to sunlight;

- Michaux's sumac, found in the areas around 3 of the 14 nominal drill sites, grows in sandy or rocky, open woods with basic soils, apparently surviving best in areas where some form of disturbance has provided an open area, including highway rights-of-way, roadsides, or on the edges of artificially maintained clearings;
- American chaffseed, found in the areas around 6 of the 14 nominal drill sites, is dependent on factors such as fire, mowing, or fluctuating water tables to maintain open to partly-open conditions; most surviving populations are in areas that are subject to frequent fire, including plantations, army base impact zones, forest management areas, and private lands burned to maintain open fields; and
- Cooley's meadowrue, found in the areas around only 2 of the 14 nominal drill sites, occurs in grass-sedge bogs and wet pine savannahs and savannah-like areas, and can also occur along fire plow lines, in roadside ditches, woodland clearings, and powerline rights-of-way.

As noted above, these four species of vegetation would be avoided during the site selection stage of the activities in the areas where they could be found by inspection and identification, and protected by locating the actual (vs. nominal) drill sites away from them.

No significant indirect impacts on terrestrial species would be anticipated.

(7) 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).

(a) Past and future research activities in the area

There are many seismic data sets available for the continental shelf and slope of the eastern U.S. However, the quality of those data is not sufficient to meet the goals of the proposed project. The *Langseth* (or equivalent academic research vessel) has not acquired seismic data in this study area in the recent past.

In 2014, the *Langseth* may also support an NSF-proposed 3-D seismic survey off the coast of New Jersey to study the sea-level changes. That cruise would last ~36 days in June–July and cover ~4900 km of track lines. Additionally, the *Langseth* may conduct 2-D seismic surveys for ~3 weeks in August 2014, covering ~3175 km of track lines, and in a future year (3 weeks, ~3125 km of track lines) for the USGS in support of the delineation of the U.S. Extended Continental Shelf (ECS) along the east coast (Fig. 7). EAs are being prepared for both of those activities, and neither of those project survey tracklines are anticipated to overlap with the proposed survey tracklines.

Other scientific research activities may be conducted in this region in the future; however, aside from those noted here, no other marine geophysical surveys are currently proposed in the region using the *Langseth* in the foreseeable future. At the present time, the proponents of the survey are not aware of other similar marine research activities planned to occur in the proposed survey area during the September–October 2014 timeframe, but research activities planned by other entities are possible, although unlikely.

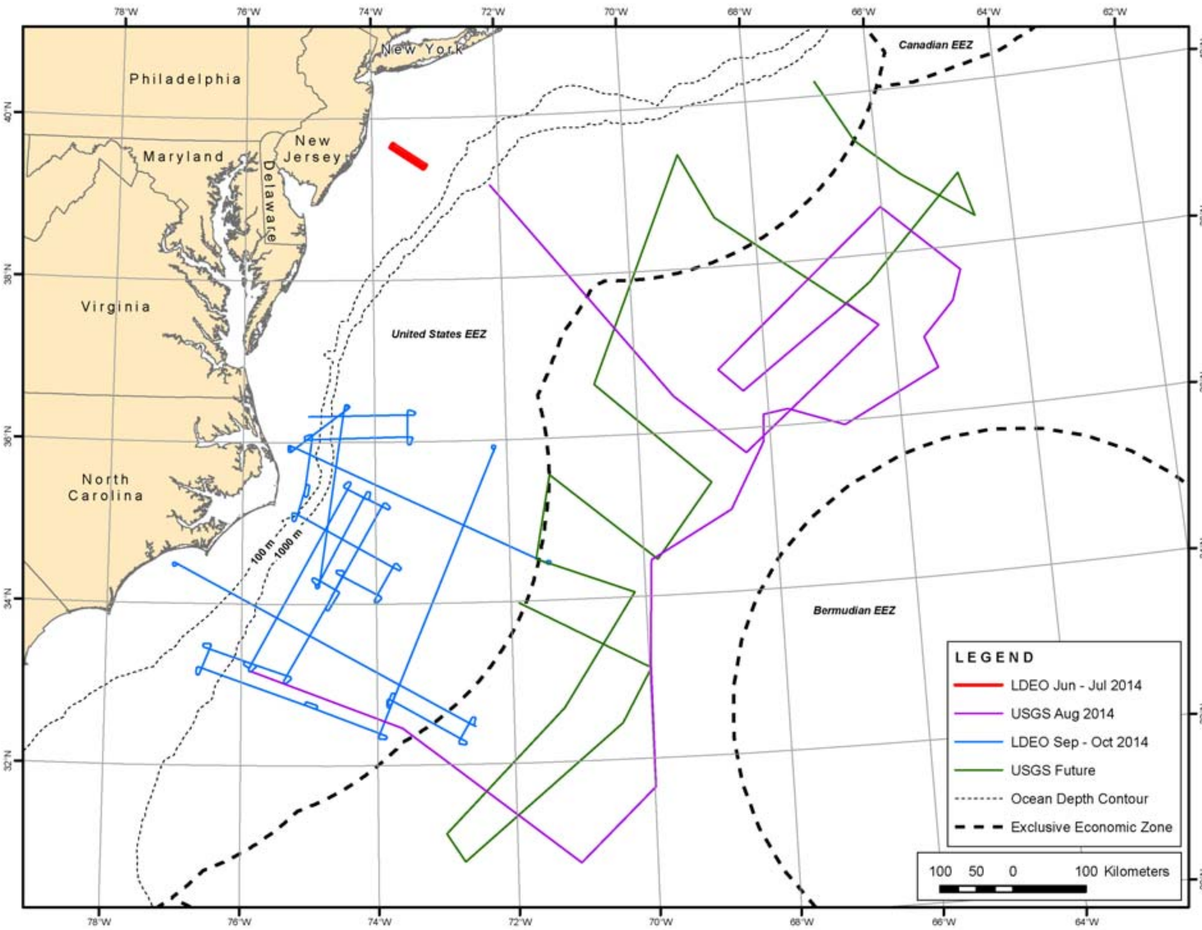

FIGURE 7. Locations of known proposed research activities off the U.S. east coast.

(b) Vessel traffic

Based on data available through the Automated Mutual-Assistance Vessel Rescue (AMVER) system managed by the U.S. Coast Guard, over 50 commercial vessels per month travelled through the proposed survey area during the months of September and October from 2008 to 2013, and for each month in 2012 and 2013 (2013 data are available for January–June) (USCG 2013).

Live vessel traffic information is available from MarineTraffic (2013), including vessel names, types, flags, positions, and destinations. Various types of vessels were in the general vicinity of the proposed survey area when MarineTraffic (2013) was accessed on 16 and 28 October 2013, including fishing vessels (2), pleasure craft/sailing vessels (78), tug/towing/pilot/port tender vessels (73), cargo vessels (41), chemical tanker (1), oil products tanker (1), tanker (1), research/survey vessel (1), military operations vessels (8), medical transport vessel (1), law enforcement vessel (1), coast guard vessel (1), search and rescue vessels (3), passenger vessels (5), survey/support vessels (4), and dredger vessels (4). With the exception of cargo vessels, the majority of vessels were U.S.A.-flagged.

The total transit distance (~10,000 km) by the *Langseth* and the *Endeavor* would be minimal relative to total transit length for vessels operating in the proposed survey area during September and October. Thus, the projected increases in vessel traffic attributable to implementation of the proposed activities 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 2013d). 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 2013d). During that mortality event, fungal, bacterial, and mixed bacterial and fungal pneumonias were common in the lungs of 79 dolphins that were examined, and the frequent occurrence 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." She 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.

(d) Fisheries

The commercial and recreational fisheries in the general area of the proposed survey are described in § III. 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 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 Virginia Capes Operating Area (VACAPES OPAREA) and Cherry Point Operating Area (CHPT OPAREA). The Virginia Capes, Cherry Point, and Charleston/Jacksonville OPAREAs are collectively referred to as the Southeast OPAREA. The VACAPES OPAREA is located in the coastal and offshore waters off Delaware, Maryland, Virginia, and North Carolina, from the entrance to Chesapeake Bay south to just north of Cape Hatteras. The CHPT OPAREA is located in the coastal and offshore waters off North Carolina from just north of Cape Hatteras south to its southeast corner 210 southeast of Cape Fear at 32.1°N. The types of activities that could occur in the OPAREAs include aircraft carrier, ship and submarine operations; anti-air and surface gunnery, missile firing, anti-submarine warfare, mine warfare, and amphibious operations; all weather flight training, air warfare, refueling, UAV flights, rocket and missile firing, and bombing exercises; and fleet training and independent unit training. L-DEO and NSF are coordinating, and would continue to coordinate, with the U.S. Navy to ensure there would be no conflicts.

(f) Oil and Gas Activities

The proposed survey site is within BOEM's Outer Continental Shelf (OCS) Mid-Atlantic and South Atlantic Planning Areas for proposed geological and geophysical (G&G) activities, for which a Draft PEIS was published in March 2012 (BOEM 2012). BOEM's intention is to authorize G&G activities in support of all three BOEM program areas: oil and gas exploration and development, renewable energy, and marine minerals. The Draft PEIS characterizes potential future G&G activities in Federal and State waters on the Atlantic OCS during 2012–2020. The activities include

- "various types of deep penetration seismic surveys used almost exclusively for oil and gas exploration and development;
- other types of surveys and sampling activities used only in support of oil and gas exploration and development, including electromagnetic surveys, deep stratigraphic and shallow test drilling, and various remote sensing methods;
- high-resolution geophysical (HRG) surveys used in all three program areas to detect geohazards, archaeological resources, and certain types of benthic communities; and
- geological and geotechnical bottom sampling used in all three program areas to assess the suitability of seafloor sediments for supporting structures (e.g., platforms, pipelines, cables, wind turbines) or to evaluate the quantity and quality of sand for beach nourishment projects."

BOEM activities were not anticipated to occur prior to 2017. Additionally, until the conclusion of the BOEM NEPA process and associated federal consultations, no oil and gas activities are anticipated in the survey region.

(8) Unavoidable Impacts

Unavoidable impacts to the species of marine mammals and turtles 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, is a temporary phenomenon that does not involve injury, and is 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 or turtles, or on the populations to which they belong. Effects on recruitment or survival would be expected to be (at most) negligible.

(9) Coordination with Other Agencies and Processes

This Draft EA was prepared by LGL on behalf of L-DEO and NSF pursuant to NEPA and EO 12114. Potential impacts to endangered species and critical habitat have also been assessed in the document; therefore, it will be used to support the ESA Section 7 consultation process with NMFS and USFWS. This document will also be used as supporting documentation for an IHA application submitted by L-DEO to NMFS, under the U.S. MMPA, for "taking by harassment" (disturbance) of small numbers of marine mammals, for this proposed seismic project. One land-based shotpoint site may be coordinated with the U.S. Marine Corps to occur within Marine Corps Base Camp Lejeune.

L-DEO and NSF have coordinated, and would continue to coordinate, with other applicable Federal agencies as required, and would comply with their requirements.

Alternative Action: Another Time

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 (~38 days in September–October) are the dates when the personnel and equipment essential to meet the overall project objectives are available.

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, such as the North Atlantic right whale and other baleen whales, would be expected to be farther north at the time of the survey, so the survey timing would be beneficial for those species (see § III, above).

No Action Alternative

An alternative to conducting the proposed activities 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 understanding how the continental crust stretched and separated during the opening of the Atlantic Ocean, and what the role of magmatism was during continental breakup, would also be lost and greater understanding of Earth processes would not be gained. The no Action Alternative would not meet the purpose and need for the proposed activities.

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