National Science Foundation
Geosciences Directorate
Division of Ocean Sciences
Arlington, Virginia

FINDING OF NO SIGNIFICANT IMPACT (FONSI) PURSUANT TO THE NATIONAL ENVIRONMENTAL POLICY ACT (NEPA), 42 U.S.C. 4321, *et seq.* and DECISION DOCUMENT

Marine Seismic Survey in the Atlantic Ocean off of Cape Hatteras, 2014

OCE 1348454
Principal Investigators/Institution: Harm Van Avendonk, G. Christeson (Co-PI), University of Texas Institute for Geophysics

Project Title: Collaborative Research: A community seismic experiment targeting the pre-, syn-, and post-rift evolution of the Mid Atlantic U.S. margin

COLLABORATIVE PROPOSALS:

OCE 1348228
Principal Investigators/Institution: B. Dugan, Rice University

OCE 1348124
Principal Investigators/Institution: B. Magnani; M. Hornbach, Southern Methodist University

OCE 1347024
Principal Investigators/Institution: S. Harder, University of Texas – El Paso

OCE 1348342
Principal Investigators/Institution: D. Lizarralde, Woods Hole Oceanographic Institution

OCE 1347498
Principal Investigators/Institution: D. Shillington, A. Becel, Columbia University Lamont-Doherty Earth Observatory

A Final Environmental Assessment (Final EA) was prepared pursuant to the National Environmental Policy Act, 42 U.S.C. 4321, *et seq.* and Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions" (EO 12114) for a collaborative research proposal received by the National Science Foundation (NSF) entitled, "A community seismic experiment targeting the pre-, syn-, and post-rift evolution of the Mid Atlantic U.S. margin." The collaborative research proposal includes land based activities and a marine seismic survey proposed to be conducted on board the research vessel *Marcus G. Langseth* (R/V *Langseth*) in the Atlantic Ocean off of Cape Hatteras (herein referred to as the "project" or "proposed activities"). Another component of the collaborative research proposal was determined to have independent utility and was analyzed separately for environmental compliance and is not discussed further herein, although it is considered in the Cumulative Effects section of the Final EA. Dr. Harm Van Avendonk is the scientific lead for the proposed project, making University of Texas Institute for Geophysics the lead institution. Collaborators on the proposed project with Dr. Van Avendonk include: B. Dugan, Rice University; B. Magnani and M. Hornbach, Southern Methodist University; S. Harder, University of Texas – El Paso; D. Lizarralde, Woods Hole Oceanographic Institution; and, D. Shillington, Columbia University Lamont-Doherty Earth Observatory (LDEO).

The Final EA entitled, "Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September-October 2014" (Report # TA8350-1) (Attachment 1), was prepared by LGL Limited environmental research associates (LGL) on behalf of NSF and analyzed the potential impacts of the proposed activities on the human and natural environment, including a marine geophysical survey. The Final EA tiers to the Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey (June 2011) and the Record of Decision (June 2012) (jointly referred to as PEIS). The conclusions from the Final EA were consistent with the conclusions of the PEIS and were used to inform the Division of Ocean Sciences (OCE) management of potential environmental impacts of the proposed activities. OCE has reviewed and concurs with the Final EA findings. The Final EA is incorporated into this Finding of No Significant Impact (FONSI) by reference as if fully set forth herein.

Public Involvement and Coordination with Other Agencies and Processes

NSF posted a Draft Environmental Assessment (Draft EA) on the NSF website for a 30 day public comment period, but received no direct public comments during the open comment period. As the Draft EA included information regarding marine mammals and threatened and endangered species in the proposed survey area, it was used for consultations with other regulatory agencies. Additionally, when preparing the Final EA, NSF took into consideration public comments (Attachment 1, Appendix F) received by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) during a 30 day public comment period for the Incidental Harassment Authorization (IHA) process and public comments received during the Coastal Zone Management Act (CZMA) process. During MMPA and ESA consultations with NMFS, technical revisions were made to proposed survey track lines, reductions in energy source levels on certain track lines (multichannel seismic (MCS) lines, Figure 1, Attachment 1), and take estimates; these changes were reflected in the Final EA. Additionally, after consideration of public comments received during the NMFS IHA and CZMA public comment periods, updates to information were made in the NSF Final EA, such as more detail on alternative survey timing and other research activities within the proposed survey area and additional material was included, such as on artificial reef sites. The new information included in the NSF Final EA, however, did not alter the overall conclusions of the Draft EA and remained consistent with the PEIS.

Endangered Species Act (ESA)
NSF engaged in formal consultation with NMFS and informal consultation with U.S. Fish and Wildlife Service (USFWS), pursuant to Section 7 of the Endangered Species Act (ESA). NSF received concurrence with USFWS that the proposed activities "may affect" but "are not likely to adversely affect" species under their jurisdiction (Attachment 1, Appendix E). NSF met every two weeks with NMFS and sometimes more frequently during the Section 7 consultation process. NMFS issued a Biological Opinion and an Incidental Take Statement for the proposed activities and consultation was concluded (Attachment 1, Appendix B).

Marine Mammal Protection Act (MMPA)
Columbia University's Lamont-Doherty Earth Observatory (LDEO) submitted to NMFS an IHA application pursuant to the Marine Mammal Protection Act (MMPA). NSF communicated regularly (often several times per week) by phone and email with NMFS as part of the consultation. As noted above, public comments were received by NMFS on the Notice of Intent to Issue an IHA (Attachment 1, Appendix F). NMFS will respond to the public comments in a Notice in the Federal Register. NMFS issued an IHA on September 12, 2014 (Attachment 1, Appendix A). The IHA includes a description of the required monitoring and mitigation measures which would serve as conditions for conducting the proposed seismic surveys.

NMFS Marine Mammal Stranding Program
Although marine mammal strandings are not anticipated as a result of the proposed activities, during ESA Section 7 and MMPA consultation with NMFS it was recommended that the NMFS Regional Marine Mammal Response Coordinator be contacted regarding the proposed activity. Both NMFS and NSF made contact with the NMFS headquarters Stranding Coordinator and Southeast Fisheries Science Center Marine Mammal Response Coordinator. Per the IHA, should any marine mammal strandings occur during the survey, NMFS, NMFS Greater Atlantic Region Marine Mammal Stranding Network and NMFS Southeast Region Marine Mammal Stranding Network would be contacted.

NOAA Office of National Marine Sanctuaries (ONMS)
The Monitor National Marine Sanctuary (MNMS) would be located outside of the survey area, with a closest approach of ~24km. In accordance with the National Marine Sanctuary Act (NMSA) Section 304(d), a federal agency is expected to consult with a Sanctuary if the proposed agency action is, "*likely to destroy, cause the loss of, or injure a sanctuary resource.*" Based on the proposed activities, the information and analysis in Attachment 1 Chapters III and IV, the distance of the survey to the sanctuary, and amount of time the vessel would be at its closest points to the sanctuary, NSF would not anticipate injury to any sanctuary resources. NSF contacted ONMS and MNMS staff about the project. ONMS staff confirmed that unless the proposed federal activities were anticipated to cause the destruction, loss, or injury to sanctuary resources, consultation for the proposed activities was not necessary.

Magnuson-Stevens Fishery Conservation and Management Act - Essential Fish Habitat (EFH)
The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires that a Federal action agency consult with NMFS for actions that "may adversely affect" Essential Fish Habitat (EFH), including a reduction in quantity or quality of EFH. Information about EFH and

Habitat Areas of Particular Concern (HAPC) were identified within the survey area and were described in the Draft EA and potential effects were also considered. Although the proposed activities may affect EFH and HAPC, the Draft EA concluded that any adverse effects would be localized and transitory and therefore would not likely be significant. Although NSF anticipated no significant impacts to EFH and HAPC, as the proposed activities may affect EFH and HAPC, in accordance with the MSA, NSF requested consultation. NSF contacted the EFH Regional Coordinator of the NMFS Southeast Regional Office (SERO) regarding the program. The SERO EFH Regional Coordinator concluded that the proposed activities may have an adverse effect on EFH. To be consistent with other proposals for seismic activities directly affecting areas of the seafloor within a hardbottom EFH-HAPC, the SERO recommended a 500-meter buffer from coral/hardbottom habitats be maintained for placement of any anchors or anchoring systems (Attachment 1, Appendix D). No other project specific EFH conservation recommendations were provided. NSF agreed to implement the EFH conservation recommendations, and in accordance with Section 305(b)(4)B of the MSA and the implementing regulations at 50CFR 600.920(k), provided a written response to SERO describing how the EFH conservation recommendation would be implemented (Attachment 1, Appendix D). SERO determined the proposed implementation measures to be consistent with the EFH recommendations (Attachment 1, Appendix D). NMFS Office of Protected Resources also consulted for EFH.

Coastal Zone Management Act

NSF considered its obligations for the proposed activities pursuant to the Coastal Zone Management Act (CZMA) (16 USC §1451, *et seq.*). NSF reviewed the Federal Consistency Listings for the states near the survey, North Carolina (NC) and Virginia (VA), and determined that the proposed activities were not listed. Given the proposed land and marine research activities, including the size of the source level for the marine seismic survey and proximity to the NC coastal zone, NSF anticipated that there could be effects to NC coastal resources. Given the proposed activities and distance to the Virginia coastal zone, NSF did not anticipate effects to VA coastal resources. NSF contacted the VA Department of Environmental Quality (DEQ) regarding the project and the VA DEQ concurred that there would be no effect to VA coastal resources and the state of VA did not seek review of the unlisted activities. NSF did not receive a request from any other state for a consistency review of the unlisted activities. NSF also discussed the proposed project with the NOAA Office of Ocean and Coastal Resource Management (OCRM) to confirm the agencies responsibilities under CZMA for the proposed unlisted activities.

NSF submitted a Consistency Determination to the North Carolina DCM on June 18, 2014 (Attachment 1, Appendix G), concluding that the proposed activities would be consistent to the maximum extent practicable with the enforceable policies of North Carolina's federally approved coastal management program (CMP). The CZMA federal consistency process included a public comment period; although not received as part of the NSF NEPA process, NSF took into consideration comments received when preparing the Final EA. On September 8, 2014 the DCM concurred that the proposed activities would be consistent to the maximum extent practicable with NC enforceable policies. DCM requested additional monitoring and mitigation measures identified in the Final Programmatic Environmental Impact Statement issued by the Bureau of Ocean Energy Management in February 2014 (Attachment 1, Appendix G). NSF provided a response to the NC DCM noting that, although not linked to the enforceable policies of the NC federally approved CMP, NSF would comply with the additional monitoring and mitigation measures to the maximum extent practicable (Attachment 1, Appendix G).

Project Objectives and Context

The purpose of the proposed activities is to collect data along the mid-Atlantic coast of the Eastern 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.

The project is proposed to be a collaborative research effort, supporting scientists and graduate students.

Summary of Proposed Action and Alternatives

Proposed Action

The proposed research activities would include a marine seismic survey (or "survey") and associated land-based activities. The survey procedures would be similar to those used during previous seismic surveys conducted by LDEO, using conventional seismic methodology. The survey location is proposed for the Atlantic Ocean off of Cape Hatteras, within the Exclusive Economic Zone of the U.S. and international waters, and outside of state waters (Attachment 1, Figure 1). The survey would consist of approximately (~) 5320 km of transect lines (including turns) in water depths of ~20 m to ~5300 m deep. The survey would involve the R/V *Langseth* as the source vessel which is proposed to deploy an array of 36 or 18 airguns with a total discharge volume of ~6600 in^3 or ~3300 in^3. The receiving system is proposed to consist of hydrophone streamers and 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 streamers or OBSs would receive the returning acoustic signals; the hydrophone streamer would transfer the data to the on-board processing system while the OBSs would record the returning acoustic signals internally for later analysis. In addition to the operations of the airgun array, a multibeam echosounder (MBES), sub-bottom profiler (SBP), and acoustic Doppler current profiler (ADCP) are proposed to be operated from the R/V *Langseth* continuously throughout the cruise, but not during transit.

The survey is proposed to be a ~38 day survey, taking place during the period allowable under the IHA, September 15, 2014 to October 31, 2014. Seismic operations would be carried out for ~33 days, with the balance of the cruise occupied in transit (~ 2 days) and equipment set-up and retrieval (~3 days). Some deviation in the length of the survey may be required, depending on logistics and weather; however, seismic operations would only occur during the timeframe allowable under the IHA.

Land-based research activities would involve passive and active components. 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. 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. No activities would occur in any protected lands, preserves, sanctuaries, or Critical Habitat for ESA-listed species.

Alternatives to Proposed Action

One alternative to the proposed action would be to conduct the marine seismic survey and associated land-based activities at an alternative time. Constraints for vessel operations and availability of equipment (including the vessel) and personnel would need to be considered for alternative survey times. Additionally, weather constraints would inhibit vessel operations during certain times of year, such as winter. Avoiding critical time periods for sensitive species, such as North Atlantic right whale migration periods, is another factor for consideration in survey timing. Limitations on scheduling the vessel include the additional research studies planned on the vessel in 2014 and beyond. Other activities, including research activities, planned within the region also would need to be considered if the survey were scheduled for an alternative time.

Another alternative to conducting the proposed activities would be the "No Action" alternative, i.e., do not issue an IHA and do not conduct the operations. If the planned research were not conducted, the "No Action" alternative would result in no disturbance to marine species attributable to the proposed activities, but geological data of considerable scientific value and relevance increasing our understanding of how the continental crust stretched and separated during the opening of the Atlantic Ocean, and the role of magmatism and the project objectives as described above would not be met.

Alternative technologies to conduct marine geophysical surveys were considered in the PEIS (Chapter 2). At the time of the publication of the PEIS, however, none of the alternative technologies investigated were fully developed and available to meet the purpose and need of marine geophysical research. NSF and LDEO have re-investigated alternative technologies, and have verified that currently no other technologies are commercially available to conduct the proposed action and meet the purpose and need. For these reasons, this alternative was eliminated from further analysis.

Conducting the proposed activity at an alternative location would not meet the purpose and need of the research activities as the proposed location is the most ideal to study the rifted margin along the mid-Atlantic coast of the Eastern North American Margin. Although considered, this alternative was eliminated from further analysis.

Summary of environmental consequences

Proposed Action

The potential effects of sounds from airguns on marine species, mammals and sea turtles of particular concern, are described in detail in Attachment 1 (Chapter IV and PEIS Chapters 3 & 4) and might 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. It is unlikely that the proposed action would result in any cases of temporary or especially permanent hearing impairment, or any significant non-auditory physical or physiological effects. Some behavioral disturbance is expected, if animals are in the general area during seismic operations, but this would be localized, short-term, and involve limited numbers of animals. The potential effects from the other proposed acoustic sources were also considered, however, they would not be likely to have a significant effect on the environment (Attachment 1, Chapter IV and PEIS Sections 3.4.7, 3.6.7, and 3.7.7).

The action includes an extensive monitoring and mitigation program to further minimize potential impacts on the environment. Mitigation efforts include pre-cruise planning activities and operational activities (Attachment 1, Chapters II and IV). Pre-cruise planning mitigation activities included consideration of energy source optimization/minimization; survey timing (i.e., environmental conditions: seasonal presence of animals and weather; and, scientific personnel and equipment availability); and calculation of mitigation zones. The operational mitigation program would further minimize potential impacts to marine species that may be present during the conduct of the research to a level of insignificance. As detailed in Attachment 1 (Chapters II and IV), the IHA (Attachment 1, Appendix A), Biological Opinion (Attachment 1, Appendix B), operational monitoring and mitigation measures would include: ramp ups; two dedicated observers maintaining a visual watch during all daytime airgun operations; two observers monitoring before and during ramp-ups during the day; passive acoustic monitoring (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 marine mammals or sea turtles are detected in or about to enter designated exclusion zones. The fact that the airgun array, as a result of its design, directs the majority of the energy downward, and less energy laterally, would also be an inherent mitigation measure. In accordance with the NMFS EFH conservation recommendation, a 500m buffer would be maintained for placement of OBSs within any designated HAPCs. In their consistency concurrence letter, the NC DCM requested that NSF employ the monitoring and mitigation measures identified in the BOEM PEIS for seismic surveys. NSF has agreed that it would implement those to the maximum extent practicable (Attachment 1, Appendix G)

With the planned monitoring and mitigation measures, unavoidable impacts to marine species that could be encountered would be expected to be minimal, and 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 or the populations to which they belong or on their habitats.

Recreational and commercial fisheries activities would not be precluded in the survey area. LDEO would coordinate with local SCUBA diving organizations and shops to avoid space-use conflicts. LDEO would also work with the local USCG Office to issue Notices to Mariners to coordinate and provide updates on operations in the area. Given the short duration of the survey and the temporary nature of potential environmental impacts, impacts to the local economy, such as to commercial/recreational fisheries and SCUBA diving industry would not be anticipated.

Impacts to land-based endangered or threatened species would not be anticipated. Land-based endangered or threatened species would be avoided during research activities. Only four of the potential 12 ESA-listed species would be anticipated to be encountered during land-based activities due to their potential habitats (i.e., along roadsides): rough-leaved loosestrife, Michaux's sumac, American chafseed, and Cooley's meadowrue. Because of the nature of their habitat, the other ESA-listed species would not be anticipated to be encountered. Researchers would inspect areas prior to deploying any equipment, thereby avoiding disturbance of any of the critical species. Therefore, no significant direct or indirect impacts on terrestrial endangered or threatened species would be anticipated from the proposed activities.

Alternatives to Proposed Action

Conducting a survey with associated land-based activities at an alternative time would result in few net benefits. Marine mammals and sea turtles are expected to be found throughout the proposed survey area and throughout the time during which the project would occur. Some marine mammal species are expected to occur in the area year-round, so altering the timing of the proposed project likely would result in no net benefits for those species. Some migratory species are expected to be farther north at the time of the survey, such as the North Atlantic right whale, so the survey timing is beneficial for those species. Weather (i.e., operational safety of crew and vessel when deploying seismic gear, such as during winter months) and availability of vessel, equipment, and personnel are also factors that need to be considered when scheduling the activities. Through inspection, avoidance, and relocation of activities, impacts to land-based endangered species would not be anticipated regardless of the timing of research activities.

The "No Action" alternative would remove the potential of the limited direct and indirect environmental consequences as described. However, it would preclude important scientific research from going forward that has distinct potential to address important environmental concerns related to earth processes. The "No Action" alternative would result in a lost opportunity to obtain important scientific data and knowledge relevant to a number of research fields and to society in general. The collaboration, involving PIs and students from a number of universities, would be lost along with the collection of new data, interpretation of these data, and introduction of new results into the greater scientific community and applicability of this data to other similar settings. Loss of NSF support often represents a significant negative impact to the academic infrastructure. The "No Action" alternative would not meet the purpose and need of the proposed action.

Conclusion and Decision

NSF has reviewed and concurs with the conclusions of the Final EA (Attachment 1) that implementation of the proposed activity will not have a significant impact on the environment. Consequently, implementation of the proposed activity will not have a significant direct, indirect or cumulative impact on the environment within the meaning of the National Environmental Policy Act (NEPA) or Executive Order 12114. Because no significant environmental impacts will result from implementing the proposed action, an Environmental Impact Statement is not required and will not be prepared. Therefore, no further study under NEPA or Executive Order 12114 is required. NSF's compliance with the Marine Mammal Protection Act, Endangered Species Act, Coastal Zone Management Act, and Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act has been completed. Accordingly, on behalf

of NSF, I authorize the issuance of a Finding of No Significant Impact for the proposed research activities which include a marine seismic survey proposed to be conducted on board the Research Vessel *Marcus G. Langseth* in the Atlantic Ocean off of Cape Hatteras during the effective time period of the IHA. I hereby approve the Proposed Action to commence.
Due to personnel and logistical issues, however, the active land-based activities will be deferred to a later time, most likely spring 2015. If there are any changes to the proposed implementation of the active land-based activities that would cause impacts to endangered or threatened species within the land-based action area, consultation will be reinitiated with any regulating agencies, such as the USFWS, at that time.

Bauke (Bob) Houtman — 9/12/14

Bauke (Bob) Houtman
Integrative Programs Section Head
Division of Ocean Sciences

Date

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

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LGL Report TA8350-1

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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, 2-D seismic survey from the R/V *Langseth* in the Atlantic Ocean ~17–422 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 ~20–5300 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 Final 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 Final 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 during the survey. 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; two dedicated observers maintaining a visual watch during all daytime airgun operations; two observers before and during ramp ups during the day; 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; and power downs (or if necessary shut downs) when marine mammals or sea turtles are detected in or about to enter designated exclusion zones. Per the request of the North Carolina Department of Environment and Natural Resources' Division of Coastal Management as part of the Coastal Zone Management Act federal consistency process, NSF will implement to the maximum extent practical the monitoring and mitigation measures identified in the Bureau of Ocean Energy Management PEIS for the Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas. 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	Eastern 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 Final 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 Final EA was prepared under the National Environmental Policy Act (NEPA) and Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions" (EO 12114). This Final 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 Final EA provides details of the proposed action at the site-specific level and addresses potential impacts of the proposed seismic survey and land-based activities on marine mammals, sea turtles, seabirds, fish, mammals, plants, and invertebrates. A Draft EA was 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 IHA would 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 Eastern 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 Final EA is described in § 1.8 of the PEIS, including the

- National Environmental Protection Act (NEPA);
- Executive Order 12114;
- Marine Mammal Protection Act (MMPA);
- Endangered Species Act (ESA);
- Coastal Zone Management Act (CZMA); and
- Magnuson Stevens Fishery Conservation and Management Act (MSA) for Essential Fish Habitat (EFH).

II. ALTERNATIVES INCLUDING PROPOSED ACTION

In this Final EA, three alternatives are evaluated: (1) the proposed seismic survey and associated land-based activities and issuance of an associated IHA, (2) a corresponding seismic survey and associated land-based activities 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 monitoring/mitigation measures for L-DEO's planned seismic survey are described in the following subsections.

(1) Project Objectives and Context

As noted previously, the goal of the proposed research is to collect and analyze data along the mid-Atlantic coast of the Eastern 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), D. Lizarralde (Woods Hole Oceanographic Institution) and S. Harder (University of Texas at El Paso), propose to conduct a 2-D marine seismic reflection and refraction survey from the R/V *Marcus G. Langseth* (*Langseth*) 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 (Fig. 1). 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.

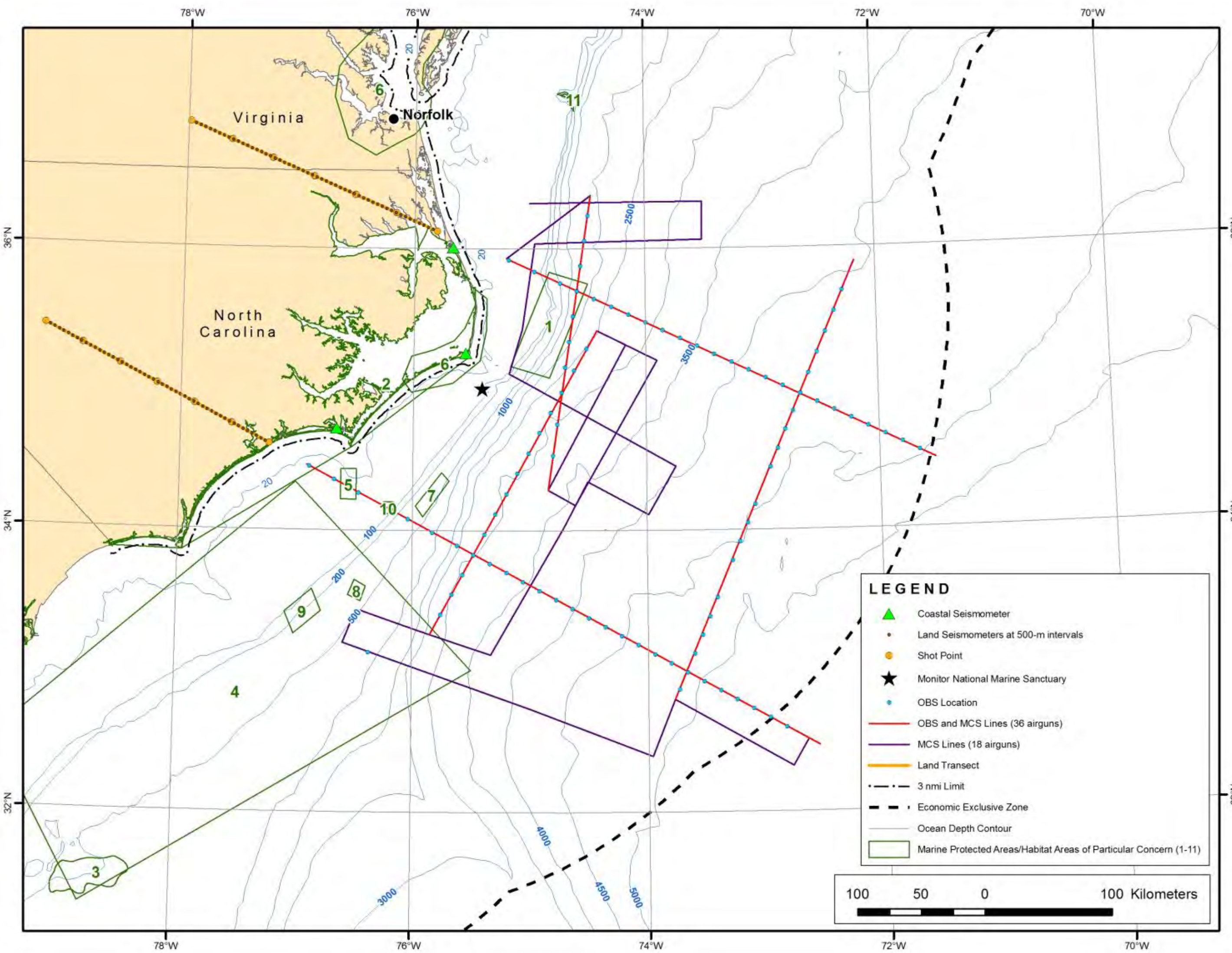


Figure 1. Location of the proposed seismic survey at the proposed survey site in the Atlantic Ocean off Cape Hatteras during September–October 2014. Also shown are a National Marine Sanctuary, one marine protected area, and 10 habitat areas of particular concern (see text).

(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 ~17–422 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 ~20–5300 m. The seismic survey would be conducted outside of state waters and mostly within the U.S. EEZ, and partly in International Waters.

(b) Description of the Marine 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 would record the returning acoustic signals internally for later analysis.

A total of ~3610 km of 2-D survey lines, including turns (~1900 km MCS and ~1710 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 ~5320 km. Although in the Draft EA a 25% contingency allowance was added to ensonified area calculations for additional seismic operations in the survey area associated with turns, infill of missing data, and/or repeat coverage of any areas where initial data quality was sub-standard, this has been eliminated from the Final EA calculations. The 25% contingency was added to some past seismic surveys, for this particular survey design, such an additional contingency was not seen as necessary and therefore was eliminated from the calculations for the proposed activities. If any track lines need to be repeated, total track lines would not exceed ~5320 km.

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. The entire survey would take ~38 days. 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. 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. Land-based activities are proposed to coincide with the marine activities.

(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* is owned by NSF and has been operated by the University of Rhode Island's Graduate School of Oceanography through a Cooperative Agreement 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 bow thruster. 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 (plus 2 spares) 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.

(g) 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 § 2.4.1.1 and 2.4.2 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 up to 40 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. Following discussions with NMFS during review of the IHA Application, the PIs decided that the number of lines using the 18-airgun subarray would be increased.

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

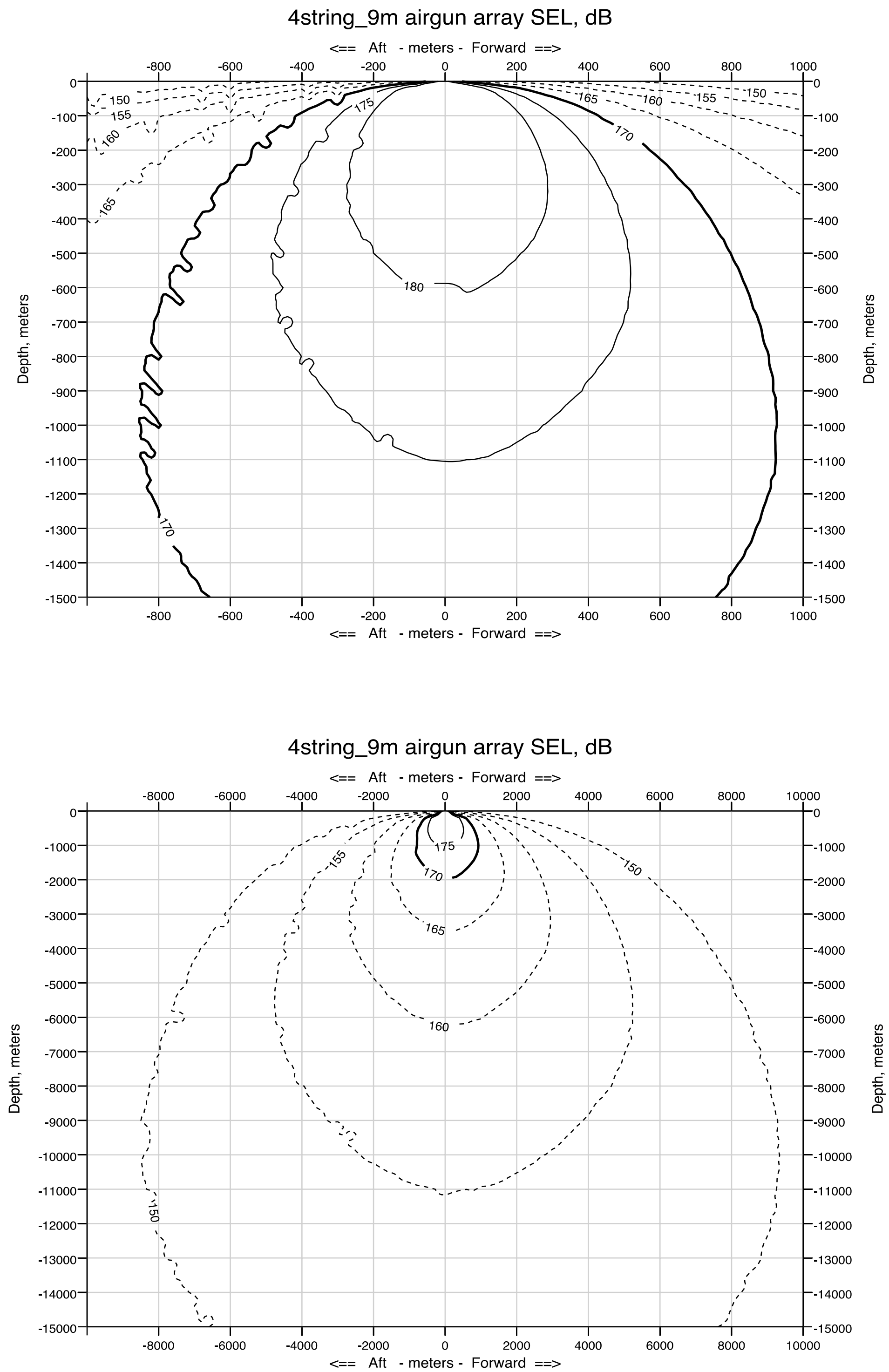
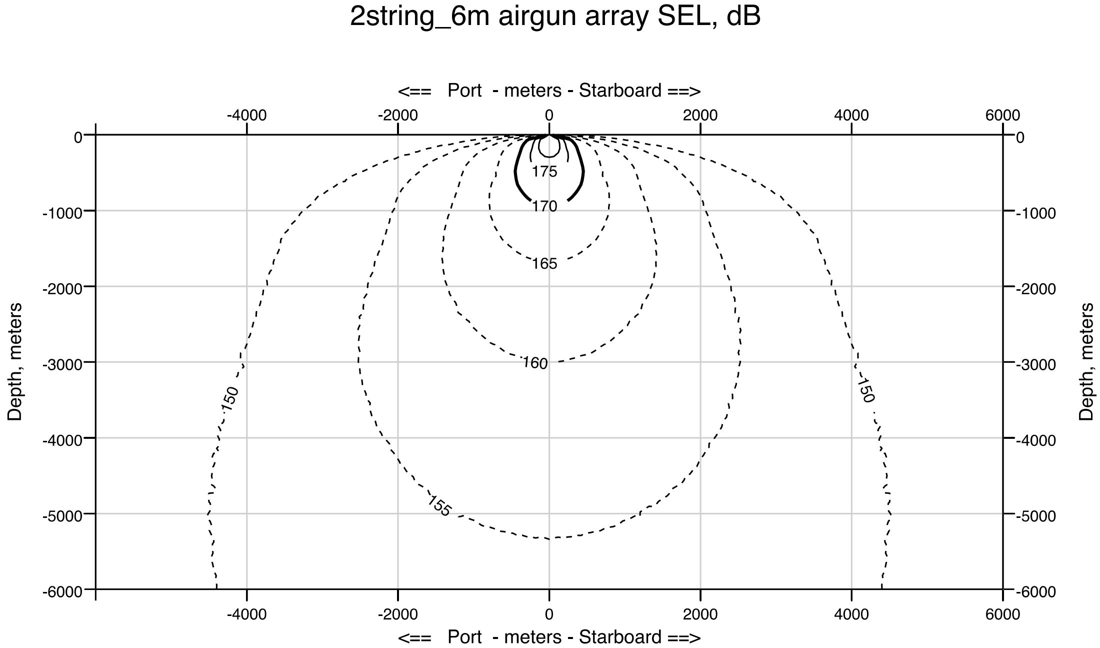


FIGURE 2. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the survey off Cape Hatteras, at a 9-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the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



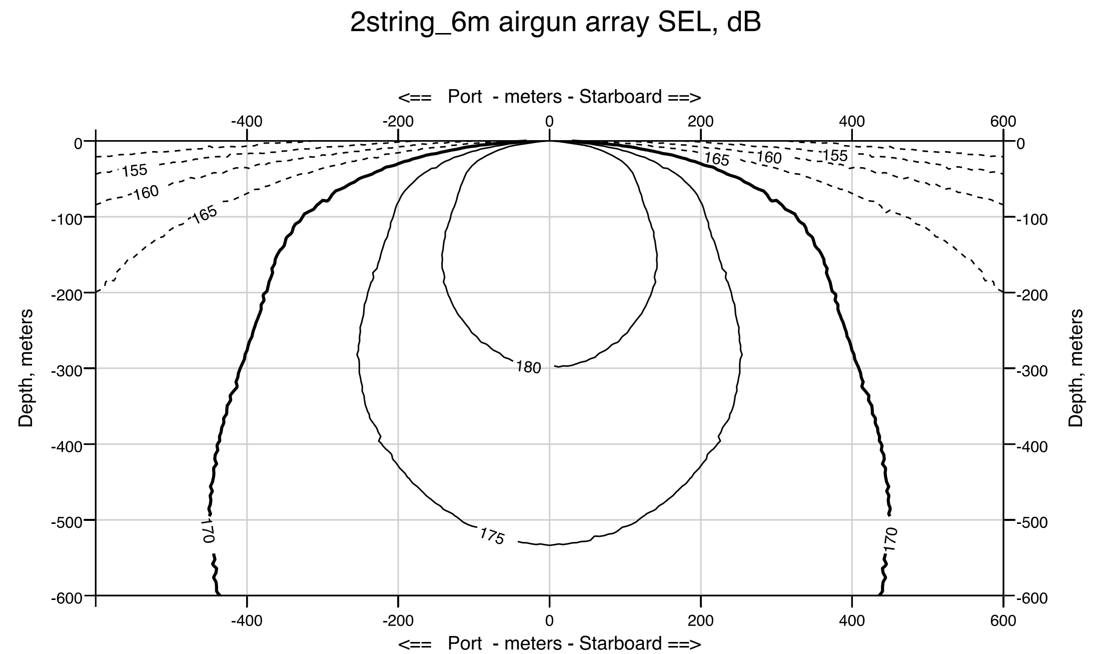


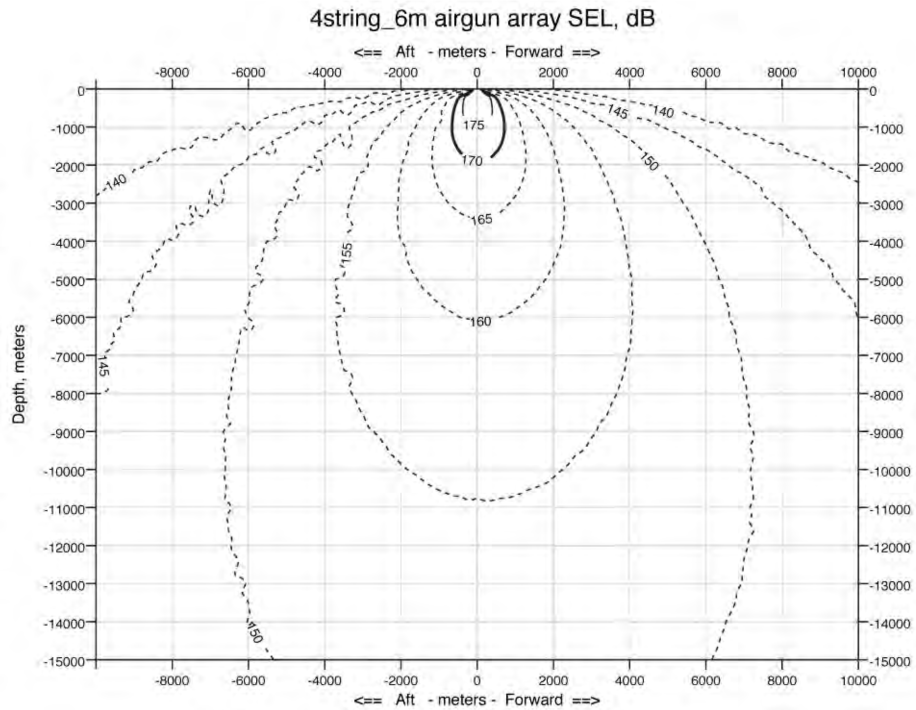
FIGURE 3. Modeled deep-water received sound levels (SELs) from the 18-airgun array planned for use during the survey off Cape Hatteras, at a 6-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 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 $1\mu Pa_{rms}$ 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. 5) and 7244 for the 36-gun array at 6-m tow depth (Fig. 4), 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. 5) and 719 m for the 36-gun array at 6-m tow depth (Fig. 4), yielding a scaling factor of 0.0542. Measured 160- and 180-dB re $1\mu Pa_{rms}$ 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 $1\mu Pa_{rms}$ 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 Final EA, the date of release of the final guidelines and how they will be implemented are unknown. As such, this Final 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).

[1] SEL (measured in dB re 1 $\mu Pa^2 \cdot s$) 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.



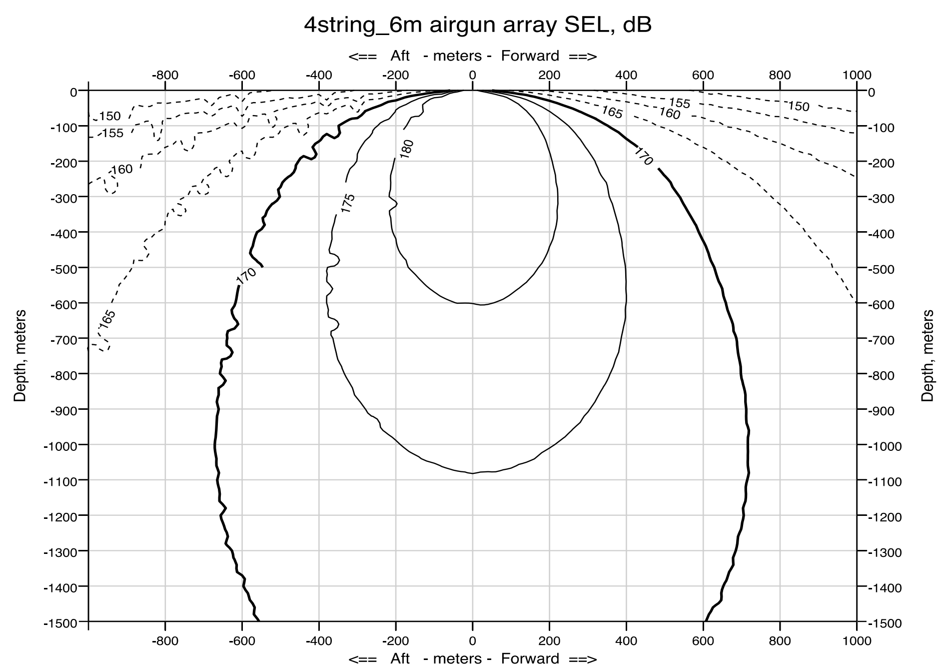
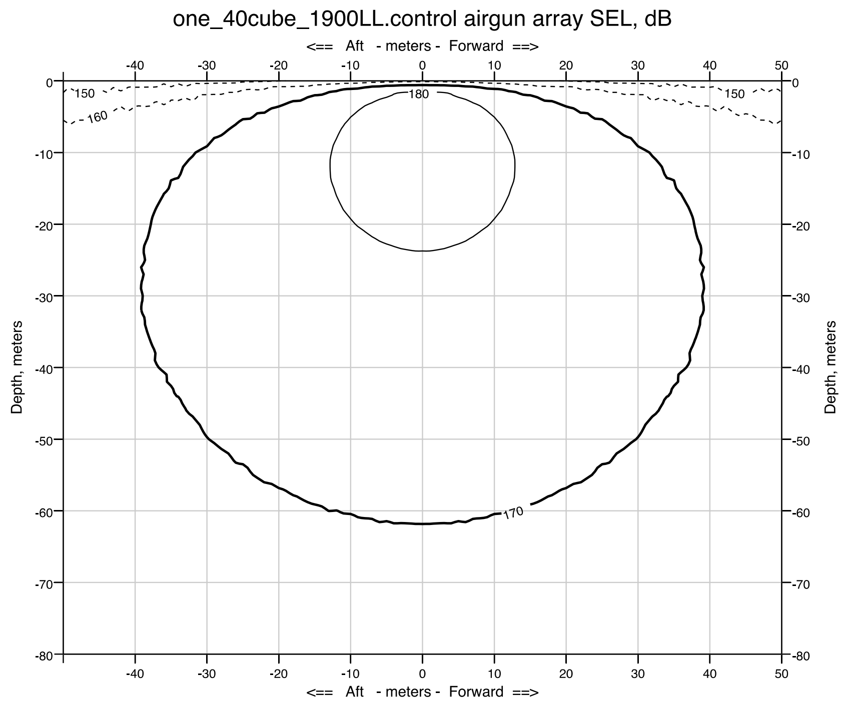


FIGURE 4. Modeled deep-water received sound levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB rms isopleth,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



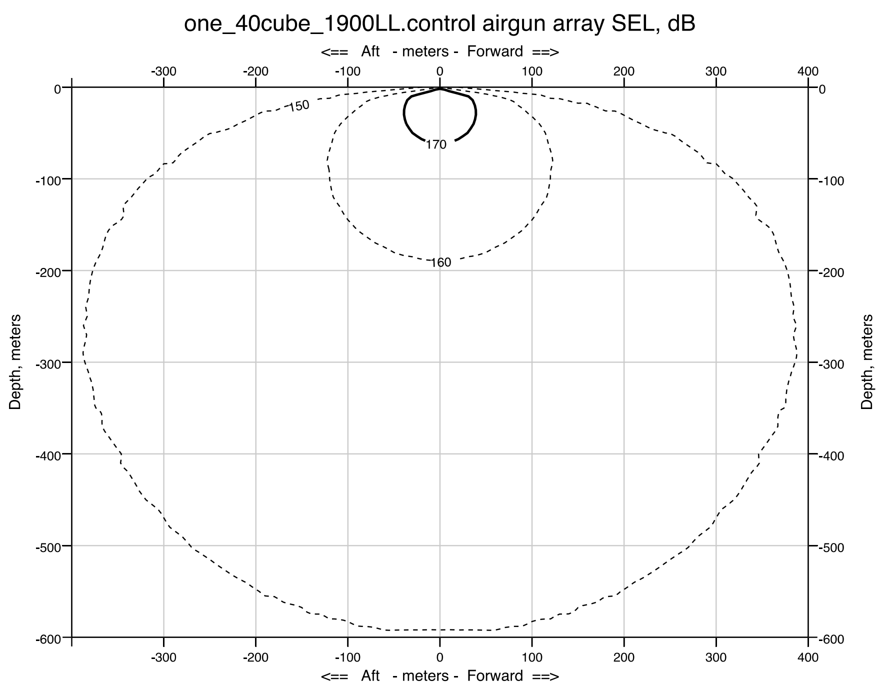


FIGURE 5. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9 m depth, which is planned for use as a mitigation gun during the proposed survey off Cape Hatteras. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to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

Per the IHA for this survey (Appendix A), the Exclusion Zone was increased by 3 dB in shallow water only (thus operational mitigation would be at the 177-dB isopleth), which adds ~50% to the power-down/shut-down radius; the IHA includes the new distances for shallow water. The 180-dB distance has been used as the exclusion zone for sea turtles, as required by NMFS in most other recent seismic projects. For operational purposes, however, the 177-dB isopleth would be observed for marine mammals, sea turtles, and foraging endangered and threatened sea birds in shallow water. Per the Biological Opinion (Appendix B), a 166-dB distance would be used for Level B takes for sea turtles.

(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 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 Final 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: Use of Alternative Technologies	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;
- *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, other vessel traffic, and SCUBA diving. Fishing, vessel traffic, SCUBA diving, 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; and
- *Cultural Resources*—With the possible exception of shipwrecks, there are no known cultural resources in the proposed Project area. Shipwrecks are discussed further in § IV. Airgun sounds would have no effects on solid structures; no significant impacts on shipwrecks would be anticipated (§ IV). No impacts to cultural resources would be anticipated.

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 centered 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 Level B (160-dB) zone also would not enter the sanctuary. Based on the proposed activities, the information and analysis in § III and § IV, the distance of the survey to the sanctuary, and the amount of time the vessel would be at its closest points to the sanctuary, we would not anticipate injury to any sanctuary resources.

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.

In 2009, NMFS designated a special research area offshore of Cape Hatteras as part of the Atlantic Pelagic Longline Take Reduction Plan (NMFS 2009). In the research area, there are specific observer and research participation requirements for fishermen operating in that area at any time during the year. Thus, it is not relevant for our activities and is not analyzed further in this EA.

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; information on Bryde's whale is included in the NMFS EA for this project, and is incorporated into this Final EA by reference as is fully set forth herein (Appendix C). 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. Information on the harbor seal is included in the NMFS EA for this project, and is incorporated into this Final EA by reference as is fully set forth herein (Appendix C).

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) Final PEIS for Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas (BOEM 2014), 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

[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, in its Final PEIS (BOEM 2014), BOEM proposed that no seismic surveys would be authorized within right whale critical habitat areas from 15 November to April 15, nor within the Mid-Atlantic and Southeast U.S. SMAs from 1 November to 30 April 30. Additionally, G&G seismic surveys would not be allowed in active DMAs. 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 32 OBIS sighting records of Cuvier's beaked whale in offshore waters off North Carolina, almost all at the shelf break, 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 three OBIS stranding records of Gervais' beaked whale for Virginia and three sighting records for North Carolina; there are also 28 sighting records of unidentified *Mesoplodon* off North Carolina, almost all along the shelf edge (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 (2008a.b) and during summer NEFSC and SEFSC surveys between 1995 and 2011 (Waring et al. 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; 1219 as of 13 April 3014; 1370 as of 29 June 2014; and 1487 as of 31 August 2014) 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 1 September 2014, 250 of 260 dolphins tested 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 were extending south; in the 4 November update, dead or dying dolphins had been reported only as far south as South Carolina, and in the 8 December update, strandings were also reported in Georgia and Florida.

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 Final PEIS (BOEM 2014), 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).

NMFS proposed (2013a) and designated (2014) 38 areas of Critical Habitat in the range of the Northwestern Atlantic Ocean Distinct Population Segment (DPS) of the loggerhead turtle, from Virginia to the Gulf of Mexico. The areas contain one or more of nearshore reproductive habitat, winter area, breeding areas, constricted migratory corridors, and *Sargassum* habitat. In the proposed survey area, the inner end of the southern on-offshore transect is in winter habitat, which extends from 20 to 100 m from shore, and there are a few transects north of Cape Hatteras that extend into winter and migratory habitat, which extends from shore to 200 m depth. There is also overlap with *Sargassum* habitat, which extends from the 200-m contour to the EEZ.

(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]

Species	Life stage[1] and habitat[2]				
	E	L/N	J	A	SA
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	

	Life stage[1] and habitat[2]				
Species	E	L/N	J	A	SA
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%). In terms of catch value, sea scallops accounted for 45% of the value. 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%). In terms of catch value, blue crab accounted for 34% of landings, followed by brown shrimp (12%), summer flounder (8%), and eastern oyster (5%). 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	Gear Type: 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. As of 24 April 2014, 15 tournaments were scheduled between mid September and mid October 2014 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 maximum 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. Additional close up map information on these sites and some artificial reef sites is included as Appendix H.

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

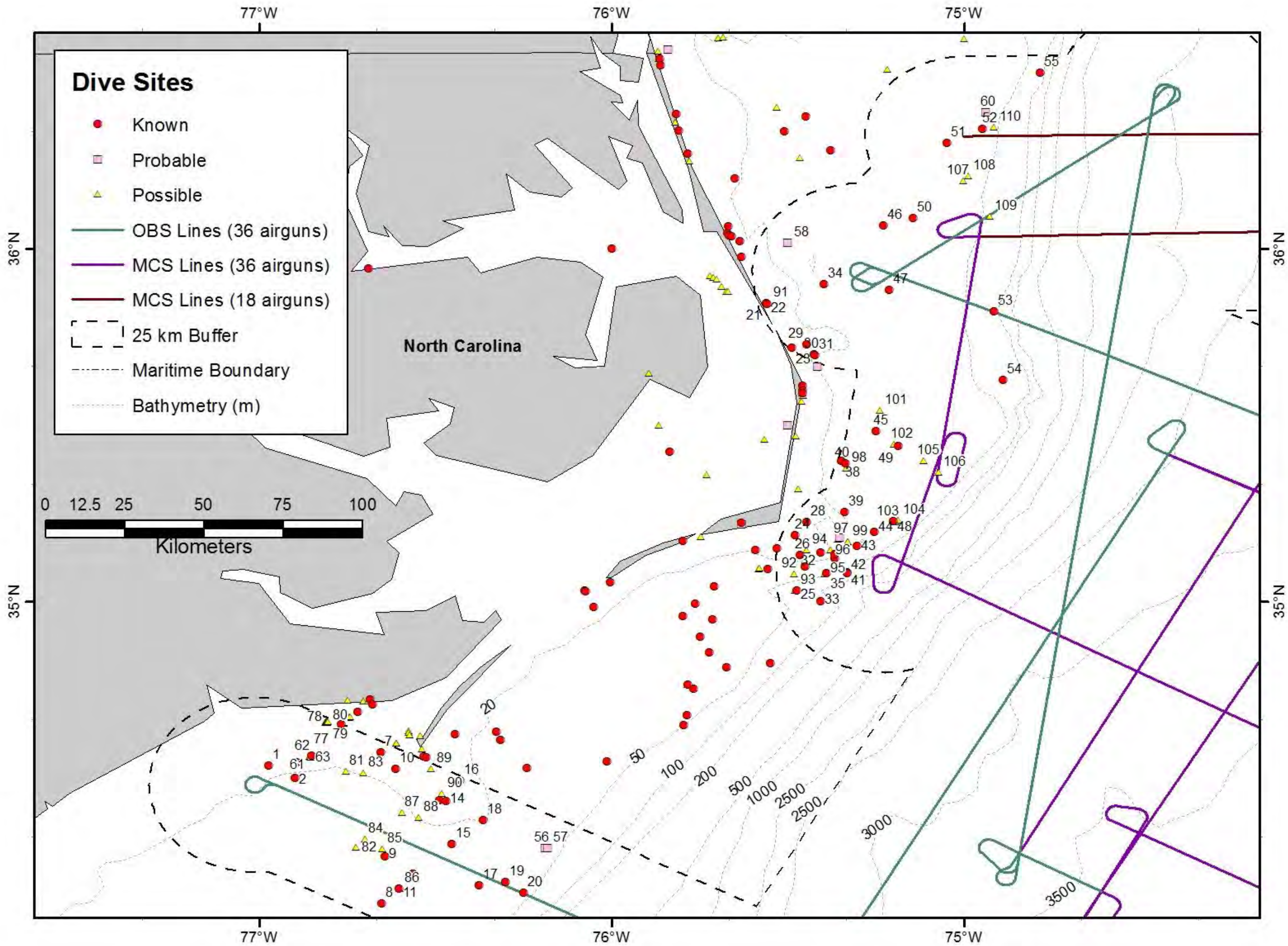


Figure 6. Potential dive sites (shipwrecks or unidentified obstructions) in water depths <100 m North Carolina waters. Source: NOAA (2014).

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 given in the PEIS, 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. Additional effects literature is given in the NMFS EA (Appendix C), and is incorporated into this Final EA by reference as if fully set forth herein.

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. Acoustic modeling for the proposed action was conducted by L-DEO, consistent with past EAs and determined to be acceptable by NMFS for use in the calculation of estimated takes under the MMPA (e.g., NMFS 2013e,f).

(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 Final 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 Final 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 Final 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. There has been no history of marine mammal vessel strikes with the R/V *Langseth*, or its predecessor, R/V *Maurice Ewing*.

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; two dedicated observers maintaining a visual watch during all daytime airgun operations; two observers monitoring before and during ramp ups during the day; 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). Per the request of the North Carolina Department of Environment and Natural Resources' Division of Coastal Management as part of the Coastal Zone Management Act federal consistency process, NSF will implement to the maximum extent practical the monitoring and mitigation measures identified in the Bureau of Ocean Energy Management PEIS for the Atlantic OCS Proposed Geological and Geophysical Activities, Mid-

Atlantic and South Atlantic Planning Areas. 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. NSF and LDEO would adhere to the monitoring and mitigation requirements of the Incidental Take Statement (ITS) and the IHA.

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 points that define the polygons were (1) the innermost ends of transects and the intersections between the transect lines and the 100-m contour, (2) the intersections between the transect lines and the 100-m contour and the 1000-m contour, and (3) the intersections between the transect lines and the 1000-m contour and the outer ends of the transects. These were entered into the GIS to create the 3 polygons. 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. As is typical during offshore ship surveys, inclement weather and equipment malfunctions are likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated EZ would result in the shut down of seismic operations as a mitigation measure.

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 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.

	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/Stock	<100	100-1000	>1000	<100	100-1000	>1000	<100	100-1000	>1000	All		
Mysticetes												
North Atlantic right whale	*0*	*0*	*0*	*9.74*	*4.07*	*27.17*	*0*	*0*	*0*	*0*	*0*	***0***
Humpback whale	*0.73*	*0.56*	*1.06*	*9.74*	*4.07*	*27.17*	*7*	*2*	*29*	*38*	*0.33*	***38***
Minke whale	0.03	0.02	0.04	9.74	4.07	*27.17*	0	0	1	1	0.01	**1**
Sei whale	*0*	*0*	*0*	*9.74*	*4.07*	*27.17*	*0*	*0*	*0*	*0*	*0*	***0***
Fin whale	*<0.01*	*0.01*	*0.01*	*9.74*	*4.07*	*27.17*	*0*	*0*	*0*	*0*	*<0.01*	***1***
Blue whale	*0*	*0*	*0*	*9.74*	*4.07*	*27.17*	*0*	*0*	*0*	*0*	*0*	***0***
Odontocetes												
Sperm whale	*0.03*	*0.68*	*3.23*	*9.74*	*4.07*	*27.17*	*0*	*3*	*88*	*91*	*0.69*	***91***
Pygmy/dwarf sperm whale	0.64	0.49	0.93	9.74	4.07	*27.17*	6	2	25	33	0.88	***33***
Beaked whales[4]	0.01	0.14	0.58	9.74	4.07	*27.17*	0	1	16	16	0.12	***16***
Rough-toothed dolphin	0.30	0.23	0.44	9.74	4.07	*27.17*	3	1	12	16	5.85	***16***
Bottlenose dolphin/O[5]	70.4	331.0	49.4	9.74	4.07	*27.17*	685	1345	1342	3374	4.35	***3374***
Bottlenose dolphin/SCM[5]	70.4	0	0	9.74	0	0	685	0	0	685	7.47	***685***
Bottlenose dolphin/NNCE[5]	70.4	0	0	0.01	0	0	1	0	0	1	0.08	***1***
Bottlenose dolphin/SNCE[5]	70.4	0	0	0.01	0	0	1	0	0	1	0.42	***1***
Pantropical spotted dolphin	14.0	10.7	20.4	9.74	4.07	*27.17*	137	44	553	734	22.01	***734***
Atlantic spotted dolphin	216.5	99.7	77.4	9.74	4.07	*27.17*	2108	405	2103	4617	10.33	***4617***
Spinner dolphin[7]	0	0	0	9.74	4.07	*27.17*	0	0	0	0	0	***0***
Striped dolphin	0	0.4	3.53	9.74	4.07	*27.17*	0	1	96	97	0.18	***97***
Clymene dolphin	6.70	5.12	9.73	9.74	4.07	*27.17*	65	21	264	350	N/A	***350***
Common dolphin	5.8	138.7	26.4	9.74	4.07	*27.17*	56	564	717	1337	0.77	***1337***
Atlantic white-sided dolphin	0	0	0	9.74	4.07	*27.17*	0	0	0	0	0	***0***
Fraser's dolphin[7]	0	0	0	9.74	4.07	*27.17*	0	0	0	0	0	***0***
Risso's dolphin	1.18	4.28	2.15	9.74	4.07	*27.17*	12	17	58	87	0.48	***87***
Melon-headed whale[7]	0	0	0	9.74	4.07	*27.17*	0	0	0	0	0	***0***
Pygmy killer whale[7]	0	0	0	9.74	4.07	*27.17*	0	0	0	0	0	***0***
False killer whale[7]	0	0	0	9.74	4.07	*27.17*	0	0	0	0	0	***0***
Killer whale[7]	0	0	0	9.74	4.07	*27.17*	0	0	0	0	0	***0***
Pilot whale	3.74	58.9	19.1	9.74	4.07	*27.17*	36	239	519	795	0.10	***795***
Harbor porpoise	0	0	0	9.74	4.07	*27.17*	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; calculated take for the fin whale was 0.31 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] O = Offshore, SCM = Southern Coastal Migratory, NNCE = Northern North Carolina Estuarine System, SNCE = Southern North Carolina Estuarine System

[6] Area of waters <3 km from shore ensonified to ≥160 dB re 1 μPa$_{rms}$

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

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. In the NMFS EA and IHA, takes were increased to account for line overlap and species turnover.

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 Final 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 1.55 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, ~40,970 km^2 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 12,275 (Table 9). That total includes

130 cetaceans listed as ***Endangered*** under the ESA, including 38 humpback whales (0.33 % of the regional population) and 91 sperm whales (0.69%). It also includes 16 beaked whales (0.12%), probably mostly Cuvier's whale. Most (98.5%) of the cetaceans potentially exposed are delphinids; the Atlantic spotted dolphin, offshore stock of the 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 4617 (10.33% of the regional population), 3374 (4.35%), 1337 (0.77%), 795 (0.10%), and 734 (22.01%) 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.

As part of the IHA process, NMFS reviewed the take estimates presented in Table 9. As part of NMFS's analysis process, however, they revised the take calculations for all but two species (Atlantic white-sided dolphin and harbor porpoise) based upon the best available density information from SERDP SDSS and other sources, the most recent population estimates from the 2014 SAR, and additional takes to account for overlap and turnover. The IHA issued by NOAA therefore included slightly different estimates of the possible numbers of marine mammals exposed to sound levels ≥160 dB re 1 mPa during the proposed seismic survey than those presented in Table 9. For all but five of the species for which take has been issued, the takes remain less than 1% of the species' regional population or stock. Additionally, the Biological Opinion presents a different methodology to analyze for multiple exposures of endangered species. NMFS does not provide specific guidance or requirements for IHA Applicants or for Section 7 ESA consultation for the development of take estimates and multiple exposure analysis, therefore variation in methodologies and calculations are likely to occur. The analysis presented in the NSF Final EA, however, is a methodology that has been used successfully for past NSF seismic surveys to generate take estimates and multiple exposures for the MMPA and ESA processes. Although NSF did not, and has not historically, estimated take for sea turtles, the Biological Opinion and ITS included analysis and take estimates for sea turtles (Appendix B). NSF and LDEO would adhere to the requirements of the Incidental Take Statement (ITS) and the IHA and associated take levels issued.

(f) Conclusions for Marine Mammals and Sea Turtles

The proposed seismic project would involve towing a 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. In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, Protected Species Observers (PSOs) and other crew members have seen no seismic sound-related marine mammal injuries or mortality.

NMFS has issued an IHA, therefore, the proposed activity meets the criteria that the proposed activities, "must not cause serious physical injury or death of marine mammals, must have negligible impacts on the species and stocks, must "take" no more than small numbers of those species or stocks, and must not have an unmitigable adverse impact on the availability of the species or stocks for legitimate subsistence uses." In the Biological Opinion, NMFS has determined that the level of incidental take is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat**.** The issuance of the IHA and the Biological Opinion further verifies that significant impacts would not 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. Some of the track lines loggerhead winter Critical Habitat, whereas the proposed survey is in fall. Some track lines are also in migratory and/or *Sargassum* habitat. Given the proposed monitoring and mitigation measures, no significant impacts on sea turtles, including loggerheads in Critical Habitat, would be anticipated. In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, Protected Species Observers (PSOs) and other crew members have seen no seismic sound-related sea turtle injuries or mortality.

In the Biological Opinion, NMFS has determined that the level of incidental take is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat**.** The Biological Opinion further verifies that significant impacts would not be anticipated from the proposed activities.

(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.

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.

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

(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. The PEIS also concluded that seismic surveys could cause temporary, localized reduced fish catch to some species, but that effects on commercial and recreation fisheries were not significant.

Most commercial 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. In decades of seismic surveys carried out by the

Langseth and its predecessor, the R/V *Ewing*, Protected Species Observers (PSOs) and other crew members have seen no seismic sound-related fish or invertebrate injuries or mortality.

NSF consulted with the NMFS Southeast Regional Fisheries Office under the Magnuson-Stevens Act for EFH (see below "Coordination with Other Agencies and Processes" for further details). The NMFS Southeast Regional Fisheries Office concluded that the proposed activities may at some level adversely affect EFH, however, only one specific conservation measure was identified for the proposed activities (Appendix D). Per the EFH conservation recommendation by NMFS, OBSs deployed within HAPC would maintain a 500 m buffer from any coral/hardbottom; the methodology to implement the conservation recommendation is described in Appendix D.

(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. In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, Protected Species Observers (PSOs) and other crew members have seen no seismic sound-related seabird injuries or mortality. Terrestrial activities would not affect seabirds because the only activities within 2 km of the coast would only involve burying passive seismometers. Furthermore, NSF received concurrence from USFWS that the proposed activities "may affect" but "are not likely to adversely affect" species under their jurisdiction (Appendix E).

(4) Indirect Effects on Marine Mammals, Sea Turtles, and Fish 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. Furthermore, NSF received concurrence from USFWS that the proposed activities "may affect" but "are not likely to adversely affect" species under their jurisdiction (Appendix E).

(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). Additionally, the NMFS EA Cumulative Effects Section on Climate Change is incorporated into this Final EA by reference as if fully set forth herein.

(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* proposed to support an NSF-proposed 3-D seismic survey off the coast of New Jersey to study the sea-level changes. That cruise was proposed to last ~36 days in June–July and cover ~4900 km of track lines. Because of mechanical issues with the vessel, however, the survey was not completed and may be rescheduled for a similar time period in 2015. The *Langseth* conducted a 2-D seismic survey for ~3 weeks in August 2014, covering ~3175 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); to finish the project, a second survey of ~3125 km of track lines would be conducted for ~3 weeks in the April–August timeframe. EAs were prepared for both of those activities, and neither of those project survey tracklines are anticipated to overlap with the proposed survey tracklines.

Broadband seismometers have been deployed on the seafloor on the coast of North Carolina as part of an NSF collaborative ENAM research activity. The broadband seismometers will record distant earthquakes for one year (April 2014 to April 2015). Recordings of the seismic waves from far away earthquakes can be used to image the mantle beneath the eastern edge of North America, which will provide information on deep processes during continental breakup, including the generation of magmas and extension of the lithosphere. Together with the EarthScope USArray seismometers onshore, these data will enable continuous imaging of the North American lithosphere across the shoreline.

Researchers at University of North Carolina Chapel Hill Institute of Marine Sciences have funding to study the reef systems and the processes affecting dynamics of reef fishes in state and federal waters off Onslow Bay. They are evaluating how the reef habitat, especially epibiotic communities but also the degree of sedimentation, vary among natural, artificial, and wreck reefs seasonally as a function of location, depth, reef structure, and physical forcing. In September and October 2014, they will be conducting dive-based research near and within the proposed survey area. NSF and LDEO would coordinate activities to avoid as much as possible space-use conflict with this research group.

A scientist from Duke University will be conducting research on beaked whales within the vicinity of the proposed seismic survey. Research efforts will include tagging beaked whales. NSF and LDEO would coordinate activities to avoid any space-use conflict.

Other scientific seismic 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 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.

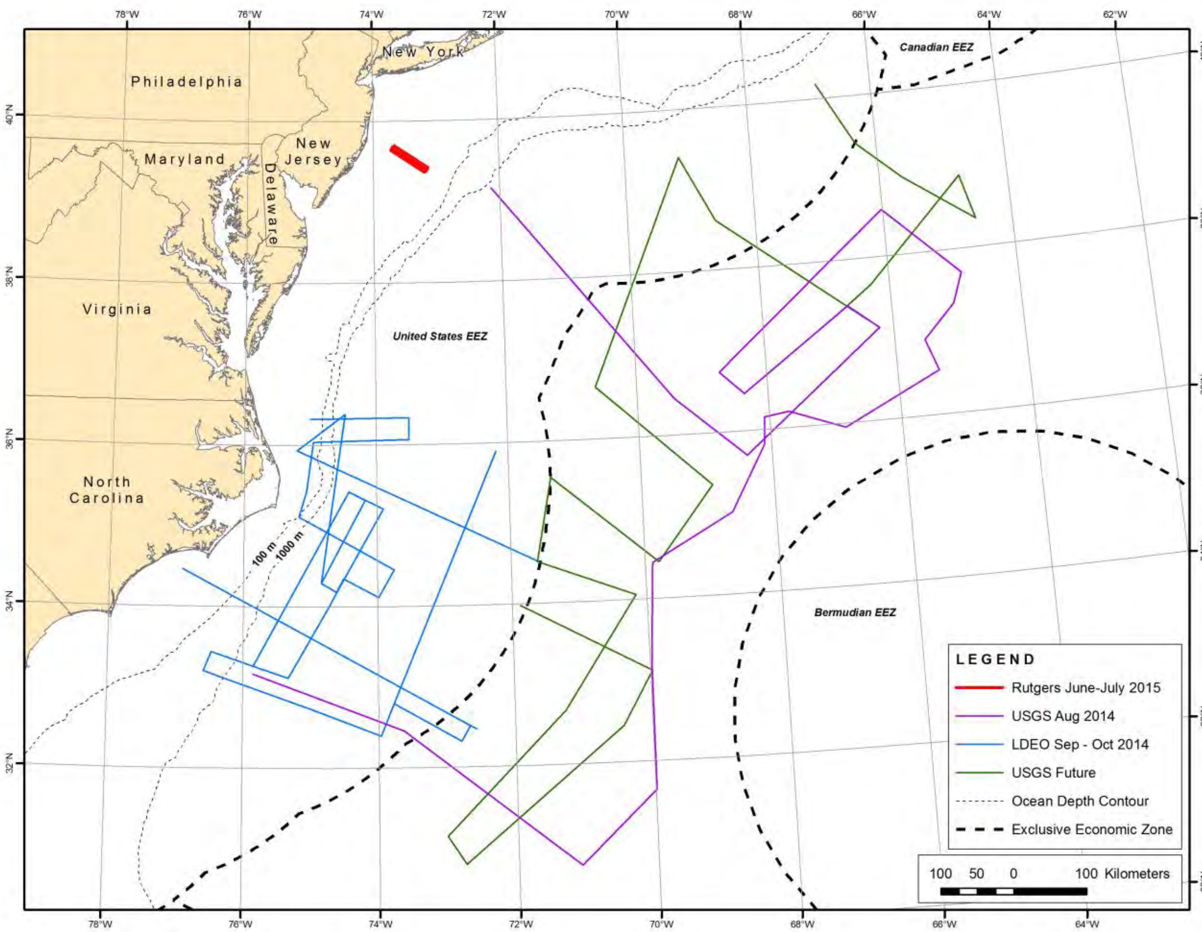


FIGURE 7. Locations of known proposed research activities off the U.S. east coast.

(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 Final PEIS was published in February 2014 (BOEM 2014) and a Record of Decision was signed in July 2014. 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 Final 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 will conduct site-specific environmental reviews for any future G&G permit applications for the Atlantic. These reviews will include coordination and consultation with federal, state and tribal authorities under a suite of statutory requirements. BOEM will also require that operators receive any required authorization from NOAA Fisheries before any final authorization from BOEM is provided. NOAA will not authorize use of G&G surveys unless there is negligible impact and no adverse effects on recruitment or survival of marine mammal species or stocks. The decision to authorize G& G activities for all three program areas (oil and gas, renewable energy and marine minerals) does not authorize leasing for oil and gas exploration and development in the Atlantic. Those decisions will be addressed through the development of the next Five Year Program for Oil and Gas Leasing. BOEM is at the beginning of the process to develop that program as required by the Outer Continental Shelf Lands Act (OCSLA). The planning process will take two-and-a-half to three years to complete.

BOEM activities are not anticipated to occur during the proposed activities. Given the separation in time with the proposed activities and any future BOEM G&G activities in the survey area, no cumulative effects would be anticipated.

(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

NSF posted the Draft EA on the NSF website for a 30-day public comment period from 5 May to 5 June 2014, but received no comments during the open comment period. As noted below, public comments were received during the NMFS IHA process and during the Coastal Zone Management Act (CZMA) process, and although not received as part of the NSF NEPA process, NSF considered the responses with respect to the information included in the Draft EA. The public comments received for the IHA process are included in Appendix F. During MMPA and ESA consultations with NMFS, technical revisions were made to proposed survey track lines, reductions in energy source levels on certain track lines (multichannel seismic (MCS) lines, Figure 1, Attachment 1), and take estimates; these changes were reflected in the Final EA. Additionally, after consideration of public comments received during the NMFS IHA and CZMA public comment periods, updates to information were made in the NSF Final EA, such as more detail on alternative survey timing and other research activities within the proposed survey area and additional material was included, such as on artificial reef sites. Potential impacts to endangered species and critical habitat were also assessed in the document; therefore, it was used to coordinate and support other consultations with Federal agencies as required and noted below. This Final EA was prepared by LGL on behalf of L-DEO and NSF pursuant to NEPA and Executive Order 12114.

Endangered Species Act (ESA)

NSF engaged in formal consultation with NMFS and informal consultation with USFWS pursuant to Section 7 of the ESA. On 12 September 2014, NSF received concurrence from USFWS that the proposed activities "may affect" but "are not likely to adversely affect" species under their jurisdiction (Appendix G). Mitigation measures would be implemented with the proposed activities, including avoidance of any endangered or threatened species within the area of land based activities and power-downs/shut-downs for foraging endangered or threatened seabirds within the exclusion zone of the marine seismic survey. NSF met every two weeks with NMFS and sometimes more frequently during the Section 7 consultation process. NMFS issued a Biological Opinion and an Incidental Take Statement (Appendix B) on 12 September 2014 for the proposed activities and consultation was concluded. For operational purposes and coordination with monitoring and mitigation measures required under the IHA, the Exclusion Zone for marine mammals, sea turtles, and foraging seabirds would be expanded to the 177-dB isopleth in shallow water (<100 m).

Marine Mammal Protection Act (MMPA)

L-DEO submitted to NMFS an IHA pursuant to the MMPA on 26 February, 2014. NSF communicated regularly (often several times per week) by phone and email with NMFS as part of the consultation. NMFS issued in the Federal Register a Notice of Intent to issue an IHA for the survey and 30-day public comment period. As noted above, public comments were received as part of the IHA process (Appendix F) and, although not received as part of the NSF NEPA process, NSF considered the responses with respect to the information included in the Draft EA. NMFS prepared a separate EA for its federal action of issuing an IHA; NMFS's EA (Appendix C) is hereby incorporated by reference in this NSF Final EA as appropriate and where indicated. NMFS issued an IHA on 12 September 2014 (Appendix A). The IHA stipulated monitoring and mitigation measures, including additional mitigation measures beyond those proposed in the NSF Draft EA and IHA Application, such as an expanded Exclusion Zone (177-dB isopleth) in shallow water (<100 m), a 60-minute period before resuming operation of the seismic source after a shutdown for beaked and sperm whales (unless the animal is observed leaving the exclusion zone), and a one-minute shot interval for the 40-in^3 mitigation airgun used during power downs or maintenance repairs. NSF and LDEO would adhere to the IHA requirements for the proposed action.

NMFS Marine Mammal Stranding Program

Although marine mammal strandings are not anticipated as a result of the proposed activities, during ESA Section 7 and MMPA consultation with NMFS it was recommended that the NMFS Regional Marine Mammal Response Coordinator be contacted regarding the proposed activity. Both NMFS and NSF made contact with the NMFS headquarters Stranding Coordinator and Southeast Fisheries Science Center Marine Mammal Response Coordinator. Should any marine mammal strandings occur during the survey, per the IHA, NMFS, NMFS Greater Atlantic Region Marine Mammal Stranding Network, and NMFS Southeast Region Marine Mammal Stranding Network would be contacted.

Magnuson Stevens Act - Essential Fish Habitat (EFH)

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires that a Federal action agency consult with NMFS for actions that "may adversely affect" Essential Fish Habitat (EFH), including a reduction in quantity or quality of EFH. EFH and Habitat Areas of Particular Concern (HAPC) were identified within the survey area. Although NSF anticipated no significant impacts to EFH and HAPC, as the proposed activities could affect EFH and HAPC, in accordance with the MSA, NSF requested consultation for EFH with the NMFS Southeast Regional Office (SERO). The SERO concluded that the proposed activities may have an adverse effect on EFH. To be consistent with other proposals for seismic activities directly affecting areas of the seafloor within a hardbottom EFH-HAPC, SERO recommended that a 500-meter buffer from coral/hardbottom habitats be maintained from placement of any anchors or anchoring systems (Attachment 1, Appendix D). No other project specific EFH conservation recommendations were provided. NSF agreed to implement the EFH conservation recommendations and in accordance with Section 305(b)(4)B of the MSA and the implementing regulations at 50CFR 600.920(k), provided a written response to SERO describing how the EFH conservation recommendation would be implemented (Attachment 1, Appendix D). SERO determined the proposed implementation measures to be consistent with the EFH recommendation and consultation was concluded (Attachment 1, Appendix D). NMFS also consulted with SERO for EFH.

Coastal Zone Management Act (CZMA)

NSF considered its obligations for the proposed activities pursuant to the Coastal Zone Management Act (CZMA) (16 USC §1451, *et seq*.). NSF reviewed the Federal Consistency Listings for the states near the survey, North Carolina (NC) and Virginia (VA), and determined that the proposed activities were not listed. Given the proposed land and marine research activities, including the size of the source level for the marine seismic survey and proximity to the NC coastal zone, NSF anticipated that there could be effects to NC coastal resources. NSF contacted the NC Department of Environment and Natural Resources' Division of Coastal Management (DCM), and they were in agreement that there could be effects from the proposed activities on NC coastal resources. Given the proposed activities and distance to the Virginia coastal zone, NSF did not anticipate effects to VA coastal resources. NSF contacted the VA Department of Environmental Quality (DEQ) regarding the project and the VA DEQ was in agreement with NSF's conclusion that there would be no effect to VA coastal resources and the state of VA did not seek review of the unlisted activities. NSF did not receive a request from any other state for a consistency review of the unlisted activities. NSF also discussed the proposed project with the NOAA Office of Ocean and Coastal Resource Management (OCRM) to confirm the agencies responsibilities under CZMA for the proposed unlisted activities.

NSF reviewed the enforceable policies of North Carolina's federally approved coastal management program and considered the potential impacts of the proposed research activities on NC coastal resources. NSF determined that the proposed activities would be situated outside of locations identified by NC as Areas of Environmental Concern. After additional review, NSF concluded that the proposed activities would be consistent, to the maximum extent practicable with the enforceable policies of North Carolina's federally approved coastal management program (CMP). NSF submitted a Consistency Determination to the DCM on June 18, 2014 (Attachment 1, Appendix G). The CZMA federal consistency process included a public comment period; although not received as part of the NSF NEPA process, NSF took into consideration comments received when preparing the Final EA. On 8 September , the DCM concurred that the proposed activities would be consistent to the maximum extent practicable with NC enforceable policies, however, did request additional monitoring and mitigation measures identified in the Final Programmatic Environmental Impact Statement issued by the Bureau of Ocean Energy Management in February 2014 (Attachment 1, Appendix D). Although not linked to the enforceable policies of the NC federally approved CMP, NSF agreed to comply with the additional monitoring and mitigation measures to the maximum extent practicable. NSF provided a response to the NC DCM accordingly (Attachment 1, Appendix D).

NOAA Office of National Marine Sanctuaries (ONMS)

As noted in § 3, Affected Environment, the Monitor National Marine Sanctuary (MNMS) is located outside of the survey area, with a closest approach of ~24km. In accordance with the National Marine Sanctuary Act (NMSA) Section 304(d), a federal agency is expected to consult with a Sanctuary if the proposed agency action is, "*likely to destroy, cause the loss of, or injure a sanctuary resource.*" At most, NSF would anticipate Level B Harassment of marine mammals that may be within the 160-dB zone around the proposed survey track lines. The Level B (160-dB) zone would remain significantly outside of the sanctuary; any marine mammals within the sanctuary would not be anticipated to be taken even during the brief period of time that the vessel would be conducting the survey closest to the sanctuary. Based on the proposed activities, the information and analysis in § III and IV, the distance of the survey to the sanctuary, and amount of time the vessel would be at its closest points to the sanctuary, we would not anticipate injury to any sanctuary resources. NSF contacted ONMS and MNMS staff about the project. ONMS staff confirmed that unless the proposed federal activities were anticipated to cause the destruction, loss, or injury to sanctuary resources, consultation for the proposed activities was not necessary.

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.

The weather in the mid Atlantic was taken into consideration when planning the proposed activities. The mid-Atlantic Ocean off North Carolina can be challenging to operate on during certain times of year, precluding the ability to safely tow seismic gear. Whereas conducting the survey at an alternative time is a viable alternative, because of the weather conditions, it would not be viable to conduct a seismic survey in winter months off the coast of North Carolina.

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 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). In particular, migration of the North Atlantic right whale occurs mostly between November and April, and the survey is timed to avoid those months.

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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VII. APPENDICES

- APPENDIX A: Incidental Harassment Authorization
- APPENDIX B: NMFS Biological Opinion
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- APPENDIX D: EFH Consultation Letters
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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

SEP 12 2014

Sean Higgins
Marine Environmental & Safety Coordinator
Department of Marine Operations
Lamont-Doherty Earth Observatory
P.O. Box 1000
Palisades, New York 10964-8000

Dear Mr. Higgins:

Enclosed is an Incidental Harassment Authorization (Authorization) issued to the Lamont-Doherty Earth Observatory, under the authority of Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*), to harass small numbers of marine mammals, by Level B harassment, incidental to the R/V *Marcus G. Langseth*'s marine seismic survey in the Atlantic Ocean during September through October, 2014.

You are required to comply with the conditions contained in the Authorization. Lamont-Doherty must report the taking of any marine mammal, in a manner prohibited under this Authorization, to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301-427-8401.

In addition, Lamont-Doherty must submit a report to the NMFS' Office of Protected Resources within 90 days after completing the survey. The Authorization requires monitoring of marine mammals by qualified individuals before, during, and after seismic activities and reporting of marine mammal observations, including species, numbers, and behavioral modifications potentially resulting from this activity.

If you have any questions concerning the Authorization or its requirements, please contact Jeannine Cody, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Donna S. Wieting

Donna S. Wieting
Director
Office of Protected Resources

Enclosures

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

INCIDENTAL HARASSMENT AUTHORIZATION

We hereby authorize the Lamont- Doherty Earth Observatory (Lamont- Doherty), Columbia University, P.O. Box 1000, 61 Route 9W, Palisades, New York 10964–8000, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to incidentally harass small numbers of marine mammals incidental to a marine geophysical survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) marine geophysical survey in the Atlantic Ocean offshore Cape Hatteras, NC September through October, 2014.

1. Effective Dates

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

2. Specified Geographic Region

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

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

3. Species Authorized and Level of Take

a. This Authorization limits the incidental taking of marine mammals, by Level B harassment only, to the species listed in Table 1 in the area described in Condition 2(a):

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

b. This Authorization prohibits the taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3 or the taking of any kind of any other species of marine mammal. Thus, it may result in the modification, suspension, or revocation of this Authorization.

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

   i. An airgun array with a total capacity of 6,600 cubic inches (in^3) (or smaller).

   ii. Lamont-Doherty will not operate the multi-beam echosounder, the sub-bottom profiler, or the acoustic Doppler current profiler during transit.

4. Reporting Prohibited Take

The Holder of this Authorization must report the taking of any marine mammal in a manner prohibited under this Authorization immediately to the Office of Protected Resources, National Marine Fisheries Service, at 301–427–8401 and/ or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

5. Cooperation

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

6. Mitigation and Monitoring Requirements

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

Visual Observers

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

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

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

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

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

  v. The *Langseth's* vessel crew will also assist in detecting marine mammals, when practicable. Visual observers will have access to reticle binoculars (7×50 Fujinon), and big-eye binoculars (25×150), optical range finders, and night vision devices.

Exclusion Zones

b. **Shallow Water (<=100 m)**: Establish a 180-dB and 190-dB exclusion zone (with 3-dB buffer) before starting the airgun subarray (6,600 in^3 or smaller); and a 180-dB and 190-dB exclusion zone (with buffer) for the single airgun (40 in^3). Observers will use the predicted radius distance for the 180-dB and 190-dB exclusion zones (with buffer) for mitigation shown in Table 2 (attached).

  Intermediate and Deep Water (>100 m): Establish a 180-dB and 190-dB exclusion zone before starting the airgun subarray (6,600 in^3 or smaller); and a 180-dB and 190-dB exclusion zone for the single airgun (40 in^3). Observers will use the predicted radius distance for the 180-dB and 190-dB exclusion zones for mitigation shown in Table 2 (attached).

Visual Monitoring at the Start of Airgun Operations

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

d. Delay airgun operations if the visual observer sees a cetacean within the 180-dB exclusion zone (with buffer as defined in Table 2) in shallow water or within the 180-dB exclusion zone in intermediate or deep water (as defined in Table 2) until the marine mammal(s) has left the area.

   Delay airgun operations if the visual observer sees a pinniped within the 190-dB exclusion zone (with buffer as defined in Table 2) in shallow water or within 190-dB exclusion zone in intermediate or deep water (as defined in Table 2) until the marine mammal(s) has left the area.

   i. If the visual observer sees a marine mammal that surfaces, then dives below the surface, the observer shall wait 30 minutes. If the observer sees no marine mammals during that time, he/she should assume that the animal has moved beyond the relevant exclusion zone (as defined in Table 2).

   ii. If, for any reason the visual observer cannot see the full relevant exclusion zone (as defined in Table 2) for the entire 30 minutes (*i.e.*, rough seas, fog, darkness), or if marine mammals are near, approaching, or within zone, the *Langseth* may not resume airgun operations.

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

Passive Acoustic Monitoring

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

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

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

   ii. Enter the information regarding the vocalization into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position, and water depth when first detected, bearing if determinable, species or species group (*e.g.*, unidentified dolphin, sperm whale), types and nature of sounds heard (*e.g.*, clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

Ramp-Up Procedures

g. Implement a ‘‘ramp-up’’ procedure when starting the airguns at the beginning of seismic operations or any time after the entire array has been shutdown for 8 minutes or longer, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the observers will monitor the exclusion zones, and if the observers sight marine mammals, the *Langseth* will implement a course/speed alteration, power-down, or shutdown as though the full array were operational.

Recording Visual Detections

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

   i. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (*e.g.*, none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace; and

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

   iii. The data listed under 6(f)(ii) at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

Speed or Course Alteration

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

Power-Down Procedures

j. Power down the airguns if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zone (as defined in Table 2). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun. This would reduce the relevant exclusion zone to the degree that the animal(s) is/are outside of that zone. When appropriate or possible, power-down of the airgun array shall also occur when the vessel is moving from the end of one trackline to the start of the next trackline. Following a power-down, if the marine mammal approaches the smaller exclusion zone (as defined in Table 2), then the *Langseth* must completely shut down the airguns.

Resuming Airgun Operations after a Power-Down

k. Airgun activity will not resume until the observer has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or the observer has not seen the animal within the relevant exclusion zone for 15 minutes for species with shorter dive durations (*i.e*., small odontocetes); or 30 minutes has passed for mysticetes and large odontocetes (including pygmy sperm, dwarf sperm, and killer whales); and 60 minutes has passed for sperm and beaked whales which can have longer dive durations.

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

Shutdown Procedures

m. Shutdown the airgun(s) if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zone (as defined in Table 2). A shutdown means that the *Langseth* turns off all operating airguns.

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

Resuming Airgun Operations after a Shutdown

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

p. Else, if the observer has not seen the animal depart the relevant exclusion zone (as defined in Table 2), the *Langseth* shall not resume airgun activity until 15 minutes has passed for species with shorter dive times (*i.e*., small odontocetes and pinnipeds); 30 minutes has passed for mysticetes and large odontocetes (including pygmy sperm, dwarf sperm, and killer whales); and 60 minutes has passed for sperm and beaked whales which can have longer dive durations. The *Langseth* will follow the ramp-up procedures described in Conditions 6(g).

Survey Operations

q. The *Langseth* may continue marine geophysical surveys into night and low-light hours if the Holder of the Authorization initiates these segment(s) of the survey when the observers can view and effectively monitor the full relevant exclusion zones (as defined in Table 2).

r. This Authorization does not permit the Holder of this Authorization to initiate airgun array operations from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the visual observers cannot view and effectively monitor the full relevant exclusion zones (as defined in Table 2).

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

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

Mitigation Airgun

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

Special Procedures for Large Whale Concentrations

v. The *Langseth* will power-down the array and avoid concentrations of humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) if possible (*i.e*., exposing concentrations of animals to 160 dB re: 1 µPa). For purposes of the survey, a concentration or group of whales will consist of six or more individuals visually sighted that do not appear to be traveling (*e.g*., feeding, socializing, etc.). The *Langseth* will follow the procedures described in Conditions 6(k) for resuming operations after a power down.

7. Reporting Requirements

This Authorization requires the Holder of this Authorization to:

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

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

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

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

   iv. An estimate of the number (by species) of marine mammals with estimated exposures (based on modeling results) to the seismic activity at received levels greater than or equal to 160 dB re: 1 µPa and/or 180 dB or 190-dB re: 1 µPa with a discussion of the nature of the probable consequences of that exposure on the individuals.

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

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

8. Reporting Prohibited Take

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by the Authorization, such as an injury, serious injury, or mortality (*e.g.*, ship-strike, gear interaction, and/or entanglement), Lamont-Doherty shall immediately cease the specified activities and immediately report the take to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

Lamont-Doherty must also contact the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network at 877-433-8299 (Blair.Mase@noaa.gov and Erin.Fougeres@noaa.gov).

The report must include the following information:

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

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

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

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition as we describe in the next section), Lamont-Doherty will immediately report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

Lamont-Doherty must also contact the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network at 877-433-8299 (Blair.Mase@noaa.gov and Erin.Fougeres@noaa.gov).

The report must include the same information identified in Condition 8. Activities may continue while we review the circumstances of the incident. We would work with Lamont-Doherty to determine whether modifications in the activities are appropriate.

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

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the injury or death is not associated with or related to the authorized activities (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Lamont-Doherty would report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

Lamont-Doherty must also contact the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network at 877-433-8299 (Blair.Mase@noaa.gov and Erin.Fougeres@noaa.gov).

Lamont-Doherty would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

11. Endangered Species Act Biological Opinion and Incidental Take Statement

Lamont-Doherty must comply with the Terms and Conditions of the Incidental Take Statement corresponding to the Endangered Species Act Biological Opinion issued to the National Science Foundation and NMFS' Office of Protected Resources, Permits and Conservation Division.

A copy of this Authorization and the Incidental Take Statement must be in the possession of all contractors and protected species observers operating under the authority of this Incidental Harassment Authorization.

Donna S. Wieting

SEP 12 2014

Donna S. Wieting
Director,
Office of Protected Resources
National Marine Fisheries Service

Date

Table 1 – Authorized Level B harassment take numbers for each marine mammal species during Lamont-Doherty's marine seismic survey in the Atlantic Ocean September 15, 2014 to October 31, 2014.

Mysticetes	Authorized Level B Take
North Atlantic right whale	5
Blue whale	3
Bryde's whale	21
Fin whale	19
Humpback whale	44
Minke whale	2
Sei whale	98
Odontocetes	**Authorized Level B Take**
Sperm whale	104
Dwarf sperm whale	39
Pygmy sperm whale	39
Cuvier's beaked whale	19
Gervais' beaked whale	19
Blainville's beaked whale	19
True's beaked whale	19
Rough-toothed dolphin	18
Bottlenose dolphin (offshore)	3,829
Bottlenose dolphin (SMC)	778
Bottlenose dolphin (NNCE)	7
Bottlenose dolphin (NNCE)	23
Pantropical spotted dolphin	830
Atlantic spotted dolphin	5,239
Spinner dolphin	74
Striped dolphin	112
Clymene dolphin	398
Short-beaked common dolphin	1,519
Atlantic white-sided-dolphin	0
Fraser's dolphin	114
Risso's dolphin	100
Melon-headed whale	114
Pygmy killer whale	57
False killer whale	18
Killer whale	7
Long-finned pilot whale	903
Short-finned pilot whale	903
Harbor porpoise	0
Harbor Seal	5

Table 2 –Exclusion Zones

Source and Volume (in^3)	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances[1] (m)				
			190 dB with Buffer	190 dB	180 dB with Buffer	180 dB	160 dB
Single Bolt airgun (40 in^3)	6 or 9	< 100 100-1,000 > 1,000	37[3] - -	27[3] - -	121[3] 100 100	86[3] 100 100	938[3] 582[2] 388[1]
18-Airgun array (3,300 in^3)	6	< 100 100-1,000 > 1,000	436[4] - -	294[4] - -	1,628[4] - -	1,097[4] 675[2] 450[1]	15,280[4] 5,640[2] 3,760[1]
36-Airgun array (6,600 in^3)	9	< 100 100-1,000 > 1,000	877[3] - -	645[3] - -	2,838[3] - -	2,060[3] 1,391[2] 927[1]	22,600[3] 8,670[2] 5,780[1]

[1] Based on Lamont-Doherty modeling results.
[2] Predicted distances based on model results with a 1.5 correction factor between deep and intermediate water depths.
[3] Predicted distances based on empirically-derived measurements in the Gulf of Mexico with scaling factor applied to account for differences in tow depth.
[4] Predicted distances based on empirically-derived measurements in the Gulf of Mexico.

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APPENDIX B: NMFS Biological Opinion

NOAA's National Marine Fisheries Service

Endangered Species Act Section 7 Consultation Biological Opinion

Agencies:	National Science Foundation-Division of Ocean Sciences and NOAA's National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division
Activities Considered:	Seismic survey by the Lamont-Doherty Earth Observatory along North Carolina's Outer Banks and Issuance of an Incidental Harassment Authorization pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act
Consultation Conducted by:	NOAA's National Marine Fisheries Service, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division
Approved by:	Donna S Wieting
Date:	SEP 1 2 2014

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List of Acronyms

ADCP-acoustic Doppler current profiler

CFR-Code of Federal Regulations

CI-confidence interval

CV-coefficient of variation

dB-decibel

DDE-dichlorodiphenyldichloroethylene

DDT-dichlorodiphenyltrichloroethane

DPS-distinct population segment

EEZ - Exclusive Economic Zone

ESA-Endangered Species Act

Hz-hertz

IHA-incidental harassment authorization

IWC-International Whaling Commission

kHz-kilohertz

kg-kilogram

L-DEO-Lamont Doherty Earth Observatory

MMPA-Marine Mammal Protection Act

NAO-North Atlantic Oscillation

NMFS-National Marine Fisheries Service

NMSDD-Navy Marine Species Density Database

NOAA-National Oceanic and Atmospheric Administration

NSF-National Science Foundation

OBIS-SEAMAP Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations

Observer-protected species visual observer

OBS-Ocean bottom seismometer

PAM-passive acoustic monitoring

PBDE-polybrominated diphenyl ethers

PCB-polychlorinated biphenyl

PDE-phosphodiesterase

PFC-perflourinated chemicals

PFCA-perfluorinated carboxylic acids

PFOA-perfluorooctanoic acid

PFOS-perfluorooctanesulfonic acid

PIT-passive integrated transponder

PSI-pounds per square inch

PTS-permanent threshold shift

RMS-root mean squared

SBP-sub-bottom profiler

SCDNR-South Carolina Department of Natural Resources

SE-standard error

SEL-sound exposure level

TED-turtle excluder device

TEWG-Turtle Expert Working Group

TTS-temporary threshold shift

U.S. -United States

USC-United States Code

1 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act (ESA; 16 U.S.C. 1531 et seq.) requires that each federal agency insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" an ESA-listed species or critical habitat designated for it, that agency is required to consult with National Oceanic Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the ESA-listed resources that may be affected. For the activities described in this document, the Federal action agencies are the National Science Foundation (NSF) and NMFS's Permits and Conservation Division.

The NSF proposes to allow the use of its research vessel, *Marcus G. Langseth* (*Langseth*), which is operated by the Lamont-Doherty Earth Observatory (L-DEO), to conduct seismic surveys off North Carolina's Outer Banks from September to October of 2014, in support of an NSF-funded research project. The NMFS's Permits and Conservation Division is also a Federal action agency as it is proposing to issue an incidental harassment authorization (IHA) for non-lethal "takes" of marine mammals incidental to the planned seismic surveys, pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371 (a)(5)(D)). The consulting agency is the NMFS's Office of Protected Resources, ESA Interagency Cooperation Division.

This document represents NMFS's ESA Interagency Cooperation Division's biological opinion (Opinion) on the effects of the proposed actions on endangered and threatened species as well as designated critical habitat and has been prepared in accordance with section 7 of the ESA. This Opinion is based on information provided in the MMPA incidental harassment authorization application, draft public notice of proposed Incidental Harassment Authorization, a draft environmental assessment prepared pursuant to the National Environmental Policy Act (NEPA), monitoring reports from similar activities, published and unpublished scientific information on endangered and threatened species and their surrogates, scientific and commercial information such as reports from government agencies and the peer-reviewed literature, biological opinions on similar activities, and other sources of information.

1.1 Consultation History

On February 14, 2014, the NMFS's ESA Interagency Cooperation Division received a request for formal consultation from the NSF to take by harassment, marine mammal and sea turtle species during conduct of a proposed seismic survey. Information was not sufficient to initiate consultation with the NSF on this date. We requested more details on the effects of the action and consideration of existing activities.

On February 26, 2014, the NMFS's Permits and Conservation Division received an application from the L-DEO to incidentally harass marine mammal species during the proposed seismic survey.

On May 5, 2014, the NSF provided the NMFS's ESA Interagency Cooperation Division with an updated draft environmental assessment. Remaining issues pertinent to assessing the effects of land-based components of the proposed action remained outstanding.

On June 9, 2014, the NMFS's ESA Interagency Cooperation Division received information on proposed land-based activities that allowed for a full understanding of these activities. With this clarification, information was sufficient to initiate consultation on this date.

On July 31, 2014, the NMFS's Permits and Conservation Division sent the application for the proposed seismic surveys out to reviewers and published a notice in the *Federal Register* soliciting public comment on their intent to issue an Incidental Harassment Authorization.

On August 25, 2014, the NMFS's ESA Interagency Cooperation Division received a request for formal consultation on proposed issuance of an Incidental Harassment Authorization from the NMFS's Permits and Conservation Division. Information was sufficient to initiate consultation with the Permits and Conservation Division on this date.

2 DESCRIPTION OF THE PROPOSED ACTIONS

The NSF proposes to allow the use of its research vessel, *Marcus G. Langseth* (*Langseth*), which is operated by the L-DEO, to conduct a seismic survey off North Carolina's Outer Banks during an approximate 41-day period in mid-September to October, 2014 in support of an NSF-funded research project. An array of 18-36 airguns will be deployed as an energy source. In addition, a multibeam echosounder, sub-bottom profiler (SBP), and acoustic Doppler current profiler (ADCP) will continuously operate from the *Langseth*, except during transits to and from the survey site. 47 ocean bottom seismometers (OBSs) will be deployed and retrieved and then deployed and retrieved again using an accessory vessel, the *R/V Endeavor*. An eight-kilometer long hydrophone streamer will also be deployed from the *Langseth*. NMFS's Permits and Conservation Division proposes to issue an incidental harassment authorization for Level B harassment (behavioral disturbance) of marine mammals that would occur incidental to these studies, pursuant to Section 101(a)(5)(D) of the MMPA.

The purpose of the proposed activities is to collect and analyze data along the mid-Atlantic coast of the East North American Margin. 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. 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.

2.1 Schedule

The NSF proposes to allow the use of the *Langseth* by L-DEO for roughly 33 days of seismic operations, two days of gear retrieval and transit to and from the action area, and an additional six days of setup, deployment, and streamer ballasting from September 15 to about October 22, 2014. Some minor deviation from the proposed dates is possible, depending on logistics and weather conditions. Unlike previous NSF-funded seismic surveys, trackline will not be reshot and no additional contingency effort is anticipated in association with the planned seismic survey trackline. During an approximate 41-day period in mid-September to October 2014, the *Langseth* would survey the action area with the assistance of the *Endeavor*. The *Langseth* would depart from Norfolk, Virginia and return to Norfolk, Virginia following the seismic survey. NMFS's Permits and Conservation Division proposes to issue an authorization that is effective from September 15, 2014 to October 31, 2014.

2.2 Source Vessel Specifications

The *Langseth* will tow the airgun array along predetermined lines (Figure 1). The *Langseth's* design is that of a seismic research vessel, with a particularly quiet propulsion system to avoid interference with the seismic signals. The operating speed during seismic acquisition is typically 7.8-8.3 km/h (4.2-4.5 knots). When not towing seismic survey gear, the *Langseth* typically cruises at 20-24 km/h (11-12 knots). The *Langseth* will also serve as the platform from which protected species visual observers (observers) would watch for animals.

The *Endeavor*, another NSF-owned vessel, can achieve speeds of 18.5 km/h (knots) and may achieve these speeds between ocean bottom seismometer (OBS) deployment and retrieval stops. However, it will operate at very low speeds near retrieval and deployment sites.

A third chase vessel, similar to the *Northstar Commander* (twin-screwed offshore multi-purpose vessel of 28 m length) will also be present to assist in operations.

2.3 Airgun Description

The airgun configuration includes two or four identical linear arrays or "strings" (Figure 1). The four airgun strings will be towed behind the vessel. The full airgun array will consist of 36 airguns, plus four spare airguns, in four strings, with a total operational volume of up to 6,600 in^3. The 36-airgun array will be used during OBS and multichannel survey (MCS) trackline portions of the seismic survey (Figure 2). Only 18 airguns from two airgun strings (totaling 3,300 in^3 in discharge volume) will be operational during some portions of the seismic survey (Figure 2). Each string will have nine airguns plus one spare. Nine airguns in each of four strings would fire at any one time. The tow depth of the array will be 9 m for the 36-airgun array and 6 m for the 18-airgun array. The airgun array will fire roughly every 65 seconds (every 150 m transected) for the OBS portion of the seismic survey and every 22 seconds (every 50 m transected) during the MCS portion. During firing, a brief (approximately 0.1 s) pulse of sound will be emitted. This signal attenuates as it moves away from the source, decreasing in amplitude, but also increasing in signal duration. Airguns will operate continually during the survey period except for unscheduled shut-downs.

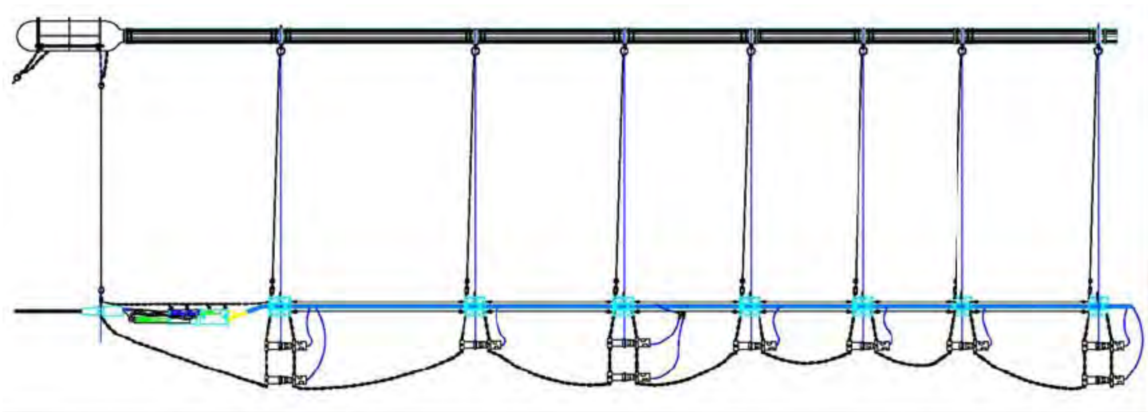


Figure 1. One linear airgun array or string with nine operating airguns, plus one spare.

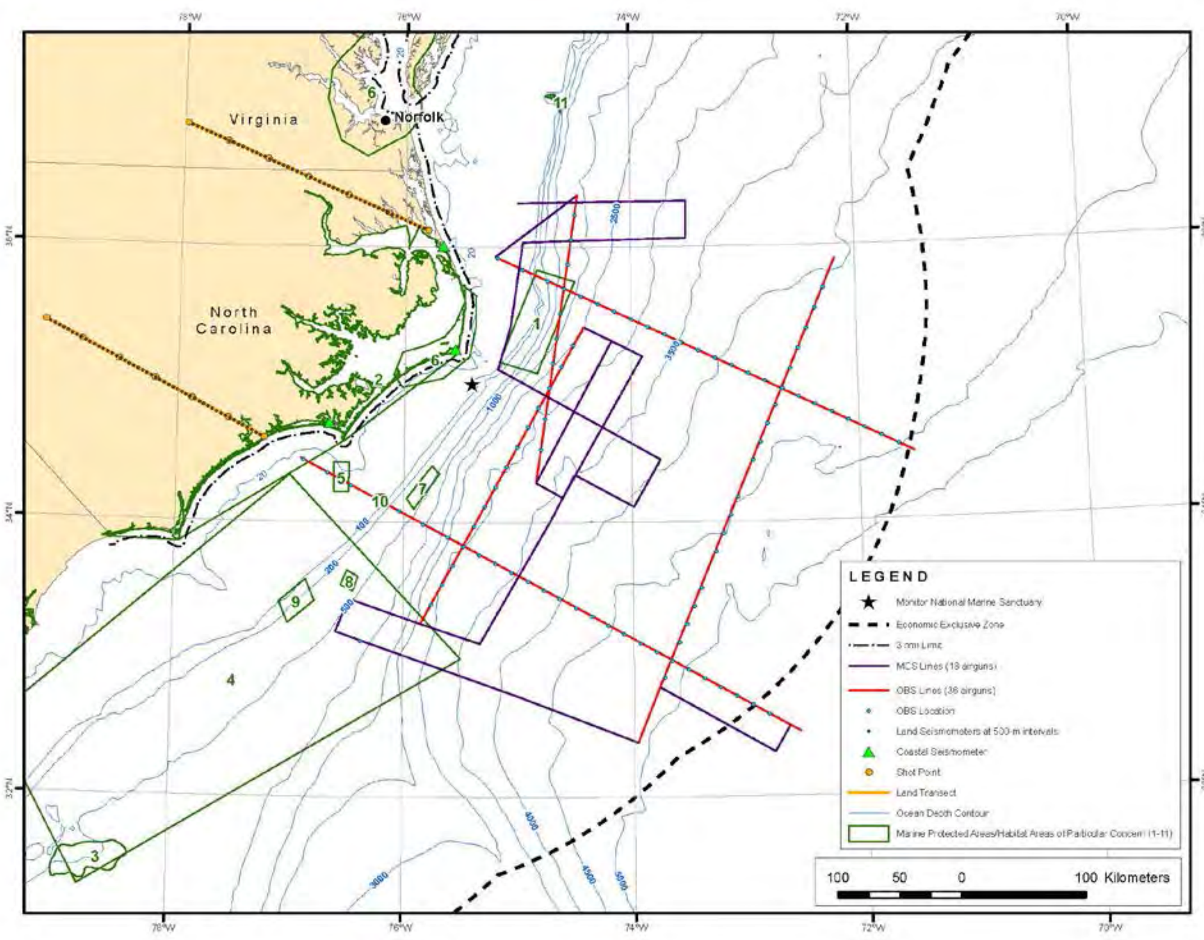


Figure 2. Proposed area for the marine seismic survey off North Carolina's Outer Banks. Trackline for the seismic survey is identified in purple and red lines for 18- and 36-airgun array activities, respectively. The exclusion zone (area where mitigation would be undertaken if protected species are observed; not the U.S. exclusive economic zone [EEZ]) is not depicted in the figure but occurs within roughly two kilometers or less to either side of the trackline, depending upon the water depth in which the vessel is located.

36-airgun array specifications

• Energy source	36- 1500LL or 1900LLX Bolt airguns of 40-360 in^3 each, in four strings of nine operating airguns per string
• Source output (downward)	0-pk is 259 dB re 1 μPa·m pk-pk is 265 dB re 1 μPa·m
• Air discharge volume	~6,600 in^3
• Dominant frequency components	2–188 Hz

18-airgun array specifications

• Energy source	18- 1500LL or 1900LLX Bolt airguns of 40-360 in^3 each, in two strings of nine operating airguns per string
• Source output (downward)	0-pk is 252 dB re 1 μPa·m pk-pk is 259 dB re 1 μPa·m
• Air discharge volume	~3,300 in^3
• Dominant frequency components	2–188 Hz

Because the actual source originates from 36 airguns rather than a single point source, the highest sound levels measurable at any location in the water is less than the nominal source level. In addition, the effective source level for sound propagating in near-horizontal directions will be substantially lower than the nominal source level applicable to downward propagation because of the directional nature of the sound from the airgun array.

2.4 Ocean Bottom Seismometers

A total of 94 OBSs would be deployed during the course of the seismic survey. The *Endeavor* will deploy 47 OBSs along seismic survey trackline and the *Langseth* would then undertake seismic survey operations over these locations. The *Endeavor* would then recover the OBSs and redeploy them at new locations along the trackline. The *Langseth* would then transect over these locations before the *Endeavor* re-recovers the OBSs.

Once ready for retrieval, an acoustic release transponder will interrogate the ocean bottom seismometer at a frequency of 9–11 kHz, and the *Langseth* will receive a response at a frequency of 10-12 kHz of 8 milliseconds duration. The burn wire release assembly will then activate, and the instrument will release from the anchor and float to the surface.

2.5 Multibeam Echosounder, Sub-bottom Profiler, and acoustic Doppler echosounder

Along with airgun operations, three additional acoustical data acquisition systems will operate during the surveys from the *Langseth*. The multibeam echosounder and sub-bottom profiler systems will map the ocean floor during the surveys and the ADCP will map ocean currents. These sound sources will operate from the *Langseth* simultaneously with the airgun array.

The multibeam echosounder is a hull-mounted system operating at 10.5-13 kHz. The beamwidth is 1 or 2° fore–aft and 150° perpendicular to the ship's line of travel. The maximum source level is 242 dB re 1 μPa·m_{rms}. For deepwater operation, each "ping" consists of eight successive fan-shaped transmissions, each 2 to 15 ms in duration and each ensonifying a sector that extends 1° fore–aft. The eight successive transmissions span an overall cross-track angular extent of about 150°, with 2 ms gaps between the pulses for successive sectors (Maritime 2005).

The Knudsen Chirp 3260 SBP is normally operated to provide information about the sedimentary features and the bottom topography that is being mapped simultaneously by the MBES. The SBP is capable of reaching depths of 10,000 m. The beam is transmitted as a 27º cone, which is directed downward by a 3.5-kHz transducer in the hull of the *Langseth*. The nominal power output is 10 kW, but the actual maximum radiated power is 3 kW or 222 dB re 1 μPa·m. The ping duration is up to 64 ms, and the ping interval is 1 s. A common mode of operation is to broadcast five pings at 1-s intervals.

***Langseth* sub-bottom profiler specifications**

• Maximum/normal source output (downward)	222 dB re 1 μPa·m
• Dominant frequency component	3.5 kHz, up to 210 kHz
• Nominal beam width	27°
• Ping duration	≤64 ms
• Bandwidth	1.0 kHz with pulse duration 4 ms 0.5 kHz with pulse duration 2 ms 0.25 kHz with pulse duration 1 ms
• Pulse duration	1, 2, or 4 ms

The ADCP is a Teledyne OS75 operating at 75 kHz with a beam width of 30° (total of four beams). The draft environmental assessment suggests that, based upon comparable equipment, the maximum source level for this device is 224 dB re 1μPam.

2.6 Proposed Exclusion Zones

The L-DEO will implement exclusion zones around the *Langseth* to minimize any potential adverse effects of airgun sound on MMPA and ESA-listed species. These zones are areas where seismic airguns would be powered down or shut-down to reduce exposure of marine mammals and sea turtles to sound levels expected to produce potential fitness consequences. These exclusion zones are based upon modeled sound levels at various distances from the *Langseth*, described below. Normally, the exclusion zone is based upon isopleth modeling from the acoustic source to the 180 dB re 1 μPa_{rms} isopleth. Due to the shallow-water nature of this cruise, the Permits and Conservation Division is requiring the exclusion zone be extended to the 177 dB re 1 μPa_{rms} isopleth for the entire cruise trackline.

Predicted Sound Levels vs. Distance and Depth. The L-DEO has predicted received sound levels in deep water (free-field model), in relation to distance and direction from the 36-airgun array (Figure 2) as well as a 40-in^3 single 1900LLX airgun used during power-downs (Figure 3). This ray-tracing model used to predict received sound levels incorporates ghost reflection from the ocean surface, but does not account for bathymetric features or for oceanographic features, such as sound channeling, ocean chemistry, or other site-specific features. Empirical data concerning 180 (normally bounds the exclusion zone) and 160 dB re 1 μPa_{rms} distances were acquired during the acoustic calibration study of the *Langseth*'s 36-airgun 6,600 in^3 array in the Gulf of Mexico (Diebold et al. 2010) at shallow (roughly 50 m), intermediate (600-1,100 m), and deep water environments (1,600 m) depths. The shallow water modeling was incorporated for estimating isopleth ranges in Table 1. However, the tow depth for the 36-airgun array was different in the Gulf of Mexico calibration study (6 m tow depth) than in the proposed survey (9 m tow depth). This field testing also involved placement of a vertical line hydrophone, which, in some cases (particularly in deep and shallow regions at longer ranges where bathymetric features strongly influence propagation) may not have detected the maximum sound pressure level (SPL) that was present at the maximum relevant depth, which was established at the maximum diving depth for ESA-listed species (2,000 m). As only sperm whales and leatherback sea turtles dive to this depth and, we expect that individuals will rarely be found at this depth for only these ESA-listed species, the isopleth distance from the source array is likely to overestimate the exposure ESA-listed individuals are expected to experience. A correction factor of 1.5 was applied to the 18-airgun array propagation estimates from deep water as an estimate for intermediate water isopleths. Although 18-airgun isopleth estimates are applied directly from the GOM calibration survey, the 36-airgun estimates are corrected by a factor of 1.29 because the tow depth was different between the GOM calibration study and that proposed to occur in the action area (6 m vs. 9 m).

The single 40-in^3 airgun has not been field tested for isopleth modeling comparison, but the L-DEO proposes to use the conservative 100m radii for the 177 dB dB re 1 μPa_{rms} exclusion zone as defined in the programmatic environmental impact statement for all low-energy sources in water depths >100m. To determine 160 dB dB re 1 μPa_{rms} radii, a correction factor of 1.5 for intermediate-water depths was applied from deep-water results. Further scaling was done from deep-water results to obtain shallow-water estimates.

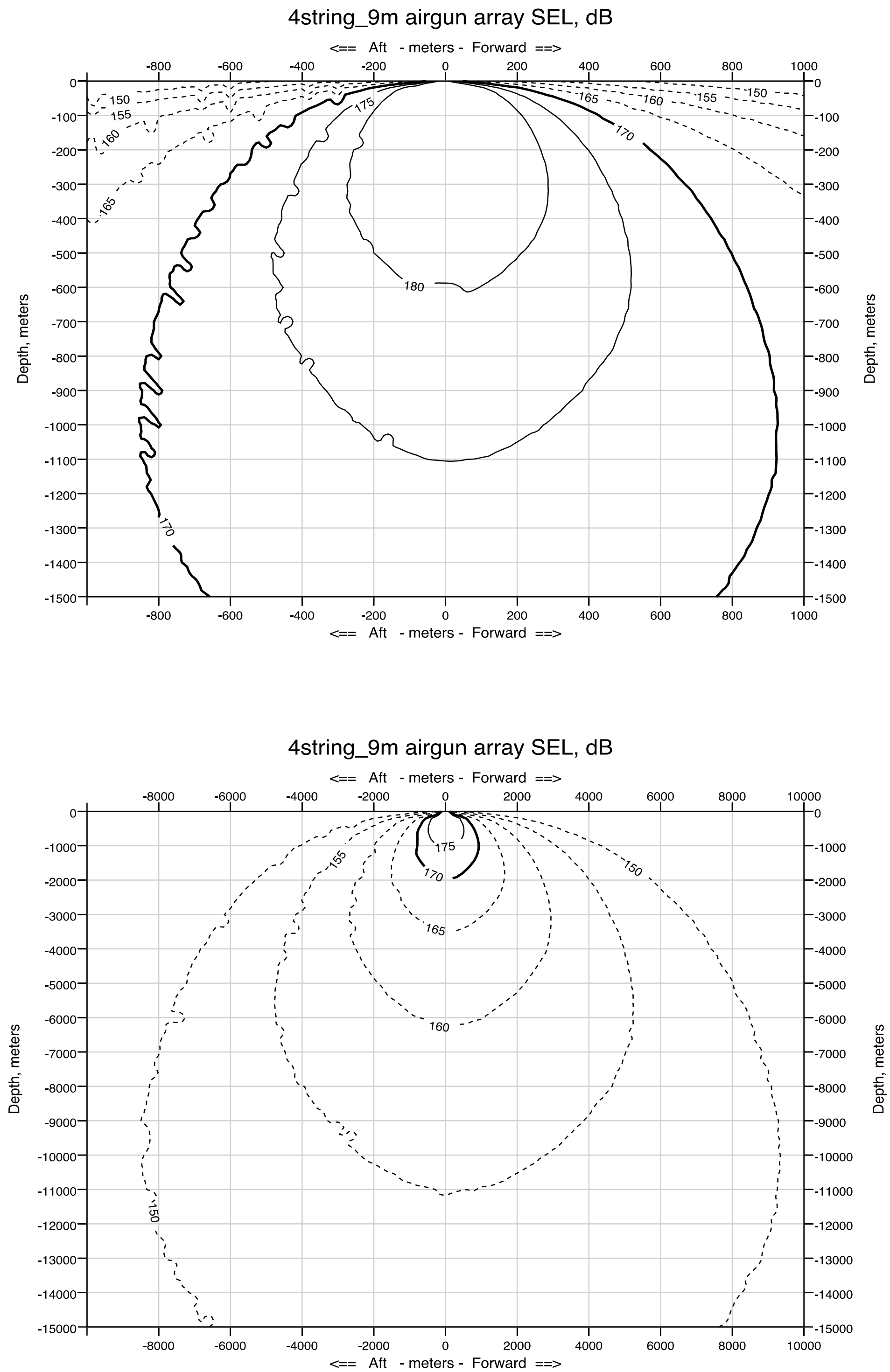


Figure 3. Modeled SEL contour distances for the 36-airgun array at nine meter tow depth in deep (>1,000 m) water.

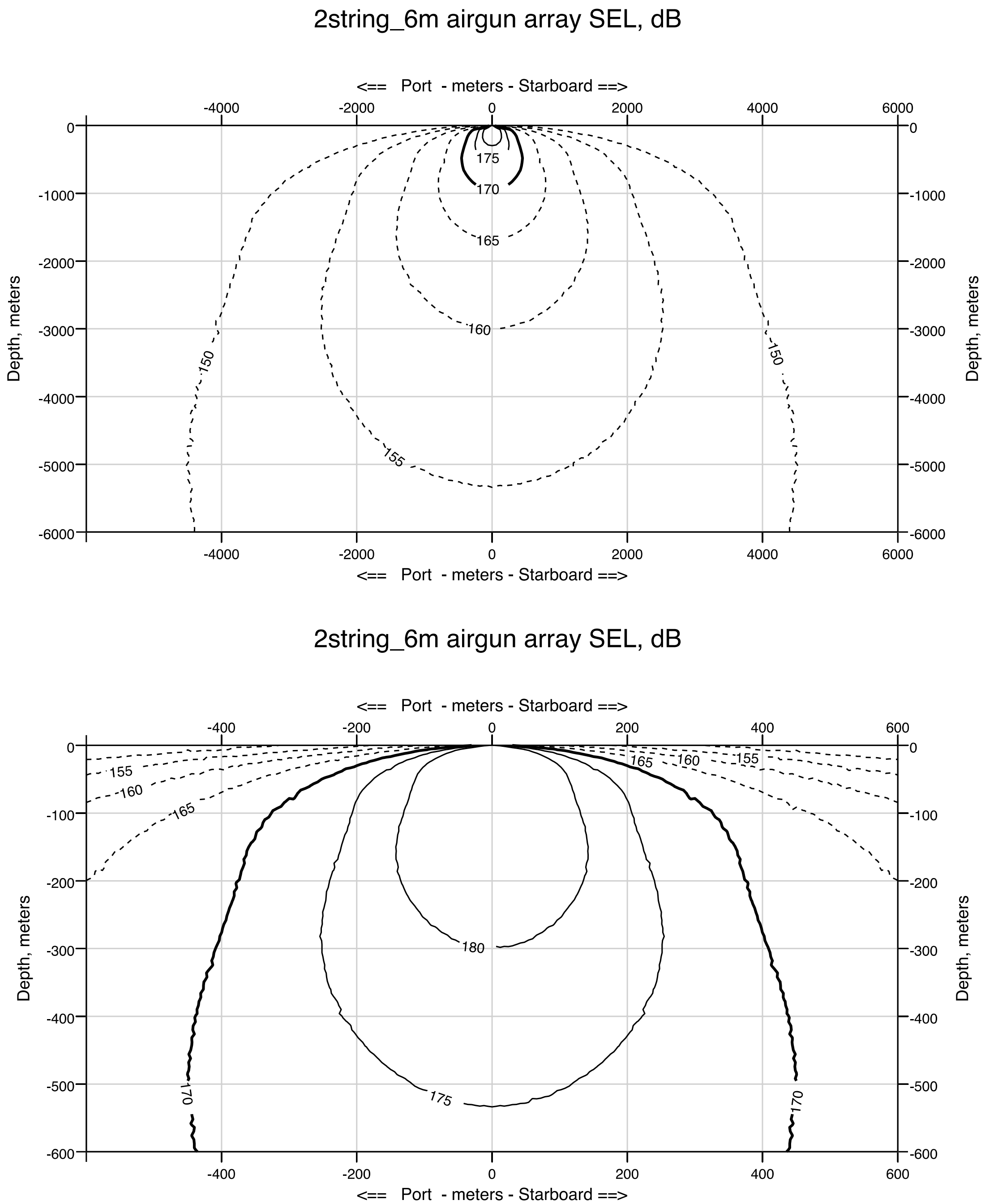
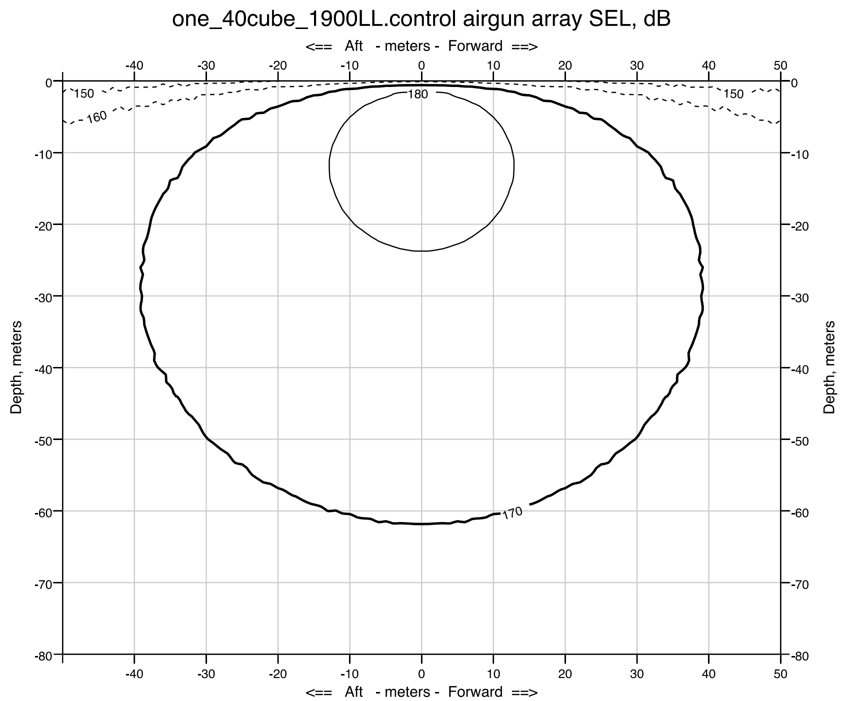


Figure 4. Modeled SEL contour distances for the 18-airgun array at six meter tow depth in deep (>1,000 m) water.



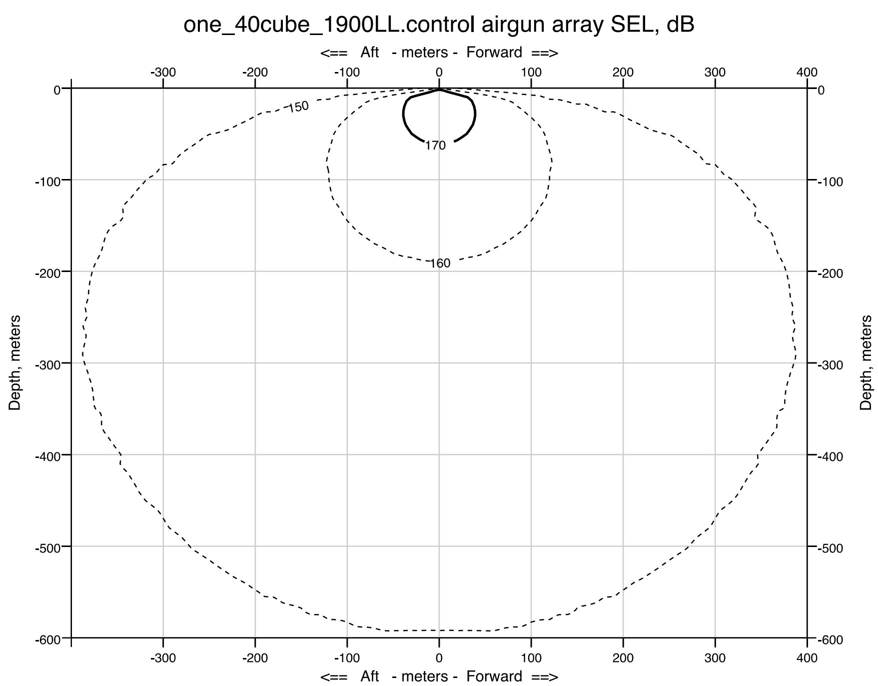


Figure 5. Modeled SEL contour distances for the 40 in^3 mitigation gun at nine meter tow depth in deep water.

Table 1 shows the distances at which three rms (root mean squared) sound levels are expected to be received from the 18- and 36-airgun array as well as a single airgun. The 180 dB re 1 μPa_{rms} distance is the exclusion zone as specified by NMFS (1995) as applicable to cetaceans under the MMPA. As previously stated, this survey will occur in part in shallow water and the Permits and Conservation Division is requiring the exclusion zone to be extended to the 177 dB re 1 μPa_{rms}

isopleth distance for portions of the trackline that occur in waters that are less than 100 m deep. For intermediate and deep water depths (collectively, greater than 100 m in water depth), the 180 dB isopleth distance will be used to define the exclusion zone for seismic airgun activities along these portions of the trackline. 180 and 177 dB re 1 μPa_{rms} distances will be used as the exclusion zone for marine mammals, as required by NMFS during most other recent L-DEO seismic projects (Cameron et al. 2013; Holst and Beland 2008; Holst and Smultea 2008b; Holst et al. 2005a; Holt 2008; L-DEO 2012; Smultea et al. 2004). The 177 dB isopleth would also be the exclusion zone boundary for sea turtles in shallow water. The 166 dB isopleth represents our best understanding of the threshold at which sea turtles exhibit behavioral responses to seismic airguns (McCauley et al. 2000a; McCauley et al. 2000b). The 160 dB re 1 μPa_{rms} distance is the distance at which MMPA take, by Level B harassment, is expected to occur.

Table 1. Predicted distances to which sound levels of 180, 177, 166, and 160 dB re 1 μPa_{rms} could be received from the 18- and 36-airgun arrays as well as the 40 in^3 airgun in shallow (<100 m), intermediate (100-1,000 m), and deep (>1,000 m) water depths.

Source, volume, and tow depth	Predicted RMS radii (m)				
	Water depth (m)	180 dB	177 dB	166 dB	160 dB
36-airgun array 6,600 in^3 @ 9 m	>1,000	927	n/a	3,740	5,780
	100-1,000	1,391	n/a	5,610	8,670
	<100	2,060	2,838	11,100	22,600
18-airgun array 3,300 in^3 @ 9 m	>1,000	450	n/a	2,194	3,760
	100-1,000	675	n/a	3,291	5,640
	<100	1,097	1,628	6,950	15,280
Single Bolt airgun, 40 in^3 @ 6 or 9 m	>1,000	100	n/a	185	388
	100-1,000	100	n/a	278	582
	<100	86	121	464	938

2.7 Land-based activities

Two, 200-km long land-based lines will be the focus of passive seismometer placement as well as land-based "shots" involving 450 kg charges (consisting of ammonium, calcium, and sodium nitrates, and diesel fuel containing the energy of roughly 35 liters of diesel fuel) detonated roughly 25 m underground. Shots would be detonated one at a time. Two of the shots, one on each line, would occur within roughly 2 km of marine and estuarine habitats.

3 INCIDENTAL HARASSMENT AUTHORIZATION

The NMFS's Permits and Conservation Division is proposing to issue an incidental harassment authorization authorizing non-lethal "takes" by Level B harassment of marine mammals incidental to the planned seismic survey to L-DEO. The incidental harassment authorization will be valid from September 15, 2014-October 31, 2014, and will authorize the incidental harassment of the following endangered species: blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), humpback whales (*Megaptera novaeangliae*), North Atlantic right whale (*Eubalaena glacialis*), sperm whales (*Physeter macrocephalus*), and other non-listed marine mammals.

L-DEO must adhere to the following conditions for the IHA to remain valid:

A. Establish an exclusion zone[1] corresponding to the anticipated 177 dB (in waters <100 m deep) or 180 (in waters >100 m deep) dB re 1 μPa_{rms} isopleth for the airgun subarray (6,600 in^3 or smaller), and single (40 in^3) airgun operations as well as a 160 dB re 1 μPa_{rms} buffer zone.

B. Cease use of the multi-beam echosounder, the sub-bottom profiler, or the acoustic Doppler current profiler during transit to and from port.

C. Use two, NMFS-approved, vessel-based observers to watch for and monitor marine mammal species near the seismic source vessel during daytime airgun operations (dawn to dusk)and while the seismic array and streamers are being deployed and retrieved. Vessel crew will also assist in detecting marine mammals, when practical. Observers will have access to reticle binoculars (7 X 50 Fujinon), big-eye binoculars (25 X 150), optical range finders, and night vision devices. Observers shifts will last no longer than four hours at a time. Observers will also observe during daytime periods when the seismic system is not operating for comparisons of animal abundance and behavior, when feasible.

D. Record the following information when a marine mammal is sighted:

i. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace.

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

iii. The data listed under ii. would also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

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1 The "exclusion zone" refers to a region around the seismic airgun source where mitigation would be undertaken to avoid or minimize the impacts of the airguns if marine mammals or sea turtles are observed within it.

E. Visually observe the entire extent of the exclusion zone using observers, for at least 30 min prior to starting the airgun (day or night), including after a shutdwon. If observers find a marine mammal within the exclusion zone, L-DEO must delay the seismic survey until the marine mammal has left the area. If the observer sees a marine mammal that surfaces, then dives below the surface, the observer shall wait 60 minutes. If the observer sees no marine mammals during that time, they should assume that the animal has moved beyond the exclusion zone. If for any reason the entire radius cannot be seen for the entire 30 min (e. g., rough seas, fog, darkness), or if marine mammals are near, approaching or in the exclusion zone, the airguns may not be started up. If one airgun is already running at a source level of at least 180 dB re 1 μPa_{rms}, L-DEO may start subsequent guns without observing the entire exclusion zone for 30 min prior, provided no marine mammals are known to be near the safety radius. While it is considered unlikely, in the event a North Atlantic right whale (*Eubalaena glacialis*) is visually sighted, the airgun array will be shut-down regardless of the distance of the animal(s) to the sound source. The array will not resume firing until 30 min after the last documented whale visual sighting. Concentrations (greater than or equal to six individuals that do not appear to be traveling) of humpback, sei, fin, blue, and/or sperm whales will be avoided if possible (*i.e.*, exposing concentrations of animals to 160 dB), and the array will be powered-down if necessary.

F. Use the passive acoustic monitoring system (PAM) to detect marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. One observer and/or bioacoustician will monitor the PAM at all times in shifts of 1-6 h. A bioacoustician shall design and set up the PAM system and be present to operate or oversee PAM, and be available if technical issues occur during the survey.

G. Do or record the following when an animal is detected by the PAM:

i. Contact the observer immediately (and initiate power or shut-down, if required);

ii. Enter the information regarding the vocalization into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position and water depth when first detected, bearing if determinable, species or species group, types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

H. Apply a "ramp-up" procedure when starting up at the beginning of seismic operations or any time after the entire array has been shut-down for 8 min, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-min period. During ramp-up, the observers will monitor the 177 (in waters $<$100 m deep) or 180 (in waters $>$100 m deep) dB re 1 μPa_{rms} exclusion zone, and if marine mammals are sighted, a course/speed alteration, power-down, or shut-down will occur as though the full array were operational.

I. Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the exclusion zone. If speed or course alteration is not safe or practical, or if after alteration the marine mammal still appears likely to enter the exclusion zone, further mitigation measures, such as power-down or shut-down, will be taken.

J. Shut-down or power-down the airguns upon marine mammal detection within, approaching, or entering the exclusion zone. A power-down means shutting down one or more airguns and reducing the buffer and exclusion zones to the degree that the animal is outside of one or both. Following a power-down, if the marine mammal approaches the smaller designated exclusion zone, the airguns must be completely shut down. Airgun activity will not resume until the marine mammal has cleared the exclusion zone, which means it was visually observed to have left the exclusion zone, or has not been seen within the exclusion zone for 15 min (small odontocetes) or 60 min (mysticetes and large odontocetes). The *Langseth* may operate a small-volume airgun (*i.e.*, mitigation airgun) during turns and short maintenance periods (less than three hours) at approximately one shot per minute. During turns or brief transits between seismic tracklines, one mitigation airgun would continue to operate.

K. Marine seismic operations may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire exclusion zone is visible and can be effectively monitored. No initiation of airgun array operations is permitted from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the entire exclusion zone cannot be effectively monitored by the observer(s) on duty. To the maximum extent practicable, seismic airgun operations should be scheduled during daylight hours and surveys (especially when near land) should transect from inshore to offshore in order to avoid trapping marine mammals in shallow water.

L. In the unanticipated event that the specified activity clearly causes any cases of marine mammal injury or mortality are judged to result from these activities (*e.g.*, ship-strike, gear interaction, and/or entanglement), L-DEO will cease operating seismic airguns and report the incident to NMFS's Office of Protected Resources at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov, the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) (Blair.Mase@noaa.gov) immediately. Airgun operation will then be postponed until NMFS is able to review the circumstances and work with L-DEO to determine whether modifications in the activities are appropriate and necessary.

M. In the event that L-DEO discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition as described in the next paragraph), L-DEO will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov, the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) (Blair.Mase@noaa.gov). Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with L-DEO to determine whether modifications in the activities are appropriate.

N. In the event that L-DEO discovers an injured or dead marine mammal, and the lead visual observer determines that the injury or death is not associated with or related to the activities (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), L-DEO shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to

Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov, the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) (Blair.Mase@noaa.gov), within 24 hours of the discovery. L-DEO shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

O. L-DEO is required to comply with the Terms and Conditions of this Opinion's Incidental Take Statement issued to both the NSF and the NMFS's Office of Protected Resources.

In addition, the proposed incidental harassment authorization requires L-DEO to adhere to the following reporting requirements:

A. The Holder of this Authorization is required to submit a report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days after the completion of the *Langseth*'s cruise.

i. Dates, times, locations, heading, speed, weather, and associated activities during all seismic operations.

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

iii. An estimate of the number (by species) of marine mammals that:

a. Are known to have been exposed to the seismic activity (visual observation) at received levels greater than or equal to 160 dB re 1 microPa (rms) and/or 177 or 180 dB re 1 microPa (rms) for cetaceans with a discussion of any specific behaviors those individuals exhibited.

b. May have been exposed (modeling results) to the seismic activity at received levels greater than or equal to 160 dB re 1 microPa (rms) and/or 177 or 180 dB re 1 microPa (rms) with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

iv. A description of the implementation and effectiveness of the:

a. Terms and conditions of the Opinion's Incidental Take Statement.

b. Mitigation measures of the IHA. For the Opinion, the report will confirm the implementation of each term and condition and describe the effectiveness, as well as any conservation measures, for minimizing the adverse effects of the action on listed whales.

4 Approach to the Assessment

The NMFS approaches its section 7 analyses of agency actions through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on ESA-listed species or on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The result of this step includes defining the *Action Area* for the consultation. The second step of our analyses identifies the ESA-listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *Exposure Analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which ESA-listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those ESA-listed resources are likely to respond given their exposure (these represent our *Response Analyses*).

The final steps of our analyses – establishing the risks those responses pose to ESA-listed resources – are different for ESA-listed species and designated critical habitat (these represent our *Risk Analyses*). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. The continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them – populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between ESA-listed species, the populations that comprise that species, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks actions pose to ESA-listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to ESA-listed individuals using the individuals' "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness.

When an individual is expected to experience reductions in fitness in response to an action's effects, those fitness reductions may reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (see Stearns 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. As a result, when ESA-listed plants or animals exposed to an action's effects are *not* expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (e.g., Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992). As a result, if we conclude that ESA-listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

Although reductions in fitness of individuals is a *necessary* condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always *sufficient* to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that ESA-listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and *Status of Listed Resources* sections of this Opinion) as our point of reference. If we conclude that reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent, we would conclude our assessment.

Reducing the viability of a population is not always *sufficient* to reduce the viability of the species those populations comprise. Therefore, in the final step of our analyses, we determine if reductions in a population's viability are likely to reduce the viability of the species those populations comprise using changes in a species' reproduction, numbers, distribution, estimates of extinction risk, or probability of being conserved. In this step of our analyses, we use the species' status (established in the *Status of Listed Resources* section of this Opinion) as our point of reference. Our final determinations are based on whether threatened or endangered species are likely to experience reductions in their viability and whether such reductions are likely to be appreciable.

To conduct these analyses, we rely on all of the best scientific and commercial evidence available to us. This evidence consists of the environmental assessment submitted by the NSF, monitoring reports submitted by past and present seismic survey operators, reports from NMFS Science Centers; reports prepared by natural resource agencies in states and other countries, reports from non-governmental organizations involved in marine conservation issues, the information provided by NMFS's Permits and Conservation Division when it initiates formal consultation, the general scientific literature, and our expert opinion.

We supplement this evidence with reports and other documents – environmental assessments, environmental impact statements, and monitoring reports – prepared by other federal and state agencies like the Bureau of Ocean Energy Management, U.S. Coast Guard, and U.S. Navy whose operations extend into the marine environment.

During the consultation, we conducted electronic searches of the general scientific literature using search engines, including Agricola, Ingenta Connect, Aquatic Sciences and Fisheries Abstracts, JSTOR, Conference Papers Index, First Search (Article First, ECO, WorldCat), Web of Science, Oceanic Abstracts, Google Scholar, and Science Direct. We also referred to an internal electronic library that represents a major repository on the biology of ESA-listed species under the NMFS's jurisdiction.

We supplemented these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically tried to identify data or other information that supports a particular conclusion (for example, a study that suggests whales will exhibit a particular response to acoustic exposure or close vessel approach) as well as data that do not support that conclusion. When data are equivocal or when faced with substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action would not have an adverse effect on ESA-listed species when, in fact, such adverse effects are likely (i.e., Type II error).

Assessment approach applied to this consultation

In this particular assessment, we identified the potential stressors associated with the action and determined which were probable based upon previous seismic surveys. Of the probable stressors, we identified the species that are expected to co-occur with the effects of the action, particularly the acoustic isopleths of the airgun and other sound sources. Utilizing survey data from previous years and predictive environmental factors, density estimates per unit area of ESA-listed whales were multiplied by the area to be ensonified where effects were expected. Our primary concerns in this consultation revolve around exposure of listed individuals to anthropogenic sound sources, where those individuals may respond with behaviors that may result in fitness consequences (Francis and Barber 2013; Nowacek and Tyack 2013) (Figure 6). However, it should not be assumed that anthropogenic stressors lead to fitness consequences at the individual or population levels (New et al. 2013).

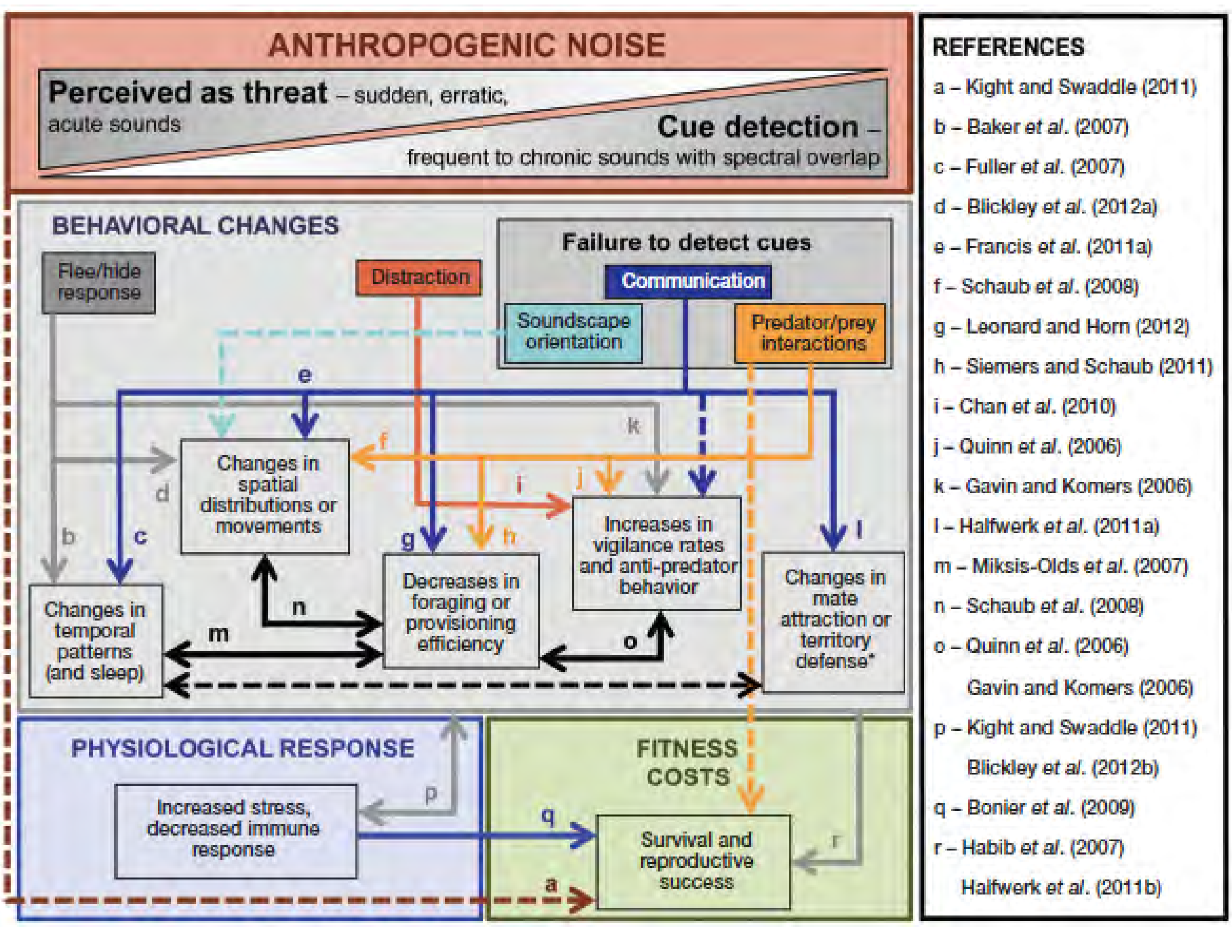

Figure 6. Conceptual framework of how anthropogenic noise impacts individuals and how those impacts may lead to fitness consequences.[2]

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2 Figure taken from Francis et al. Francis, C. D., and J. R. Barber. 2013. A framework for understanding noise impacts on wildlife: An urgent conservation priority. Frontiers in Ecology

In order to reach conclusions regarding whether proposed actions are likely to jeopardize ESA-listed species, we had to make several assumptions. These included:

- Baleen whales can generally hear low-frequency sound (Southall et al. 2007a) better than high frequencies (Southall et al. 2007a), as the former is primarily the range in which they vocalize. Humpback whales frequently vocalize with mid-frequency sound (Southall et al. 2007a) and are likely to hear at these frequencies as well. Because of this, we can partition baleen whales into two groups: those that are specialists at hearing low frequencies (e.g., blue, fin, and sei whales) and those that hear at low- to mid-frequencies

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and the Environment 11(6):305-313.. Original supporting literature A., F. R., W. P. H., and G. K. J. 2007. Daytime noise predicts nocturnal singing in urban robins. Biology Letters 3:368–370, Baker, P. J., C. V. Dowding, S. E. Molony, P. C. L. White, and S. Harris. 2007. Activity patterns of urban red foxes (*Vulpes vulpes*) reduce the risk of traffic-induced mortality. Behavioral Ecology 18:716–724, Blickley, J. L., D. Blackwood, and G. L. Patricelli. 2012. Experimental evidence for the effects of chronic anthropogenic noise on abundance of greater sage-grouse at leks. Conservation Biology 26:461-471, Blickley, J. L., and G. L. Patricelli. 2012. Potential acoustic masking of greater sage-grouse display components by chronic industrial noise. Ornithology Monographs 74:23-35, Bonier, F., I. T. Moore, P. R. Martin, and R. J. Robertson. 2009. The relationship between fitness and baseline glucocorticoids in a passerine bird. General and Comparative Endocrinology 163:208-213, Chan, A. A. Y.-H., and coauthors. 2010. Increased amplitude and duration of acoustic stimuli enhance distraction. Animal Behavior 80:1075–1079, D., F. C., O. C. P., and C. A. 2011. Noise pollution filters bird communities based on vocal frequency. PLoS One 6:e27052, Gavin, S. D., and P. E. Komers. 2006. Do pronghorn (*Antilocapra americana*) perceive roads as a predation risk? Canadian Journal of Zoology 84:1775–1780, Habib, L., E. M. Bayne, and S. Boutin. 2007. Chronic industrial noise affects pairing success and age structure of ovenbirds *Seiurus aurocapilla*. Journal of Applied Ecology 44:176–184, Halfwerk, W., and coauthors. 2011a. Low-frequency songs lose their potency in noisy urban conditions. Proceedings of the National Academy of Science of the USA 108:14549–14554, Halfwerk, W., L. J. M. Holleman, C. M. Lessells, and H. Slabbekoorn. 2011b. Negative impact of traffic noise on avian reproductive success. Journal of Applied Ecology 48:210–219, Kight, C. R., and J. P. Swaddle. 2011a. How and why environmental noise impacts animals: An integrative, mechanistic review. Ecology Letters 14:1052-1061, Leonard, M. L., and A. G. Horn. 2012. Ambient noise increases missed detections in nestling birds. Biology Letters 8:530-532, Miksis-Olds, J. L., P. L. Donaghay, J. H. Miller, P. L. Tyack, and J. A. Nystuen. 2007. Noise level correlates with manatee use of foraging habitats. Journal of the Acoustical Society of America 121:3011–3020, Quinn, J. L., M. J. Whittingham, S. J. Butler, and W. Cresswell. 2006. Noise, predation risk compensation and vigilance in the chaffinch *Fringilla coelebs*. Journal of Avian Biology 37:601–608, Schaub, A., J. Ostwald, and B. M. Siemers. 2008. Foraging bats avoid noise. Journal of Experimental Biology 211:3174-3180, Siemers, B. M., and A. Schaub. 2011. Hunting at the highway: Traffic noise reduces foraging efficiency in acoustic predators. Proceedings of the Royal Society B: Biological Sciences 278:1646-1652.

(humpback whales). Toothed whales (such as sperm whales) are better adapted to hear mid- and high-frequency sound for the same reason (although this species also responds to low-frequency sound and is considered to hear at low-, mid-, and high frequencies; i.e., vocalization, as is assumed for baleen whales). Sperm whales are also assumed to have similar hearing qualities as other, better studied, toothed whales. Hearing in sea turtles is generally similar within the taxa, with data from loggerhead and green sea turtles being representative of the taxa as a whole.

- Species for which little or no information on response to sound at different received sound levels will respond similarly to their close taxonomic or ecological relatives (i.e., baleen whales respond similarly to each other; same for sea turtles).

5 Action Area

The seismic survey is proposed to be conducted along and offshore of North Carolina's Outer Banks (Figure 7), outside of state waters, and both within the U.S. EEZ as well as outside of it. The region in which the seismic survey will occur is between 32° and 37° N and 71.5° and 77° W. The region encompasses water depths from 30-4,300 m along roughly 5,321 km of trackline. Of this, roughly 3,609 km will be subject to seismic survey by the 18-airgun array (323 km in shallow, 241 km in intermediate, and 3,046 km in deep water depths, respectively) and roughly 1,711 km will be surveyed by the 36-airgun array (115 km in shallow, 56 km in intermediate, and 1,540 km in deep water depths, respectively). No additional trackline has been requested to account for equipment failures, a need to reshoot some areas, or other logistical impacts. The action area includes these regions, but also transit to and from the port of Norfolk as well as the region that sound from the seismic survey vessels and their sound sources decrease to ambient background levels.

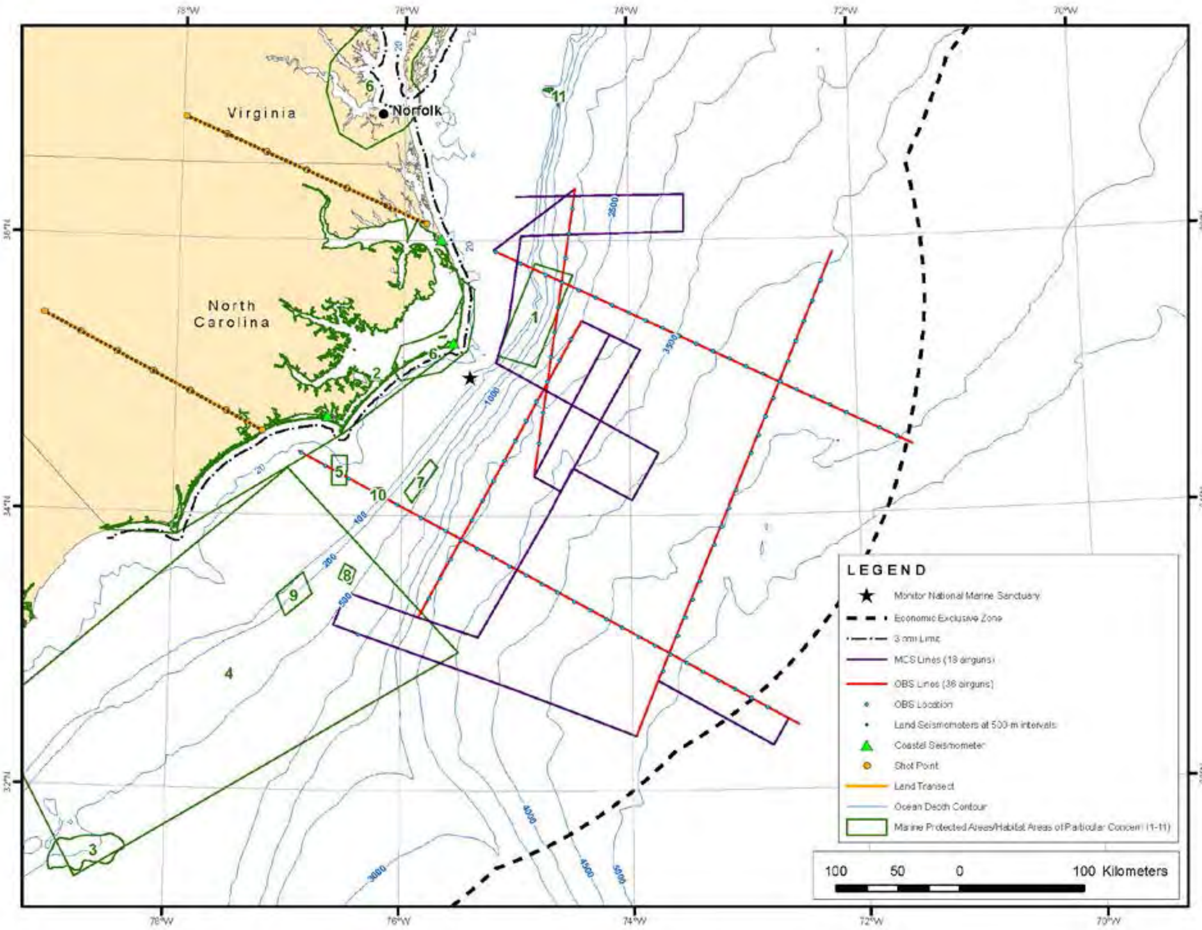

Figure 7. Proposed area for the marine seismic survey off North Carolina's Outer Banks. Trackline for the seismic survey is identified in purple and red lines for 18- and 36-airgun array activities, respectively. The exclusion zone (area where mitigation would be undertaken if protected species are observed; not the U.S. EEZ) is not visible but occurs roughly one kilometer to either side of the trackline.

6 Status of Listed Resources

The actions considered in this Opinion may affect ESA-listed species in Table 2.

Table 2. ESA-listed species in the action area that may may be affected by the proposed actions.

Common Name	*Scientific Name*	*Status*
Cetaceans		
Blue whale	*Balaenoptera musculus*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Marine Turtles		

Common Name	Scientific Name	Status
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle – Northwest Atlantic distinct population segment	*Caretta caretta*	Threatened
Anadromous Fishes		
Atlantic sturgeon- Gulf of Maine distinct population segment	*Acipenser oxyrhynchus*	Threatened
Atlantic sturgeon- New York Bight distinct population segment		Endangered
Atlantic sturgeon- Chesapeake Bay distinct population segment		Endangered
Atlantic sturgeon- Carolina distinct population segment		Endangered
Atlantic sturgeon- South Atlantic distinct population segment		Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered

Listed Resources Not Considered Further

There are several additional listed species that could potentially be found within the action area. However, due to the lack of anticipated effects, we do not consider these species further for the following reasons. The action area co-occurs with designated critical habitat of Northwestern Atlantic Distinct Population Segment (DPS) loggerhead sea turtles, specifically *Sargassum*, winter, and migratory habitat. The primary constituent elements of the *Sargassum* habitat include: 1) convergence zones, surface-water downwelling areas, and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads, 2) *Sargassum* in concentrations that support adequate prey abundance and cover, 3) available prey and other material associated with *Sargassum* habitat such as, but not limited to, plants and cyanobacteria and animals endemic to the *Sargassum* community such as hydroids and copepods, and 4) sufficient water depth (greater than 10 m) and proximity to available currents to ensure offshore transport, and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads. The primary constituent elements of winter (identified as November through April in the final rule) critical habitat include: 1) Water temperatures above 10°C from November through April, 2) Continental shelf waters in proximity to the western boundary of the Gulf Stream, and 3) Water depths between 20 and 100 m. We do not expect any stressors associated with the proposed actions to alter oceanographic or bathymetry features of the action area, impact the way in which *Sargassum* concentrates, or alter plant, cyanobacteria, or prey species of loggerheads. Therefore, we do not expect the proposed actions to affect winter or *Sargassum* loggerhead critical habitat. We do consider *Sargassum* critical habitat further.

One primary constituent element of constricted migratory critical habitat allows for the passage of loggerhead sea turtles. The timing of the seismic survey overlaps with an expected peak in loggerhead sea turtle migration through the region, particularly in the migratory critical habitat along the continental shelf region. This region narrows in the northwest sector of the action area and overlaps with area we expect might receive up to several days of exposure to sound levels sufficient to cause behavioral changes in loggerhead sea turtles. Discussions with members of the listing team inform us that passage conditions that were articulated in consideration of physical barriers, such as fishing nets or energy infrastructure.Potential acoustic barriers, such as seismic sound sources, were not considered to be a barrier to migration in establishing the critical habitat. Furthermore, the analyses that support the designation of the critical habitat identify oil and gas activities as a speculative stressor that requires further evaluation to establish adverse effects. Based upon this information, we consider the effect of airgun operations as part of the adverse effect evaluation to individual loggerhead sea turtles and do not consider it as an effect to the passage condition of the critical habitat designation. As we cannot identify any other stressor associated with the proposed action that may affect loggerhead critical habitat, we find the effects of the action to be insignificant and we do not consider loggerhead critical habitat further in this Opinion.

Although shortnose sturgeon do enter marine waters to travel between river and estuary systems, the nearest location to the action area that shortnose sturgeon occur is at Cape Fear. The nearest river system to the north of this location (approaching the action area) is beyond the expected range that shortnose sturgeon would travel. We therefore do not expect that shortnose sturgeon will be exposed to stressors associated with the proposed action.

Atlantic sturgeon are found more frequently and widely in marine waters but we do not expect that they will receive meaningful exposures to the proposed actions. Only subadult and adult age classes venture into marine waters. During the time of the proposed action, adults will be in freshwater and estuary systems engaged in spawning. Bycatch data indicate that this is also a time when Atlantic sturgeon, including subadults, are generally not in marine waters (Laney et al. 2007; Stein et al. 2004a; Stein et al. 2004b). Based upon these factors, we find the likelihood of exposing Atlantic sturgeon to activities associated with the proposed seismic survey to be insignificant and do not consider the species further.

Listed Resources Considered in this Opinion Further

This section of this Opinion considers the biology and ecology of listed species that may be adversely affected by the proposed actions. Summaries of the global status and trends of each species presented provide a foundation for the analysis of species as a whole.

6.1 Blue whale

Subspecies. Several blue whale subspecies have been characterized from morphological and geographical variability, but the validity of blue whale subspecies designations remains uncertain (McDonald et al. 2006). The largest, the Antarctic or true blue whale (*Balaenoptera musculus intermedia*), occurs in the highest Southern Hemisphere latitudes (Gilpatrick and Perryman. 2009). During austral summers, “true” blue whales occur close to Antarctic ice. A slightly smaller blue whale, *B. musculus musculus*, inhabits the Northern Hemisphere (Gilpatrick and Perryman. 2009). The pygmy blue whale (*B. musculus brevicauda*), may be geographically distinct from *B. m. musculus* (Kato et al. 1995). Pygmy blue whales occur north of the Antarctic Convergence (60°-80° E and 66°-70° S), while true blue whales are found south of the Convergence (58° S) in the austral summer (Kasamatsu et al. 1996; Kato et al. 1995). A fourth subspecies, *B. musculus indica*, may exist in the northern Indian Ocean (McDonald et al. 2006), although these whales are frequently referred to as *B. m. brevicauda* (Anderson et al. 2012). Inbreeding between *B. m. intermedia* and *B. m. brevicauda* does occur (Attard et al. 2012).

Population structure. Little is known about population and stock structure[3] of blue whales. Studies suggest a wide range of alternative population and stock scenarios based on movement, feeding, and acoustic data. Some suggest that as many as 10 global populations may exist, while other studies suggest that the species is composed of a single panmictic population (Gambell 1979; Gilpatrick and Perryman. 2009; Reeves et al. 1998). For management purposes, the International Whaling Commission (IWC) considers all Pacific blue whales to be a single stock, whereas under the MMPA, the NMFS recognizes four stocks of blue whales: western North Pacific Ocean, eastern North Pacific Ocean, Northern Indian Ocean, and Southern Hemisphere.

Until recently, blue whale population structure had not been tested using molecular or nuclear genetic analyses (Reeves et al. 1998). A recent study by Conway (2005) suggested that the global population could be divided into four major subdivisions, which roughly correspond to major ocean basins: eastern North and tropical Pacific Ocean, Southern Indian Ocean, Southern Ocean, and western North Atlantic Ocean. The eastern North/tropical Pacific Ocean subpopulation includes California, western Mexico, western Costa Rica, and Ecuador (Conway 2005). Genetic studies of blue whales occupying a foraging area south of Australia (most likely pygmy blue whales) have been found to belong to a single population (Attard et al. 2010). Herein, blue whales are treated as four distinct populations as outlined by Conway (2005).

North Atlantic. Blue whales are found from the Arctic to at least mid-latitude waters, and typically inhabit the open ocean with occasional occurrences in the U.S. EEZ (Gagnon and Clark 1993; Wenzel et al. 1988b; Yochem and Leatherwood 1985). Yochem and Leatherwood (1985) summarized records suggesting winter range extends south to Florida and the Gulf of Mexico. The U.S. Navy's Sound Surveillance System acoustic system has detected blue whales in much of the North Atlantic, including subtropical waters north of the West Indies and deep waters east of the U.S. EEZ (Clark 1995). Blue whales are rare in the shelf waters of the eastern U.S. In the western North Atlantic, blue whales are most frequently sighted from the Gulf of St. Lawrence and eastern Nova Scotia and in waters off Newfoundland, during the winter (Sears et al. 1987). In the eastern North Atlantic, blue whales have been observed off the Azores, although Reiner et al. (1993) did not consider them common in that area. Observations of feeding have recently occurred over Ireland's western continental slope (Wall et al. 2009).

No blue whale sightings have been made in the action area and the species' occurrence off the U.S. mid-Atlantic is considered to be occasional to rare (IOC 2014; U.S. Navy 2005; U.S. Navy 2008a; Waring et al. 2010b; Wenzel et al. 1988a).

Age distribution. Blue whales may reach 70–80 years of age (COSEWIC 2002; Yochem and Leatherwood 1985).

"Populations" herein are a group of individual organisms that live in a given area and share a common genetic heritage. While genetic exchange may occur with neighboring populations, the rate of exchange is greater between individuals of the same population than among populations---a population is driven more by internal dynamics, birth and death processes, than by immigration or emigration of individuals. To differentiate populations, NMFS considers geographic distribution and spatial separation, life history, behavioral and morphological traits, as well as genetic differentiation, where it has been examined. In many cases, the behavioral and morphological differences may evolve and be detected before genetic variation occurs. In some cases, the term "stock" is synonymous with this definition of "population" while other usages of "stock" are not.

Reproduction. Gestation takes 10-12 months, followed by a 6-7 month nursing period. Sexual maturity occurs at 5-15 years of age and calves are born at 2-3 year intervals (COSEWIC 2002; NMFS 1998b; Yochem and Leatherwood 1985). Recent data from illegal Russian whaling for Antarctic and pygmy blue whales support sexual maturity at 23 m and 19-20 m, respectively (Branch and Mikhalev 2008). The mean intercalving interval in the Gulf of California is roughly two and half years (Sears et al. 2014). Once mature, females return to the same areas where they were born to give birth themselves (Sears et al. 2014).

Movement. Satellite tagging indicates that, for blue whales tagged off Southern California, movement is more linear and faster (3.7 km/h) while traveling versus while foraging (1.7 km/h)(Bailey et al. 2009). Residency times in what are likely prey patches averages 21 days and constituted 29% of an individual's time overall, although foraging could apparently occur at any time of year for tagged individuals (Bailey et al. 2009). Broad scale movements also varied greatly, likely in response to oceanographic conditions influencing prey abundance and distribution (Bailey et al. 2009). Blue whales along Southern California were found to be traveling 85% of the time and milling 11% (Bacon et al. 2011). Blue whales are highly mobile, and their migratory patterns are not well known (Perry et al. 1999; Reeves et al. 2004). Blue whales migrate toward the warmer waters of the subtropics in fall to reduce energy costs, avoid ice entrapment, and reproduce (NMFS 1998a). In the eastern Central Atlantic, blue whales appear to migrate from areas along Greenland and Iceland to the Azores over and east of the Mid-Atlantic Ridge, apparently engaging in some random movement along the way (Anil et al. 2013).

Feeding. Data indicate that some summer feeding takes place at low latitudes in upwelling-modified waters, and that some whales remain year-round at either low or high latitudes (Clarke and Charif 1998b; Hucke-Gaete et al. 2004; Reilly and Thayer 1990; Yochem and Leatherwood 1985). Prey availability likely dictates blue whale distribution for most of the year (Burtenshaw et al. 2004; Clapham et al. 1999; Sears 2002 as cited in NMFS 2006a). The large size of blue whales requires higher energy requirements than smaller whales and potentially prohibits fasting Mate et al. (1999). Blue whales typically occur alone or in groups of up to five animals, although larger foraging aggregations of up to 50 have been reported including aggregations mixed with other rorquals such as fin whales (Corkeron et al. 1999; Shirihai 2002). While feeding, blue whales show slowed and less obvious avoidance behavior then when not feeding (Sears et al. 1983 as cited in NMFS 2005b).

Diving. Blue whales spend greater than 94% of their time underwater (Lagerquist et al. 2000). Generally, blue whales dive 5-20 times at 12-20 sec intervals before a deep dive of 3-30 min (Croll et al. 1999; Leatherwood et al. 1976; Mackintosh 1965; Maser et al. 1981; Strong 1990; Yochem and Leatherwood 1985). Average foraging dives are 140 m deep and last for 7.8 min (Croll et al. 2001). Non-foraging dives are shallower and shorter, averaging 68 m and 4.9 min (Croll et al. 2001). However, dives of up to 300 m are known (Calambokidis et al. 2003). Nighttime dives are generally shallower (50 m). Blue whales near Sri Lanka averaged 18 sec between breaths during surfacing dives, but went an average of 640 sec during deep dives (de Vos et al. 2013).

Blue whales occur singly or in groups of two or three (Aguayo 1974; Mackintosh 1965; Nemoto 1964; Pike and MacAskie 1969; Ruud 1956; Slijper 1962). However, larger foraging aggregations, even with other species such as fin whales, are regularly reported (Fiedler et al.

1998; Schoenherr 1991).

Vocalization and hearing. Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5-400 Hz, with dominant frequencies from 16-25 Hz, and songs that span frequencies from 16-60 Hz that last up to 36 sec repeated every 1 to 2 min (see Cummings and Thompson 1971; Cummings and Thompson 1977; Edds-Walton 1997b; Edds 1982; McDonald et al. 1995a; Thompson and Friedl 1982). Berchok et al. (2006) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17.0-78.7 Hz. Reported source levels are 180-188 dB re 1μPa, but may reach 195 dB re 1μPa (Aburto et al. 1997; Clark and Ellison 2004; Ketten 1998b; McDonald et al. 2001). Samaran et al. (2010) estimated Antarctic blue whale calls in the Indian Ocean at 179 ± 5 dB re 1 μPa_{rms} in the 17-30 Hz range and pygmy blue whale calls at 175± 1 dB re 1 μPa_{rms} in the 17-50 Hz range.

In temperate waters, intense bouts of long patterned sounds are very common from fall through spring, but these also occur to a lesser extent during the summer in high latitude feeding areas. Short sequences of rapid calls in the 30-90 Hz band are associated with animals in social groups. The seasonality and structure of long patterned sounds suggest that these sounds are male displays for attracting females, competing with other males, or both. The context for the 30-90 Hz calls suggests that they are communicative but not related to a reproductive function. Vocalizations attributed to blue whales have been recorded in presumed foraging areas, along migration routes, and during the presumed breeding season (Beamish and Mitchell 1971; Cummings et al. 1972; Cummings and Thompson 1971; Cummings and Thompson 1977; Cummings and Thompson 1994; Rivers 1997; Thompson et al. 1996).

As with other baleen whale vocalizations, blue whale vocalization function is unknown, although numerous hypotheses exist (maintaining spacing between individuals, recognition, socialization, navigation, contextual information transmission, and location of prey resources (Edds-Walton 1997a; Payne and Webb 1971; Thompson et al. 1992a). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes, but these also occur less frequently while in summer high-latitude feeding areas. Short, rapid sequences of 30-90 Hz calls are associated with socialization and may be displays by males based upon call seasonality and structure.

Blue whale calls appear to vary between western and eastern North Pacific regions, suggesting possible structuring in populations (Rivers 1997; Stafford et al. 2001).

Direct studies of blue whale hearing have not been conducted, but it is assumed that blue whales can hear the same frequencies that they produce (low-frequency) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995c).

Status and trends. Blue whales (including all subspecies) were originally listed as endangered in 1970 (35 FR 18319), and this status continues since the inception of the ESA in 1973.

Table 3 contains historic and current estimates of blue whales. Globally, blue whale abundance has been estimated at between 5,000-13,000 animals (COSEWIC 2002; Yochem and Leatherwood 1985), a fraction of the 200,000 or more that are estimated to have populated the oceans prior to whaling (Maser et al. 1981; U.S. Department of Commerce 1983). Consideration of the status of populations outside of the action area is important under the present analysis to determine the how the risk to the affected population(s) bears on the status of the species as a whole.

North Atlantic. Commercial hunting had a severe effect on blue whales, such that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic (Sigurjónsson and Gunnlaugsson 1990). Sigurjónsson and Gunnlaugsson (1990) estimated that at least 11,000 blue whales were harvested from all whaling areas from the late-nineteenth to mid-twentieth centuries.

Current trends are unknown, although an increasing annual trend of 4.9% was reported for 1969–1988 off western and southwestern Iceland (Sigurjónsson and Gunnlaugsson 1990). Sigurjónsson and Gunnlaugsson (1990) concluded that the blue whale population had been increasing since the late 1950s. In the northeastern Atlantic, blue whales are most common west and south of Iceland and may be the largest concentration of blue whales in the North Atlantic (Pike et al. 2009b). In this area, the population may be recovering at a rate of 4-5% (Pike et al. 2009b). Punt (2010) estimated the rate of increase for blue whales in the central North Atlantic to be 9% annually (3.83 SE) between 1987 and 2001.

Table 3. Summary of past and present blue whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Current estimate	95% CI	Source
Global	~~	200,000	~~	11,200-13,000	~~	(DOC 1983; Maser et al. 1981)
	~~	~~	~~	5,000-12,000	~~	(COSEWIC 2002)
North Atlantic	Basinwide	1,100-1,500	~~	100-555	~~	(Braham 1991; Gambell 1976)
	~~			1,000-2,000		(Sigurjonsson 1995)
	NMFS-western North Atlantic stock	~~	~~	440	~~	(Waring et al. 2013)
	Central and northeast Atlantic	~~	~~	855	351-1,589	(Pike et al. 2009b)

*Note: Confidence Intervals (C. I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

Natural threats. As the world's largest animals, blue whales are only occasionally known to be killed by killer whales (Sears et al. 1990; Tarpy 1979). Blue whales engage in a flight response to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Blue whales are known to become infected with the nematode *Carricauda boopis*, which are believed to have caused mortality in fin whale due to renal failure (Lambertsen 1986).

Anthropogenic threats. Blue whales have faced threats from several historical and current sources. Blue whale populations have been severely depleted due to historical whaling activity.

Ship strike remains a major concern for blue whales (Figure 6). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. Studies have shown that blue whales respond to approaching ships in a variety of ways, depending on the behavior of the animals at the time of approach, and speed and direction of the approaching vessel. While feeding, blue whales react less rapidly and with less obvious avoidance behavior than whales that are not feeding (Sears 1983).

Increasing noise in the ocean may impair blue whale behavior. Although available data do not presently support traumatic injury from sonar, the general trend in increasing ambient low-frequency noise in the deep oceans of the world, primarily from ship engines, could impair the ability of blue whales to communicate or navigate through these vast expanses (Aburto et al. 1997; Clark 2006). Blue whales off California altered call levels and rates in association with changes in local vessel traffic (McKenna 2011). Either due to ship strike, vessel noise, whale watching, or a combination of these factors, displacement from preferred habitat may be occurring off Sri Lanka (Ilangakoon 2012).

Figure 8. A near collision between a blue whale and a commercial cargo vessel in the Santa Barbara Channel Traffic Separation Scheme. Photo credit: NOAA Channel Islands National Marine Sanctuary, 2002 (Permit CINMS-2002-001).

There is a paucity of contaminant data related to blue whales. Available information indicates that organochlorines, including dichloro-diphenyl-trichloroethane (DDT), polychlorinated biphenyls (PCB), benzene hexachloride, hexachlorobenzene, chlordane, dieldrin, methoxychlor, and mirex have been isolated from blue whale blubber and liver samples (Gauthier et al. 1997c;

Metcalfe et al. 2004). Contaminant transfer between mother and calf occurs, meaning that young often start life with concentrations of contaminants equal to their mothers, before accumulating additional contaminant loads during life and passing higher loads to the next generation (Gauthier et al. 1997b; Metcalfe et al. 2004). This is supported by ear plug data showing maternal transfer of pesticides and flame retardants in the first year of life (Trumble et al. 2013). These data also support pulses of mercury in body tissues of the male studied (Trumble et al. 2013).

Critical habitat. The NMFS has not designated critical habitat for blue whales.

6.2 Fin whale

Subspecies. There are two recognized subspecies of fin whales, *Balaenoptera physalus physalus*, which occurs in the North Atlantic Ocean, and *B. p. quoyi*, which occurs in the Southern Ocean. These subspecies and North Pacific fin whales appear to be organized into separate populations, although there is a lack of consensus in the published literature as to population structure.

Population structure. Population structure has undergone only a rudimentary framing. Genetic studies by Bérubé et al. (1998) indicate that there are significant genetic differences among fin whales in differing geographic areas (Sea of Cortez, Gulf of St. Lawrence, and Gulf of Maine). Further, individuals in the Sea of Cortez may represent an isolated population from other eastern North Pacific fin whales (Berube et al. 2002). Even so, mark-recapture studies also demonstrate that individual fin whales migrate between management units designated by the IWC (Mitchell 1974; Sigujónsson and Gunnlaugsson 1989).

North Atlantic. Fin whales are common off the Atlantic coast of the U.S. in waters immediately off the coast seaward to the continental shelf (about the 1,800 m contour). Fin whales occur during the summer from Baffin Bay to near Spitsbergen and the Barents Sea, south to Cape Hatteras in North Carolina and off the coasts of Portugal and Spain (Rice 1998a). In areas north of Cape Hatteras, fin whales account for about 46% of the large whales observed in 1978-1982 surveys (CETAP 1982b). Little is known about the winter habitat of fin whales, but in the western North Atlantic, the species has been found from Newfoundland south to the Gulf of Mexico and Greater Antilles, and in the eastern North Atlantic their winter range extends from the Faroes and Norway south to the Canary Islands. Fin whales in the eastern North Atlantic have been found in highest densities in the Irminger Sea between Iceland and Greenland (Víkingsson et al. 2009). The singing location of fin whales in the Davis Strait and Greenland has been correlated with sea ice fronts; climate change may impact fin whale distribution and movement by altering sea ice conditions (Simon et al. 2010). A general fall migration from the Labrador and Newfoundland region, south past Bermuda, and into the West Indies has been theorized (Clark 1995). Historically, fin whales were by far the most common large whale found off Portugal (Brito et al. 2009).

As with other baleen whales, fin whale occurrence in the action area is higher during winter and spring and generally lower during the time of the proposed seismic survey. However, records support fin whale occurrence during the timeframe of the proposed seismic survey, both in continental shelf and offshore waters (CETAP 1982a; U.S. Navy 2008a; U.S. Navy 2008b; Waring et al. 2013).

Fin whales are also endemic to the Mediterranean Sea, where (at least in the western Mediterranean), individuals tend to aggregate during summer and disperse in winter over large spatial scales (Cotte et al. 2009), although this seasonal trend is reversed in the Bonifacio Strait (Arcangeli et al. 2013a). Mediterranean fin whales are genetically distinct from fin whales in the rest of the North Atlantic at the population level (Berube et al. 1999). However, some fin whales from the northeastern North Atlantic have been tracked into the Mediterranean during winter and overlap in time and space with the Mediterranean population may exist (Castellote et al. 2010). Individuals also tend to associate with colder, saltier water, where steep changes in temperature, and where higher northern krill densities would be expected (Cotte et al. 2009). A genetically distinct population resides year-round in the Ligurian Sea (IWC 2006). Fin whales seem to track areas of high productivity in the Mediterranean, particularly along coastal areas of France, northern Italy, and the southern and middle Adriatic (Druon et al. 2012). Several sightings have been within the study area, particularly in the northwestern sector, but also over the continental slope and abyssal plain (Belford et al. 2014). However, sightings are very common near the continental shelf break and over the continental shelf (Belford et al. 2014).

Age distribution. Aguilar and Lockyer (1987) suggested annual natural mortality rates in northeast Atlantic fin whales may range from 0.04 to 0.06. Fin whales live 70-80 years (Kjeld et al. 2006).

Reproduction. Fin whales reach sexual maturity between 5-15 years of age (COSEWIC 2005; Gambell 1985a; Lockyer 1972). Mating and calving occurs primarily from October-January, gestation lasts ~11 months, and nursing occurs for 6-11 months (Boyd et al. 1999; Hain et al. 1992). The average calving interval in the North Atlantic is estimated at about 2-3 years (Agler et al. 1993; Christensen et al. 1992a). The location of winter breeding grounds is uncertain but mating is assumed to occur in pelagic mid-latitude waters (Perry et al. 1999). This was recently contradicted by acoustic surveys in the Davis Strait and off Greenland, where singing by fin whales peaked in November through December; the authors suggested that mating may occur prior to southbound migration (Simon et al. 2010). Although seasonal migration occurs between presumed foraging and breeding locations, fin whales have been acoustically detected throughout the North Atlantic Ocean and Mediterranean Sea year-round, implying that not all individuals follow a set migratory pattern (Notarbartolo-Di-Sciara et al. 1999; Simon et al. 2010). Reductions in pregnancy rates appear correlated with reduced blubber thickness and prey availability (Williams et al. 2013).

Movement. In the eastern Central Atlantic, fin whales appear to migrate from areas along Iceland to the Azores east of the Mid-Atlantic Ridge, apparently traveling directly without random movement patterns in between (Anil et al. 2013).

Behavior. Fin whales along Southern California were found to be traveling 87% of the time and milling 5% in groups that averaged 1.7 individuals (Bacon et al. 2011). Fin whales tend to avoid tropical and pack-ice waters, with the high-latitude limit of their range set by ice and the lower-latitude limit by warm water of approximately 15° C (Sergeant 1977). Fin whale concentrations generally form along frontal boundaries or mixing zones between coastal and oceanic waters, which corresponds roughly to the 200 m isobath (the continental shelf edge (Cotte et al. 2009; Nasu 1974)).

Feeding. Fin whales in the North Atlantic eat pelagic crustaceans (mainly krill and schooling fish such as capelin, herring, and sand lance (Borobia and Béland 1995; Christensen et al. 1992a; Hjort and Ruud 1929; Ingebrigtsen 1929; Jonsgård 1966; Mitchell 1974; Overholtz and Nicolas 1979; Sergeant 1977; Shirihai 2002; Watkins et al. 1984)). Fin whales frequently forage along cold eastern current boundaries (Perry et al. 1999). Feeding may occur in waters as shallow as 10 m when prey are at the surface, but most foraging is observed in high-productivity, upwelling, or thermal front marine waters (Gaskin 1972; Nature Conservancy Council 1979 as cited in ONR 2001; Panigada et al. 2008; Sergeant 1977). While foraging, fin whales in the Mediterranean Sea have been found to move through restricted territories in a convoluted manner (Lafortuna et al. 1999). Fin whales in the central Tyrrhenian Sea appear to ephemerally exploit the area for foraging during summer, particularly areas of high primary productivity (Arcangeli et al. 2013b).

Diving. The amount of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5-20 shallow dives, each of 13-20 sec duration, followed by a deep dive of 1.5-15 min (Gambell 1985a; Lafortuna et al. 2003; Stone et al. 1992). Other authors have reported that the fin whale's most common dives last 2-6 min (Hain et al. 1992; Watkins 1981). The most recent data support average dives of 98 m and 6.3 min for foraging fin whales, while non-foraging dives are 59 m and 4.2 min (Croll et al. 2001). Foraging dives in excess of 150 m are known (Panigada et al. 1999). In waters off the U.S. Atlantic Coast, individuals or duos represented about 75% of sightings (Hain et al. 1992). Individuals or groups of less than five individuals represented about 90% of observations.

Vocalization and hearing. Fin whales produce a variety of low-frequency sounds in the 10-200 Hz range (Edds 1988; Thompson et al. 1992a; Watkins 1981; Watkins et al. 1987b). Typical vocalizations are long, patterned pulses of short duration (0.5-2 s) in the 18-35 Hz range, but only males are known to produce these (Croll et al. 2002; Patterson and Hamilton 1964). Richardson et al. (1995b) reported the most common sound as a 1 sec vocalization of about 20 Hz, occurring in short series during spring, summer, and fall, and in repeated stereotyped patterns during winter. Au (2000b) reported moans of 14-118 Hz, with a dominant frequency of 20 Hz, tonal vocalizations of 34-150 Hz, and songs of 17-25 Hz (Cummings and Thompson 1994; Edds 1988; Watkins 1981). Source levels for fin whale vocalizations are 140-200 dB re 1μPa·m (Clark and Ellison. 2004; Erbe 2002b). The source depth of calling fin whales has been reported to be about 50 m (Watkins et al. 1987b). In temperate waters, intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clarke and Charif 1998a). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald et al. 1995b). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999).

Although their function is still debated, low-frequency fin whale vocalizations travel over long distances and may aid in long-distance communication (Edds-Walton 1997a; Payne and Webb 1971). During the breeding season, fin whales produce pulses in a regular repeating pattern, which have been proposed to be mating displays similar to those of humpbacks (Croll et al. 2002). These vocal bouts last for a day or longer (Tyack 1999). The seasonality and stereotype of the bouts of patterned sounds suggest that these sounds are male reproductive displays (Watkins et al. 1987a), while the individual counter-calling data of McDonald et al. (1995b) suggest that the more variable calls are contact calls. Some authors feel there are geographic differences in the frequency, duration and repetition of the pulses (Thompson et al. 1992b).

Direct studies of fin whale hearing have not been conducted, but it is assumed that fin whales can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995c).

Status and trends. Fin whales were originally listed as endangered in 1970 (35 FR 18319), and this status continues since the inception of the ESA in 1973. Although fin whale population structure remains unclear, various abundance estimates are available (Table 4). Consideration of the status of populations outside of the action area is important under the present analysis to determine the how the risk to the affected population(s) bears on the status of the species as a whole. Historically, worldwide populations were severely depleted by commercial whaling, with more than 700,000 whales harvested in the twentieth century (Cherfas 1989b; Cherfas 1989a).

North Atlantic. Over 48,000 fin whales were caught between 1860-1970 (Braham 1991). Although protected by the IWC, from 1988-1995 there have been 239 fin whales harvested from the North Atlantic. Recently, Iceland resumed whaling of fin whales despite the 1985 moratorium imposed by the IWC. Vikingsson et al. (2009) concluded that actual numbers were likely higher due to negative bias in their analysis, and that the population(s) were increasing at 4% annually. The abundance of fin whales in the Baffin Bay-Davis Strait summer feeding area is believed to be increasing (Heide-Jorgensen et al. 2010).

Table 4. Summary of past and present fin whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	~~	>464,000	~~	119,000	~~	(Braham 1991)
North Atlantic	Basinwide	30,000-50,000	~~	~~	~~	(Sergeant 1977)
	~~	360,000	249,000-481,000	~~	~~	(Roman and Palumbi 2003)
	~~			>50,000		(Sigurjonsson 1995)
	Eastern North Atlantic			25,000		(2009) circa 2001
	Central and northeastern Atlantic	~~	~~	30,000	23,000-39,000	(IWC 2007)
	Western North Atlantic	~~	~~	3,590-6,300	~~	(Braham 1991)
	NMFS-western North Atlantic stock	~~	~~	3,985	CV=0.24	(NMFS 2008; Waring et al. 2012)
	Northeastern U.S. Atlantic cont'l shelf	~~	~~	2,200-5,000	~~	(Hain et al. 1992; Waring et al. 2000)
	IWC-Newfoundland-Labrador stock	~~	~~	13,253	0-50,139*	(IWC 1992)
	Bay of Biscay			7,000-8,000		(Goujon et al.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
						1994)
	IWC-British Isles, Spain, and Portugal stock	10,500	9,600-11,400	4,485	3,369-5,600	(Braham 1991)
	~~	~~	~~	17,355	10,400-28,900	(Buckland et al. 1992)
	IWC-east Greenland to Faroe Islands	~~	~~	22,000	16,000-30,000	(IWC 2014)
	IWC-west Greenland stock	~~	~~	4,500	1,900-10,000	(IWC 2014)
	Mediterranean Sea			3,583	2,130-6,027	(Forcada 1996)

*Note: Confidence Intervals (C. I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

Natural threats. Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggested annual natural mortality rates might range from 0.04 to 0.06 for northeast Atlantic fin whales. The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure and may be preventing some fin whale populations from recovering (Lambertsen 1992). Adult fin whales engage in a flight responses (up to 40 km/h) to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Shark attacks may also result in serious injury or death in very young and sick individuals (Perry et al. 1999).

Anthropogenic threats. Increased noise in the ocean stemming from shipping seems to alter the acoustic patterns of singing fin whales, possibly hampering reproductive parameters across wide regions (Castellote et al. 2012).

The organochlorines DDE, DDT, and PCBs have been identified from fin whale blubber, but levels are lower than in toothed whales due to the lower level in the food chain that fin whales feed at (Aguilar and Borrell 1988; Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983; Marsili and Focardi 1996). Females contained lower burdens than males, likely due to mobilization of contaminants during pregnancy and lactation (Aguilar and Borrell 1988; Gauthier et al. 1997b; Gauthier et al. 1997c). Contaminant levels increase steadily with age until sexual maturity, at which time levels begin to drop in females and continue to increase in males (Aguilar and Borrell 1988).

Climate change also presents a potential threat to fin whales, particularly in the Mediterranean Sea, where fin whales appear to rely exclusively upon northern krill as a prey source. These krill occupy the southern extent of their range and increases in water temperature could result in their decline and that of fin whales in the Mediterranean Sea (Gambaiani et al. 2009).

Critical habitat. The NMFS has not designated critical habitat for fin whales.

6.3 Humpback whale

Population designations. Populations have been relatively well defined for humpback whales.

North Atlantic. Humpback whales range from the mid-Atlantic Bight and the Gulf of Maine across the southern coast of Greenland and Iceland to Norway in the Barents Sea. Whales migrate to the western coast of Africa (Waerebeek et al. 2013), the Cape Verde Islands, and the Caribbean Sea during the winter. Humpback whales aggregate in four summer feeding areas: Gulf of Maine and eastern Canada, west Greenland, Iceland, and Norway (Boye et al. 2010; Katona and Beard 1990; Smith et al. 1999). Four sightings have been within the study area, particularly in the northern half of the region (Belford et al. 2014). However, sightings are commonplace near the continental shelf break and over the continental shelf (Belford et al. 2014).

Increasing range and occurrence in the Mediterranean Sea coincides with population growth and may represent reclaimed habitat from pre-commercial whaling (Frantzis et al. 2004; Genov et al. 2009). The principal breeding range for Atlantic humpback whales lies from the Antilles and northern Venezuela to Cuba (Balcomb III and Nichols 1982; Whitehead and Moore 1982; Winn et al. 1975). The largest breeding aggregations occur off the Greater Antilles where humpback whales from all North Atlantic feeding areas have been photo-identified (Clapham et al. 1993; Katona and Beard 1990; Mattila et al. 1994; Palsbøll et al. 1997; Smith et al. 1999; Stevick et al. 2003b). However, the possibility of historic and present breeding further north remains enigmatic but plausible (Smith and G.Pike 2009). Winter aggregations also occur at the Cape Verde Islands in the eastern North Atlantic and along Angola (Cerchio et al. 2010; Reeves et al. 2002; Reiner et al. 1996; Weir 2007). Accessory and historical aggregations also occur in the eastern Caribbean (Levenson and Leapley 1978; Mitchell and Reeves 1983; Reeves et al. 2001a; Reeves et al. 2001b; Schwartz 2003; Smith and Reeves 2003; Swartz et al. 2003; Winn et al. 1975). To further highlight the "open" structure of humpback whales, a humpback whale migrated from the Indian Ocean to the South Atlantic Ocean, demonstrating that interoceanic movements can occur (Pomilla and Rosenbaum 2005). Genetic exchange at low-latitude breeding groups between Northern and Southern Hemisphere individuals and wider-range movements by males has been suggested to explain observed global gene flow (Rizzo and Schulte 2009). However, there is little genetic support for wide-scale interchange of individuals between ocean basins or across the equator.

Distribution. Humpback whales are a cosmopolitan species that occur in the Atlantic, Indian, Pacific, and Southern oceans. Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they breed and give birth to calves, although feeding occasionally occurs) and cooler, temperate or sub-Arctic waters in summer months (where they feed; (Gendron and Urban 1993). In both regions, humpback whales tend to occupy shallow, coastal waters. However, migrations are undertaken through deep, pelagic waters (Winn and Reichley 1985). Humpback whales wintering in the West Indies migrate relatively directly to the Gulf of Maine and areas around Iceland and Norway (Kennedy et al. 2013). Some individuals may not migrate, or species occurrence in foraging areas may extend beyond summer months (Van Opzeeland et al. 2013).

Occurrence in the action area is similar to North Atlantic right whales, with greater numbers over the continental shelf than in offshore waters and generally occurring later in the year (winter) (IOC 2014; U.S. Navy 2008a; U.S. Navy 2008b).

Reproduction and growth. Humpback whale calving and breeding generally occurs during winter at lower latitudes. Gestation takes about 11 months, followed by a nursing period of up to one year (Baraff and Weinrich 1993). Sexual maturity is reached at between 5-7 years of age in the western North Atlantic, but may take as long as 11 years in the North Pacific, and perhaps over 11 years (e.g., southeast Alaska, Gabriele et al. 2007). Females usually breed every 2-3 years, although consecutive calving is not unheard of (Clapham and Mayo 1987; 1990; Glockner-Ferrari and Ferrari 1985 as cited in NMFS 2005b; Weinrich et al. 1993). Males appear to return to breeding grounds more frequently than do females (Herman et al. 2011). Larger females tend to produce larger calves that may have a greater chance of survival (Pack et al. 2009). Females appear to preferentially select larger-sized males (Pack et al. 2012). In some Atlantic areas, females tend to prefer shallow nearshore waters for calving and rearing, even when these areas are extensively trafficked by humans (Picanco et al. 2009). Offspring appear to return to the same breeding areas at which they were born one they are independent (Baker et al. 2013).

In calving areas, males sing long complex songs directed towards females, other males, or both. The breeding season can best be described as a floating lek or male dominance polygamy (Clapham 1996). Calving occurs in the shallow coastal waters of continental shelves and oceanic islands worldwide (Perry et al. 1999). Males "cort" females in escort groups and compete for proximity and presumably access to reproduce females (particularly larger females)(Pack et al. 2009). Although long-term relationships do not appear to exist between males and females, mature females do pair with other females; those individuals with the longest standing relationships also have the highest reproductive output, possibly as a result of improved feeding cooperation (Ramp et al. 2010). Site fidelity off Brazilian breeding grounds was extremely low, both within and between years (Baracho-Neto et al. 2012).

Generation time for humpback whales is estimated at 21.5 years, with individuals surviving from 80-100 years (COSEWIC 2011).

Diving. In Hawaiian waters, humpback whales remain almost exclusively within the 1,800 m isobath and usually within water depths of less than 182 m. Maximum diving depths are approximately 170 m (but usually <60 m), with a very deep dive (240 m) recorded off Bermuda (Hamilton et al. 1997). Dives can last for up to 21 min, although feeding dives ranged from 2.1-5.1 min in the North Atlantic (Dolphin 1987). In southeast Alaska, average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). In the Gulf of California, humpback whale dive durations averaged 3.5 min (Strong 1990). Because most humpback prey is likely found within 300 m of the surface, most humpback dives are probably relatively shallow. In Alaska, capelin are the primary prey of humpback and are found primarily between 92 and 120 m; depths to which humpbacks apparently dive for foraging (Witteveen et al. 2008).

Feeding. During the feeding season, humpback whales form small groups that occasionally aggregate on concentrations of food that may be stable for long-periods of times. Humpbacks use a wide variety of behaviors to feed on various small, schooling prey including krill and fish (Hain et al. 1982; Hain et al. 1995; Jurasz and Jurasz 1979; Weinrich et al. 1992; Witteveen et al. 2011). The principal fish prey in the western North Atlantic are sand lance, herring, and capelin (Kenney et al. 1985a). There is good evidence of some territoriality on feeding and calving areas (Clapham 1994; Clapham 1996; Tyack 1981). Humpback whales are generally believed to fast while migrating and on breeding grounds, but some individuals apparently feed while in low-latitude waters normally believed to be used exclusively for reproduction and calf-rearing (Danilewicz et al. 2009; Pinto De Sa Alves et al. 2009). Some individuals, such as juveniles, may not undertake migrations at all (Findlay and Best. 1995). Additional evidence, such as songs sung in northern latitudes during winter, provide additional support to plastic seasonal distribution (Smith and G.Pike 2009). Relatively high rates of resighting in foraging sites suggest whales return to the same areas year after year (Ashe et al. 2013; Kragh Boye et al. 2010). This trend appears to be maternally linked, with offspring returning to the same areas their mothers brought them to once calves are independent (Baker et al. 2013; Barendse et al. 2013). Humpback whales in foraging areas may forage largely or exclusively at night when prey are closer to the surface (Friedlaender et al. 2013).

Vocalization and hearing. Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hz to 4 kHz with estimated source levels from 144-174 dB (Au 2000b; Au et al. 2006; Frazer and Mercado 2000; Payne 1970; Richardson et al. 1995c; Winn et al. 1970). Both mature and immature males sing in breeding areas (Herman et al. 2013). Males also produce sounds associated with aggression, which are generally characterized as frequencies between 50 Hz to 10 kHz and having most energy below 3 kHz (Silber 1986; Tyack 1983). Such sounds can be heard up to 9 km away (Tyack and Whitehead 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995c; Tyack and Whitehead 1983). While in northern feeding areas, both sexes vocalize in grunts (25 Hz to 1.9 kHz), pulses (25-89 Hz), and songs (ranging from 30 Hz to 8 kHz but dominant frequencies of 120 Hz to 4 kHz) which can be very loud (175-192 dB re 1 μPa at 1 m; (Au 2000b; Erbe 2002a; Payne and Payne 1985; Richardson et al. 1995c; Thompson et al. 1986; Vu et al. 2012). However, humpbacks tend to be less vocal in northern feeding areas than in southern breeding areas, possibly due to foraging (Richardson et al. 1995c; Vu et al. 2012). During migration, social vocalizations are generated at 123 to 183 dB re 1 μPa at1 m with a median of 158 dB re 1 μPa at 1 m (Dunlop et al. 2013).

Status and trends. Humpback whales were originally listed as endangered in 1970 (35 FR 18319), and this status remains under the ESA. (Winn and Reichley 1985) argued that the global humpback whale population consisted of at least 150,000 whales in the early 1900s, mostly in the Southern Ocean. Consideration of the status of populations outside of the action area is important under the present analysis to determine the risk to the affected population(s) bears on the status of the species as a whole. Table 5 provides estimates of historic and current abundance for ocean regions.

Table 5. Summary of past and present humpback whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	~~	1,000,000	~~	~~	~~	(Roman and Palumbi 2003)
				10,000		(NMFS 1987)

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
North Atlantic	Basinwide	240,000	156,000-401,000*	11,570	10,005-13,135*	(Stevick et al. 2003a)
	~~	~~	~~	>5,500	~~	(Sigurjonsson 1995)
	Basinwide-females	~~	~~	2,804	1,776-4,463	(Palsbøll et al. 1997)
	Basinwide-males	~~	~~	4,894	3,374-7,123	(Palsbøll et al. 1997)
	Western North Atlantic	~~	~~	11,600	10,000-13,000	(IWC 2014)
	Western North Atlantic from Davis Strait, Iceland, to the West Indies	>4,685*	~~	~~	~~	*circa 1865; (Mitchell and Reeves 1983)
	West Greenland	~~	~~	2,154	CV=0.36	(Heide-Jorgensen et al. 2012)
	Iceland	~~	~~	5,000	~~	(Pike et al. 2009a)
	NMFS-Gulf of Maine stock	~~	~~	847	CV=0.55	(Waring et al. 2012)
	NMFS-Gulf of Maine stock including portions of the Scotian Shelf	~~	~~	902	177-1,627	(Clapham et al. 2003)
	Barents and Norwegian Seas	~~	~~	889	331-1,447*	(Øien 2001) *in* (Waring et al. 2004)

*Note: Confidence Intervals (C. I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

North Atlantic. Historical estimates have ranged from 40,000-250,000 (Smith and G.Pike 2009). Smith and Reeves (2010) estimated that roughly 31,000 individuals were removed from the North Atlantic due to whaling since the 1600s. Estimates of animals on Caribbean breeding grounds exceed 2,000 individuals (Balcomb III and Nichols 1982). Several researchers report an increasing trend in abundance for the North Atlantic population, which is supported by increased sightings within the Gulf of Maine feeding aggregation (Barlow 1997; Katona and Beard 1990; Smith et al. 1999; Waring et al. 2001). The rate of increase varies from 3.2-9.4%, with rates of increase slowing over the past two decades (Barlow 1997; Katona and Beard 1990; Stevick et al. 2003a). If the North Atlantic population has grown according to the estimated instantaneous rate of increase ($r = 0.0311$), this would lead to an estimated 18,400 individual whales in 2008 (Stevick et al. 2003a). Punt (2010) estimated the rate of increase for humpback whales in the Gulf of Maine to be 6.3% annually (1.2 SE). Pike et al. (2009a) suggested that the eastern and northeastern waters off Iceland are areas of significant humpback utilization for feeding, estimating nearly 5,000 whales in 2001 and proposing an annual growth rate of 12% for the area. The authors suggest that humpback whales in the area had probably recovered from whaling. However, recent data suggest that the upward growth may have slowed or ceased around Iceland according to analysis of survey data there (Pike et al. 2010). The Gulf of Maine stock is estimated to be increasing at a rate of 3.1% annually (Waring et al. 2013). Humpback whales summering off West Greenland appear to be increasing at a rate of 9.4% annually (Heide-Jorgensen et al. 2012).

Natural threats. Natural sources and rates of mortality of humpback whales are not well known. Based upon prevalence of tooth marks, attacks by killer whales appear to be highest among humpback whales migrating between Mexico and California, although populations throughout the Pacific Ocean appear to be targeted to some degree (Steiger et al. 2008). Juveniles appear to be the primary age group targeted. Humpback whales engage in grouping behavior, flailing tails, and rolling extensively to fight off attacks. Calves remain protected near mothers or within a group and lone calves have been known to be protected by presumably unrelated adults when confronted with attack (Ford and Reeves 2008).

Parasites and biotoxins from red-tide blooms are other potential causes of mortality (Perry et al. 1999). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992). Studies of 14 humpback whales that stranded along Cape Cod between November 1987 and January 1988 indicate they apparently died from a toxin produced by dinoflagellates during this period. One-quarter of humpback whales of the Arabian Sea population show signs of tattoo skin disease, which may reduce the fitness of afflicted individuals (Baldwin et al. 2010).

Anthropogenic threats. Three human activities are known to represent major threats to humpback whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of whales and was ultimately responsible for several species being listed as endangered.

Organochlorines, including PCB and DDT, have been identified in humpback whale blubber (Gauthier et al. 1997b). Higher PCB levels have been observed in western Atlantic waters versus Pacific waters along the United States and levels tend to increase with individual age (Elfes et al. 2010); eastern Atlantic individuals fall between these two in contaminant burden (Ryan et al. 2014) . Although humpback whales in the Gulf of Maine and off Southern California tend to have the highest PCB concentrations, overall levels are on par with other baleen whales, which are generally lower than odontocete cetaceans (Elfes et al. 2010). These contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to that of mothers before bioaccumulating additional contaminants during life and passing the additional burden to the next generation (Metcalfe et al. 2004). Contaminant levels are relatively high in humpback whales as compared to blue whales. Humpback whales feed higher on the food chain, where prey carry higher contaminant loads than the krill that blue whales feed on.

Critical habitat. The NMFS has not designated critical habitat for humpback whales.

6.4 North Atlantic right whale

Population. All North Atlantic right whales compose a single population. Although not all individuals undergo the same migratory pattern, no subpopulation structuring has been identified.

Distribution. Right whales occur in sub-polar to temperate waters in all major ocean basins in the world, with a clear migratory pattern of high latitudes in summer and lower latitudes in winter (Cummings 1985; Perry et al. 1999; Rice 1998b). The historical range of North Atlantic right whales extended as far south as Florida and northwestern Africa, and as far north as Labrador, southern Greenland, Iceland, and Norway (Cummings 1985; Reeves et al. 1978; Rice 1998b). Recent sightings have been made through some of the broader historical range, including Iceland, Greenland, Norway, and the Azores (Hamilton et al. 2009; Hamilton et al. 2007; Jacobsen et al. 2004; Silva et al. 2012). Additional rare sightings have been made in the Gulf of Mexico (Moore and Clark 1963; Schmidly et al. 1972). Most sightings in the western North Atlantic are concentrated within five primary habitats or high-use areas: coastal waters of the southeastern U.S., Cape Cod and Massachusetts Bays, the Great South Channel, the Bay of Fundy, and the Scotian Shelf (Winn et al. 1986). In 1994, the first three of these areas were designated as critical habitat for the North Atlantic right whale.

North Atlantic right whales have been observed from the mid-Atlantic Bight northward through the Gulf of Maine year-round, but are primarily found along the northeast U.S. during summer and Florida during winter, with migratory routes in between. In New England, peak abundance of North Atlantic right whales in feeding areas occurs in Cape Cod Bay beginning in late winter. In early spring (late February to April), peak North Atlantic right whale abundance occurs in Jordan and Wilkinson Basins to the Great South Channel (Kenney et al. 1995; Nichols et al. 2008; Pace III and Merrick 2008). In late June and July, North Atlantic right whale distribution gradually shifts to the northern edge of Georges Bank. In late summer (August) and fall, much of the population is found in waters in the Bay of Fundy, the western Gulf of Maine and around Roseway Basin (Kenney et al. 2001; Kenney et al. 1995; Pace III and Merrick 2008; Winn et al. 1986). However, year-to-year variation in space and time are known and likely result from patchy prey distribution (Nichols et al. 2008). Variation in the abundance and development of suitable food patches appears to modify the general patterns of movement by reducing peak numbers, stay durations, and specific locales (Brown et al. 2001; Kenney 2001). In particular, large changes in the typical pattern of food abundance will dramatically change the general pattern of North Atlantic right whale habitat use (Kenney 2001).

North Atlantic right whales regularly migrate through the action area (largely over the continental shelf) during winter and spring moving between feeding and calving areas. However, the proposed seismic survey is expected to be completed before all but very early migrants will move south through the region. Published literature support right whale occurrence off North Carolina during October at very low levels (Beaudin Ring 2002). However, survey effort during the September to October time frame is low. Discussion with regional experts support the possibility of North Atlantic right whale occurrence in the action area during the timeframe of the proposed survey, particularly in continental shelf waters and north of the Gulf Stream, which may act as a thermal barrier to passage southward (W. McLellan, University of North Carolina at Wilmington pers. comm. to B. Bloodworth, NMFS, July 11, 2014; C. Good, Duke University pers. comm. to B. Bloodworth, NMFS, July 11, 2014).

Migration and movement. North Atlantic right whales exhibit extensive migratory patterns, traveling along the eastern seaboard of the U.S. and Canada between calving grounds off Georgia and Florida to northern feeding areas off the northeast U.S. and Canada in March/April and the reverse direction in November/December. The longest tracking of a North Atlantic right whale was a migration of 1,200 miles in 23 days the Bay of Fundy to Georgia (Mate and Baumgartner 2001). Migrations are typically within 30 nautical miles of the coastline and in waters less than 160 feet deep. Although this pattern is well-known, most of the population, particularly the males and non-pregnant females, is not found in the calving area and may not follow this pattern. It is unknown where the majority of the non-calving population spends the winter. Whales may remain in their foraging habitat during winter (Morano et al. 2012).

There have been a few recent sightings of North Atlantic right whales far offshore, including those from Dutch ships indicating some individuals occur between 40° and 50° N, in waters influenced by the North Atlantic Current (the broad, eastward-flowing extension of the Gulf Stream). Right whales have been sighted offshore (greater than 30 miles) during surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2001. These include three sightings in 1996, one in 1997, 13 in 1998, six in 1999, 11 in 2000, and six in 2001 (within each year, some were repeat sightings). Mate et al. (1997) recorded radio-tagged animals making extensive movements from the Gulf of Maine into deeper waters off the continental shelf (Mate et al. 1997). The frequency with which North Atlantic right whales occur in offshore waters in the southeastern U.S. remains unclear. Occasionally, individuals are observed in distant locations, including the Gulf of Mexico, Bermuda, Azores, the Gulf of St. Lawrence, Newfoundland, Greenland, Iceland, and northern Norway (an area known as a historical North Atlantic right whale feeding area Silva et al. 2012; Smith et al. 2006). The Norwegian sighting (September 1992) represents one of only two sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described.

Reproduction, growth, and demography. Data through the 1990s suggests that mean calving interval increased since 1992 from 3.67 years to more than five years, a significant trend that hampers North Atlantic right whale recovery (Best et al. 2001a; Kraus et al. 2007). This reproductive rate was approximately half that reported from studied populations of southern right whales (Best et al. 2001b). This has been attributed to several possible causes, including higher abortion or perinatal losses (Browning et al. 2009). An analysis of the age structure of North Atlantic right whales suggests that the population contains a smaller proportion of juvenile whales than expected, which may reflect lowered recruitment and/or high juvenile mortality (Best et al. 2001a; Hamilton et al. 1998). In addition, it is possible that the apparently low reproductive rate is due in part to unstable age structure or to reproductive senescence on the part of some females. However, knowledge on either factor is poor. Even though investment in calves is high for North Atlantic right whales, an incident of calf exchange (probably accidentally and soon after birth) and subsequent adoption through weaning has been found (Frasier et al. 2010). Although North Atlantic right whales historically separated from their calves within one year, a shift appears to have taken place around 2001 where mothers (particularly less experienced mothers) return to wintering grounds with their yearling at a much greater frequency (71% overall)(Hamilton and Cooper. 2010). The significance of this change is unknown.

Calves reach roughly three-quarters of their adult body size by the time they wean at 12 months, roughly doubling their original body size and gaining about 36 kg daily (Fortune et al. 2012).

Habitat. Available evidence from North Atlantic right whale foraging and habitat studies shows that North Atlantic right whales focus foraging activities where physical oceanographic features such as water depth, current, and mixing fronts combine to concentrate copepods (Baumgartner et al. 2003; Davies et al. 2014; Mayo and Marx 1990; Murison and Gaskin 1989; Wishner et al. 1988a).

Feeding. North Atlantic right whales fast during the winter and feed during the summer, although some may opportunistically feed during migration. North Atlantic right whales use their baleen to sieve copepods from dense patches, found in highly variable and spatially unpredictable locations in the Bay of Fundy, Roseway Basin, Cape Cod Bay, the Great South Channel, and other areas off of northern U.S. and Canada (Pendleton et al. 2009). The primary prey of North Atlantic right whales is zooplankton, especially shrimp-like copepods such as *Calanus* (Beardsley et al. 1996; Kenney et al. 1985b). North Atlantic right whales feed largely by skimming these prey from the ocean surface (Mayo and Marx 1990; Pivorunas 1979), but may feed anywhere in the water column (Goodyear 1993; Watkins and Schevill 1976; Watkins and Schevill 1979; Winn et al. 1995). Feeding behavior has only been observed in northern areas and not on calving grounds or during migration (Kraus et al. 1993).

Diving. Although North Atlantic right whales are known to be primarily surface feeders, foraging dives frequently extend to the deepest layers of the water column (Baumgartner et al. 2003; Goodyear 1993; Mate et al. 1997). North Atlantic right whale feeding dives are characterized by a rapid descent from the surface to between 80 and 175 m, where dives level off and individuals remain for 5 to 14 min before rapidly ascending back to the surface (Baumgartner and Mate 2003). Dive depth has been shown to be strongly correlated with the depth of peak copepod abundance (Baumgartner and Mate 2003). Prolonged periods at the surface have been noted for mothers and calves (Baumgartner and Mate 2003). Shallow foraging dives in the Great South Channel average 2 min and 6 to 8 m (Winn et al. 1995). However, dives along the outer shelf average 7 min (CETAP 1982c). Although North Atlantic right whales are not champion divers, they can dive to over 300 m (Mate et al. 1992). Group size varies, but is generally less than one dozen and singletons and pairs are most frequently observed (Jefferson et al. 1993).

North Atlantic right whales produce a variety of calls from 159-192 dB re: 1 μPa while in surface active groups on breeding grounds (Tryonis et al. 2013).

Vocalization and hearing. Right whales vocalize to communicate over long distances and for social interaction, including communication apparently informing others of prey patch presence (Biedron et al. 2005; Tyson and Nowacek 2005). Vocalization patterns amongst all right whale species are generally similar, with six major call types: scream, gunshot, blow, up call, warble, and down call (McDonald and Moore 2002; Parks and Tyack 2005). A large majority of vocalizations occur in the 300-600 Hz range with up- and down sweeping modulations (Vanderlaan et al. 2003). Vocalizations below 200 Hz and above 900 Hz were rare (Vanderlaan et al. 2003). Calls tend to be clustered, with periods of silence between clusters (Vanderlaan et al. 2003). Gunshot bouts last 1.5 hours on average and up to seven hours (Parks et al. 2012a). Blows are associated with ventilation and are generally inaudible underwater (Parks and Clark 2007). Up calls are 100-400 Hz (Gillespie and Leaper 2001). Gunshots appear to be a largely or exclusively male vocalization (Parks et al. 2005b). Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews et al. 2001). Moans are usually produced within 10 m of the surface (Matthews et al. 2001). Up calls were detected year-round in Massachusetts Bay except July and August and peaking in April (Mussoline et al. 2012). Individuals remaining in the Gulf of Maine through winter continue to call, showing a strong diel pattern of up call and gunshot vocalizations from November through January possibly associated with mating (Bort et al. 2011; Morano et al. 2012; Mussoline et al. 2012). Estimated source levels of gunshots in non-surface active groups are 201 dB re 1 μPa p-p (Hotchkin et al. 2011). While in surface active groups, females produce scream calls and males produce up calls and gunshot calls as threats to other males; calves (at least female calves) produce warble sounds similar top their mothers' screams (Parks et al. 2003; Parks and Tyack 2005). Source levels for these calls in surface active groups range from 137-162 dB rms re: 1 μPa-m, except for gunshots, which are 174-192 dB rms re: 1 μPa-m (Parks and Tyack 2005). Up calls may also be used to reunite mothers with calves (Parks and Clark 2007). Atlantic right whales shift calling frequencies, particularly of up calls, as well as increase call amplitude over both long and short-term periods due to exposure to vessel noise (Parks and Clark 2007; Parks et al. 2005a; Parks et al. 2007a; Parks et al. 2011a; Parks et al. 2010; Parks et al. 2012b; Parks et al. 2006). North Atlantic right whales respond to anthropogenic sound designed to alert whales to vessel presence by surfacing (Nowacek et al. 2003; Nowacek et al. 2004b).

No direct measurements of right whale hearing have been undertaken (Parks and Clark 2007). Models based upon right whale auditory anatomy suggest a hearing range of 10 Hz to 22 kHz (Parks et al. 2007b).

Status and trends. The Northern right whale was originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. The early listing included both the North Atlantic and the North Pacific populations, although subsequent genetic studies conducted by Rosenbaum (2000) resulted in strong evidence that North Atlantic and North Pacific right whales are separate species. Following a comprehensive status review, NMFS concluded that North Atlantic and North Pacific right whales are separate species. In March 2008, NMFS published a final rule listing North Pacific and North Atlantic right whales as separate species (73 FR 12024).

North Atlantic right whales were formerly abundant, with an estimated 5,500 individuals present in the 16th century throughout the North Atlantic (Reeves 2001; Reeves et al. 2007). However, genetic evidence suggests a much larger historical population size of 112,000 individuals (95 % confidence interval 45,000–235,000)(Ruegg et al. 2013). A review of the photo-id recapture database in June 2006, indicated that only 313 individually recognized North Atlantic right whales were observed during 2001. Recent additions to the photo-ID catalog lead to a minimum population estimate of 444 individuals (Waring et al. 2013). This represents a nearly complete census, and the estimated minimum population size. However, no estimate of abundance with an associated coefficient of variation has been calculated for the population. Furthermore, 55% of fathers have not been genetically identified, suggesting the population may be significantly larger than presently thought (Frasier 2005). This also suggests the occurrence of right whales in as yet unidentified habitats (Frasier 2005). The population growth rate reported for the period 1986 to 1992 by Knowlton et al. (1994) was 2.5%, suggesting the stock was showing signs of slow recovery. However, work by Caswell et al. (1999) suggested that crude survival probability declined from about 0.99 in the early 1980's to about 0.94 in the late 1990s. Additional work conducted in 1999 showed that survival had indeed declined in the 1990s, particularly for adult females (Best et al. 2001a). Another workshop in September 2002 further confirmed the decline in this population (Clapham 2002). The best available estimate of population trajectory suggests the population is increasing at a rate of 2.6% over the 1990-2009 timeframe (Waring et al. 2013).

Natural threats. Several researchers have suggested that the recovery of North Atlantic right whales has been impeded by competition with other whales for food (Rice 1974; Scarff 1986). Mitchell (1975) analyzed trophic interactions among baleen whales in the western North Atlantic and noted that the foraging grounds of North Atlantic right whales overlapped with the foraging grounds of sei whales. Both species feed preferentially on copepods. Mitchell (1975) argued that the North Atlantic right whale population had been depleted by several centuries of whaling before steam-driven boats allowed whalers to hunt sei whales; from this, he hypothesized that the decline of the right whale population made more food available to sei whales and helped their population to grow. He then suggested that competition with the sei whale population impedes or prevents the recovery of the right whale population. Shark predation has been repeatedly documented on right whales calves along the southeastern U.S., some of which may be fatal (Taylor et al. 2013).

Other natural factors influencing right whale recovery are possible, but unquantified. Right whales have been subjects of killer whale attacks and, because of their robust size and slow swimming speed, tend to fight killer whales when confronted (Ford and Reeves 2008). Similarly, mortality or debilitation from disease and red tide events are not known, but have the potential to be significant problems in the recovery of right whales because of their small population size.

Anthropogenic threats. Several human activities are known to threaten North Atlantic right whales: whaling, commercial fishing, shipping, and environmental contaminants. Historically, whaling represented the greatest threat to every population of right whales and was ultimately responsible for listing right whales as an endangered species. As its legacy, whaling reduced North Atlantic right whales to about 300 individuals in the western North Atlantic Ocean; the number of North Atlantic right whales in the eastern North Atlantic Ocean is probably much smaller, if present at all.

Concern also exists over climate change and its effect on the ability of North Atlantic right whales to recover (Greene et al. 2003b). Specifically, the variations in oceanography resulting from current shifts and water temperatures can significantly affect the occurrence of the North Atlantic right whale's primary food, copepod crustaceans. If climate changes such that current feeding areas cannot sustain North Atlantic right whales, the population may have to shift to reflect changes in prey distribution, pursue other prey types, or face prey shortage. Changes in calving intervals with sea surface temperature have already been documented for southern right whales (Leaper et al. 2006).

North Atlantic right whales, as with many marine mammals, are exposed to numerous toxins in their environment, many of which are introduced by humans. Levels of chromium in North Atlantic right whale tissues are sufficient to be mutagenic and cause cell death in lung, skin, or testicular cells and are a concern for North Atlantic right whale recovery (Chen et al. 2009; Wise et al. 2008). The organochlorines DDT, DDE, PCBs, dieldrin, chlordane, hexachlorobenzene, and heptachlor epoxide have been isolated from blubber samples and reported concentrations may underestimate actual levels (Woodley et al. 1991). Mean PCB levels in North Atlantic right whales are greater than any other baleen whale species thus far measured, although less than one-quarter of the levels measured in harbor porpoises (Gauthier et al. 1997a; Van Scheppingen et al.

1996). Organochlorines and pesticides, although variable in concentration by season, do not appear to currently threaten North Atlantic right whale health and recovery (Weisbrod et al. 2000). Flame retardants such as polybrominated diphenyl ethers (PBDEs) (known to be carcinogenic) have also been measured in North Atlantic right whales (Montie et al. 2010).

Critical habitat. Although no critical habitat occurs in the action area, critical habitat is designated for right whales in the North Atlantic. NMFS designated three areas in June 1994 as critical habitat for *Eubalaena glacialis* for feeding and calving (59 FR 28805). The critical habitats for feeding cover portions of the Great South Channel (east of Cape Cod), Massachusetts Bay and Cape Cod Bay, and Stellwagen Bank. Northern critical habitat was designated because of the concentration of right whales that feed in the area, apparently associated with complex oceanographic features that drive prey density and distribution. This area has come under considerable scrutiny within the past few years because of the concern over ship strikes in this area. Boston serves as a major port facility and vessels transiting to and from the port cross critical habitat where North Atlantic right whale mortality occurs. Shipping traffic has generally increased in the recent past and could be considered to degrade the habitat due to the additional mortality and injury risk now present in the area. Although voluntary regulations are in place, these are frequently ignored and mandatory regulations are under consideration. The southern critical habitats are along Georgia and northeastern Florida coasts (waters from the coast out 15 nautical miles between the latitudes of 31°15’ N and 30°15’ N and from the coast out five nautical miles between 30°15’ N and 28°00’ N). Southern critical habitat is designated to protected calving and breeding grounds for North Atlantic right whales, which generally calve and breed in shallow coastal waters. This critical habitat has generally fared better than northern critical habitat and significant degradation has not been clearly identified. Modeling efforts suggest water temperature and depth are driving factors for right whale occurrence along the coasts of Florida and Georgia during winter, some of which occur in designated critical habitat and some of which do not (Keller et al. 2012).

6.5 Sei whale

Population designations. The population structure of sei whales is unknown and populations herein assume (based upon migratory patterns) population structuring is discrete by ocean basin.

North Atlantic. In the western North Atlantic, a major portion of the sei whale population occurs in northern waters, potentially including the Scotian Shelf, along Labrador and Nova Scotia, south into the U.S. EEZ, including the Gulf of Maine and Georges Bank (Mitchell and Chapman 1977; Waring et al. 2004). These whales summer in northern areas before migrating south to waters along Florida, in the Gulf of Mexico, and the northern Caribbean Sea (Gambell 1985b; Mead 1977). Sei whales may range as far south as North Carolina. In the U.S. EEZ, the greatest abundance occurs during spring, with most sightings on the eastern edge of Georges Bank, in the Northeast Channel, and in Hydrographer Canyon (CETAP 1982b). In 1999, 2000, and 2001, the NMFS aerial surveys found sei whales concentrated along the northern edge of Georges Bank during spring (Waring et al. 2004). Surveys in 2001 found sei whales south of Nantucket along the continental shelf edge (Waring et al. 2004). During years of greater prey abundance (e. g., copepods), sei whales are found in more inshore waters, such as the Great South Channel (1987 and 1989), Stellwagen Bank (1986), and the Gulf of Maine (Payne et al. 1990a; Schilling et al. 1992). In the eastern Atlantic, sei whales occur in the Norwegian Sea, occasionally occurring as far north as Spitsbergen Island, and migrate south to

Spain, Portugal, and northwest Africa (Gambell 1985b; Jonsgård and Darling 1977).

Sei whales have not been sighted in the action area during the time of the proposed seismic survey. They have been sighted in the region off Virginia and North Carolina during winter and spring (CETAP 1982a; IOC 2014; U.S. Navy 2008a), however, and an individual swam into the Elizabeth River, Virginia during August 2014. The paucity of sightings may be due to low survey effort in the region during late summer-early fall as well as the deeper water tendencies of the species. Discussion with regional efforts leads the ESA Interagency Cooperation Division to conclude that, although documented occurrence is not well established, it would not be surprising to find sei whales in the region (W. McLellan, University of North Carolina at Wilmington pers. comm. to B. Bloodworth, NMFS, July 11, 2014; C. Good, Duke University pers. comm. to B. Bloodworth, NMFS, July 11, 2014).

Movement. The migratory pattern of this species is thought to encompass long distances from high-latitude feeding areas in summer to low-latitude breeding areas in winter; however, the location of winter areas remains largely unknown (Perry et al. 1999). Sei whales are often associated with deeper waters and areas along continental shelf edges (Hain et al. 1985). This general offshore pattern is disrupted during occasional incursions into shallower inshore waters (Waring et al. 2004). The species appears to lack a well-defined social structure and individuals are usually found alone or in small groups of up to six whales (Perry et al. 1999). When on feeding grounds, larger groupings have been observed (Gambell 1985b).

Reproduction. Very little is known regarding sei whale reproduction. Reproductive activities for sei whales occur primarily in winter. Gestation is about 12.7 months, calves are weaned at 6-9 months, and the calving interval is about 2-3 years (Gambell 1985b; Rice 1977). Sei whales become sexually mature at about age 10 (Rice 1977). Of 32 adult female sei whales harvested by Japanese whalers, 28 were found to be pregnant while one was pregnant and lactating during May-July 2009 cruises in the western North Pacific (Tamura et al. 2009).

Feeding. Sei whales are primarily planktivorous, feeding mainly on euphausiids and copepods, although they are also known to consume fish (Waring et al. 2006). In the Northern Hemisphere, sei whales consume small schooling fish such as anchovies, sardines, and mackerel when locally abundant (Konishi et al. 2009; Mizroch et al. 1984; Rice 1977).

Vocalization and hearing. Data on sei whale vocal behavior is limited, but includes records off the Antarctic Peninsula of broadband sounds in the 100-600 Hz range with 1.5 sec duration and tonal and upsweep calls in the 200-600 Hz range of 1-3 sec durations (McDonald et al. 2005). Source levels of 189 ±5.8 dB re 1 μPa at 1m have been established for sei whales in the northeastern Pacific (Weirathmueller et al. 2013). Differences may exist in vocalizations between ocean basins (Rankin and Barlow 2007b). The first variation consisted of sweeps from 100 to 44 Hz, over 1.0 sec. During visual and acoustic surveys conducted in the Hawaiian Islands in 2002, Rankin and Barlow (2007a) recorded 107 sei whale vocalizations, which they classified as two variations of low-frequency downswept calls. The second variation, which was more common (105 out of 107) consisted of low frequency calls which swept from 39 to 21 Hz over 1.3 sec. These vocalizations are different from sounds attributed to sei whales in the Atlantic and Southern Oceans but are similar to sounds that had previously been attributed to fin whales in Hawaiian waters. Vocalizations from the North Atlantic consisted of paired sequences (0.5-0.8 sec, separated by 0.4-1.0 sec) of 10-20 short (4 ms) FM sweeps between 1.5-3.5 kHz (Thomson and Richardson 1995).

Status and trends. The sei whale was originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. Consideration of the status of populations outside of the action area is important under the present analysis to determine the how risk the risk to the affected population(s) bears on the status of the species as a whole. Table 6 provides estimates of historic and current abundance for ocean regions.

Table 6. Summary of past and present sei whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	--	>105,000	--	25,000	--	(Braham 1991)
North Atlantic	Basinwide	--	--	>4000	--	(Braham 1991)
	~~			>13,500		(Sigurjonsson 1995)
	NMFS-Nova Scotia stock	--	--	386	--	(NMFS 2008; Waring et al. 2012)
	Northeast Atlantic	--	--	10,300	0.268	(Cattanach et al. 1993)

*Note: Confidence Intervals (C. I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

North Atlantic. No information on sei whale abundance exists prior to commercial whaling (Perry et al. 1999). Between 1966 and 1972, whalers from land stations on the east coast of Nova Scotia engaged in extensive hunts of sei whales on the Nova Scotia shelf, killing about 825 individuals (Mitchell and Chapman 1977). In 1974, the North Atlantic stock was estimated to number about 2,078 individuals, including 965 whales in the Labrador Sea group and 870 whales in the Nova Scotia group (Mitchell and Chapman 1977). In the northwest Atlantic, Mitchell and Chapman (1977) estimated the Nova Scotia stock to contain 1,393-2,248 whales; an aerial survey program conducted from 1978 to 1982 on the continental shelf and edge between Cape Hatteras, North Carolina, and Nova Scotia generated an estimate of 280 sei whales (CETAP 1982b). These two estimates are more than 30 years out of date and likely do not reflect the current true abundance; in addition, the Cetacean and Turtle Assessment Program estimate has a high degree of uncertainty and is considered statistically unreliable (Perry et al. 1999; Waring et al. 2004; Waring et al. 1999). The total number of sei whales in the U.S. Atlantic EEZ remains unknown (Waring et al. 2006). Rice (1977) estimated total annual mortality for adult females as 0.088 and adult males as 0.103.

Natural threats. Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same areas. Sei whales engage in a flight responses to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Endoparasitic helminths (worms) are commonly found in sei whales and can result in pathogenic effects when infestations occur in the liver and kidneys (Rice 1977).

Anthropogenic threats. Human activities known to threaten sei whales include whaling, commercial fishing, and maritime vessel traffic. Historically, whaling represented the greatest threat to every population of sei whales and was ultimately responsible for listing sei whales as an endangered species. Sei whales are thought to not be widely hunted, although harvest for scientific whaling or illegal harvesting may occur in some areas. In 2009, 100 sei whales were killed during western North Pacific surveys (Bando et al. 2010).

Sei whales are known to accumulate DDT, DDE, and PCBs (Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983). Males carry larger burdens than females, as gestation and lactation transfer these toxins from mother to offspring.

Critical habitat. The NMFS has not designated critical habitat for sei whales.

6.6 Sperm whale

Populations. There is no clear understanding of the global population structure of sperm whales (Dufault et al. 1999). Recent ocean-wide genetic studies indicate low, but statistically significant, genetic diversity and no clear geographic structure, but strong differentiation between social groups (Lyrholm and Gyllensten 1998; Lyrholm et al. 1996; Lyrholm et al. 1999). Chemical analysis also suggest significant differences in diet for animals captured in different regions of the North Atlantic. However, vocal dialects indicate parent-offspring transmission that support differentiation in populations (Rendell et al. 2011). Therefore, population-level differences may be more extensive than are currently understood.

The IWC currently recognizes four sperm whale stocks: North Atlantic, North Pacific, northern Indian Ocean, and Southern Hemisphere (Dufault et al. 1999; Reeves and Whitehead 1997). The NMFS recognizes six stocks under the MMPA- three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawaii; (Perry et al. 1999; Waring et al. 2004)). Genetic studies indicate that movements of both sexes through expanses of ocean basins are common, and that males, but not females, often breed in different ocean basins than the ones in which they were born (Whitehead 2003). Sperm whale populations appear to be structured socially, at the level of the clan, rather than geographically (Whitehead 2003; Whitehead et al. 2008). Matrilinear groups in the eastern Pacific share nuclear DNA within broader clans, but North Atlantic matrilinear groups do not share this genetic heritage (Whitehead et al. 2012).

North Atlantic. In the western North Atlantic, sperm whales range from Greenland south into the Gulf of Mexico and the Caribbean, where they are common, especially in deep basins off of the continental shelf (Romero et al. 2001; Wardle et al. 2001). The northern distributional limit of female/immature pods is probably around Georges Bank or the Nova Scotian shelf (Whitehead et al. 1991). Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Hansen et al. 1996; Mullin et al. 1994). Sperm whale distribution follows a distinct seasonal cycle, concentrating east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight. A long-term study of sperm whales along Dominica, West Indies supports 17 discreet groups habituating this area (Gero et al. 2013). In the eastern Atlantic, mature male sperm whales have been recorded as far north as Spitsbergen (Øien 1990). Recent observations of sperm whales and stranding events involving sperm whales from the eastern North Atlantic suggest that solitary and paired mature males predominantly occur in waters off Iceland, the Faroe Islands, and the Norwegian Sea (Christensen et al. 1992a; Christensen et al. 1992b; Gunnlaugsson and Sigurjónsson 1990; Øien 1990).

The Mid-Atlantic Bight is considered a summer habitat for sperm whales (Palka 2006), including regular year-round occurrence off Virginia and North Carolina over the continental shelf and further offshore (CETAP 1982a; IOC 2014; U.S. Navy 2008a; U.S. Navy 2008b).

Movement. Mature males range between 70º N in the North Atlantic and 70º S in the Southern Ocean (Perry et al. 1999; Reeves and Whitehead 1997), whereas mature females and immature individuals of both sexes are seldom found higher than 50º N or S (Reeves and Whitehead 1997). In winter, sperm whales migrate closer to equatorial waters (Kasuya and Miyashita 1988; Waring et al. 1993) where adult males join them to breed. Males identified in the Azores have been resighted in Norwegian waters (Steiner et al. 2012). In the North Pacific, female sperm whales and their calves are usually found in tropical and temperate waters year round, while it is generally understood that males move north in the summer to feed in the Gulf of Alaska, Bering Sea, and waters off of the Aleutian Islands (Kasuya and Miyashita 1988). Movement patterns of Pacific female and immature male groups appear to follow prey distribution and, although not random, movements are difficult to anticipate and are likely associated with feeding success, perception of the environment, and memory of optimal foraging areas (Whitehead et al. 2008). However, no sperm whale in the Pacific has been known to travel to points over 5,000 km apart and only rarely have been known to move over 4,000 km within a time frame of several years. This means that although sperm whales do not appear to cross from eastern to western sides of the Pacific (or vice-versa), significant mixing occurs that can maintain genetic exchange. Movements of several hundred kilometers are common (i.e., between the Galapagos Islands and the Pacific coastal Americas). Movements appear to be group or clan specific, with some groups traveling straighter courses than others over the course of several days. However, general transit speed averages about 4 km/h. Sperm whales in the Caribbean region appear to be much more restricted in their movements, with individuals repeatedly sighted within less than 160 km of previous sightings.

Habitat. Sperm whales have a strong preference for waters deeper than 1,000 m (Reeves and Whitehead 1997; Watkins 1977), although Berzin (1971) reported that they are restricted to waters deeper than 300 m. While deep water is their typical habitat, sperm whales are rarely found in waters less than 300 m in depth (Clarke 1956; Rice 1989b). Sperm whales have been observed near Long Island, New York, in water between 40-55 m deep (Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in topography where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). Such areas include oceanic islands and along the outer continental shelf.

Sperm whales are frequently found in locations of high productivity due to upwelling or steep underwater topography, such as continental slopes, seamounts, or canyon features (Jaquet and Whitehead 1996; Jaquet et al. 1996). Cold-core eddy features are also attractive to sperm whales in the Gulf of Mexico, likely because of the large numbers of squid that are drawn to the high concentrations of plankton associated with these features (Biggs et al. 2000; Davis et al. 2000c; Davis et al. 2000d; Davis et al. 2000e; Davis et al. 2002; Wormuth et al. 2000). Surface waters with sharp horizontal thermal gradients, such as along the Gulf Stream in the Atlantic, may also be temporary feeding areas for sperm whales (Griffin 1999; Jaquet et al. 1996; Waring et al. 1993). Sperm whales over George's Bank were associated with surface temperatures of 23.2-24.9° C (Waring et al. 2003).

Reproduction. Female sperm whales become sexually mature at an average of 9 years or 8.25-8.8 m (Kasuya 1991). Males reach a length of 10 to 12 m at sexual maturity and take 9-20 years to become sexually mature, but require another 10 years to become large enough to successfully breed (Kasuya 1991; Würsig et al. 2000). Mean age at physical maturity is 45 years for males and 30 years for females (Waring et al. 2004). Adult females give birth after roughly 15 months of gestation and nurse their calves for 2-3 years (Waring et al. 2004). The calving interval is estimated to be every 4-6 years between the ages of 12 and 40 (Kasuya 1991; Whitehead et al. 2008). It has been suggested that some mature males may not migrate to breeding grounds annually during winter, and instead may remain in higher latitude feeding grounds for more than one year at a time (Whitehead and Arnbom 1987).

Sperm whale age distribution is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980). In addition to anthropogenic threats, there is evidence that sperm whale age classes are subject to predation by killer whales (Arnbom et al. 1987; Pitman et al. 2001).

Stable, long-term associations among females form the core of sperm whale societies (Christal et al. 1998). Up to about a dozen females usually live in such groups, accompanied by their female and young male offspring. Young individuals are subject to alloparental care by members of either sex and may be suckled by non-maternal individuals (Gero et al. 2009). Group sizes may be smaller overall in the Caribbean Sea (6-12 individuals; 7-9 along Dominica) versus the Pacific (25-30 individuals)(Gero et al. 2013; Jaquet and Gendron 2009). Groups may be stable for long periods, such as for 80 days in the Gulf of California (Jaquet and Gendron 2009). Males start leaving these family groups at about six years of age, after which they live in “bachelor schools,” but this may occur more than a decade later (Pinela et al. 2009). The cohesion among males within a bachelor school declines with age. During their breeding prime and old age, male sperm whales are essentially solitary (Christal and Whitehead 1997).

Diving. Sperm whales are one of the deepest and longest diving mammalian species, with dives to 3 km down and durations in excess of 2 hours (Clarke 1976; Watkins et al. 1993; Watkins et al. 1985). However, dives are generally shorter (25- 45 min) and shallower (400-1,000 m). Dives are separated by 8-11 min rests at the surface (Gordon 1987; Jochens et al. 2006; Papastavrou et al. 1989; Watwood et al. 2006; Würsig et al. 2000). Sperm whales typically travel ~3 km horizontally and 0.5 km vertically during a foraging dive (Whitehead 2003). Differences in night and day diving patterns are not known for this species, but, like most diving air-breathers for which there are data (rorquals, fur seals, and chinstrap penguins), sperm whales probably make relatively shallow dives at night when prey are closer to the surface.

Feeding. Sperm whales appear to feed regularly throughout the year (NMFS 2006b). It is estimated they consume about 3-3.5% of their body weight daily (Lockyer 1981). They seem to forage mainly on or near the bottom, often ingesting stones, sand, sponges, and other non-food items (Rice 1989b). A large proportion of a sperm whale’s diet consists of low-fat, ammoniacal, or luminescent squids (Clarke 1996; Clarke 1980b; Martin and Clarke 1986). While sperm whales feed primarily on large and medium-sized squids, the list of documented food items is fairly long and diverse. Prey items include other cephalopods, such as octopi, and medium- and large-sized demersal fishes, such as rays, sharks, and many teleosts (Angliss and Lodge 2004; Berzin 1972; Clarke 1977; Clarke 1980a; Rice 1989b). The diet of large males in some areas, especially in high northern latitudes, is dominated by fish (Rice 1989b). In some areas of the North Atlantic, however, males prey heavily on the oil-rich squid *Gonatus fabricii*, a species also frequently eaten by northern bottlenose whales (Clarke 1997).

Vocalization and hearing. Sound production and reception by sperm whales are better understood than in most cetaceans. Sperm whales produce broad-band clicks in the frequency range of 100 Hz to 20 kHz that can be extremely loud for a biological source (200-236 dB re 1μPa), although lower source level energy has been suggested at around 171 dB re 1 μPa (Goold and Jones 1995; Møhl et al. 2003; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). Most of the energy in sperm whale clicks is concentrated at around 2-4 kHz and 10-16 kHz (Goold and Jones 1995; NMFS 2006d; Weilgart and Whitehead 1993). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Cranford 1992; Norris and Harvey 1972; Norris and Harvey. 1972). Long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). However, clicks are also used in short patterns (codas) during social behavior and intragroup interactions (Weilgart and Whitehead 1993). They may also aid in intra-specific communication. Another class of sound, “squeals”, are produced with frequencies of 100 Hz to 20 kHz (e.g., Weir et al. 2007).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potentials were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5-60 kHz. However, behavioral responses of adult, free-ranging individuals also provide insight into hearing range; sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins et al. 1985; Watkins and Schevill 1975). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Because they spend large amounts of time at depth and use low-frequency sound, sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll et al. 1999).

Status and trends. Sperm whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained with the inception of the ESA in 1973. Although population structure of sperm whales is unknown, several studies and estimates of abundance are available. Consideration of the status of populations outside of the action area is important under the present analysis to determine how the risk to the affected population(s) bears on the status of the species as a whole. Table 7 contains historic and current estimates of sperm whales. Sperm whale populations probably are undergoing the dynamics of small population sizes, which is a threat in and of itself. In particular, the loss of sperm whales to directed Soviet whaling likely inhibits recovery due to the loss of adult females and their calves, leaving sizeable gaps in demographic and age structuring (Whitehead 2003). Small changes in reproductive parameters, such as the loss of adult females, can significantly alter the population trajectory of sperm whale populations (Chiquet et al. 2013).

Table 7. Summary of past and present sperm whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	~~	~~	~~	900,000	~~	(Würsig et al. 2000)
	~~	1,110,000	672,000-1,512,000	360,000	105,984-614,016*	(Whitehead 2002)
North Atlantic	Basinwide-females	224,800	~~	22,000	~~	(Gosho et al. 1984; Würsig et al. 2000)
	Northeast Atlantic, Faroes, Iceland, and U.S. East coast	~~	~~	13,190	~~	(Whitehead 2002)
	NMFS-North Atlantic stock	>4,685*	~~	4,804	1,226-8,382*	(Waring et al. 2012)
	Iceland	~~	~~	1,234	823-1,645*	(Gunnlaugsson and Sigurjónsson 1990)
	Faroe Islands	~~	~~	308	79-537*	(Gunnlaugsson and Sigurjónsson 1990)
	Norwegian Sea	~~	~~	5,231	2,053-8,409*	(Christensen et al. 1992b)
	Northern Norway to Spitsbergen	15,000	~~	2,548	1,200-3,896*	(Øien 1990)

*Note: Confidence Intervals (C. I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

North Atlantic.190,000 sperm whales were estimated to have been in the entire North Atlantic, but CPUE data from which this estimate is derived are unreliable according to the IWC (Perry et al. 1999). The total number of sperm whales in the western North Atlantic is unknown (Waring et al. 2008). Sperm whale were widely harvested from the northeastern Caribbean (Romero et al. 2001) and the Gulf of Mexico where sperm whale fisheries operated during the late 1700s to the early 1900s (NMFS 2006b; Townsend 1935).

Natural threats. Sperm whales are known to be occasionally predated upon by killer whales (Jefferson and Baird 1991; Pitman et al. 2001) and large sharks (Best et al. 1984) and harassed by pilot whales (Arnbom et al. 1987; Palacios and Mate 1996; Rice 1989a; Weller et al. 1996; Whitehead 1995). Strandings are also relatively common events, with one to dozens of individuals generally beaching themselves and dying during any single event. Although several hypotheses, such as navigation errors, illness, and anthropogenic stressors, have been proposed

(Goold et al. 2002; Wright 2005), direct widespread causes of strandings remain unclear. Calcivirus and papillomavirus are known pathogens of this species (Lambertsen et al. 1987; Smith and Latham 1978).

Anthropogenic threats. Sperm whales historically faced severe depletion from commercial whaling operations. From 1800 to 1900, the IWC estimated that nearly 250,000 sperm whales were killed by whalers, with another 700,000 from 1910 to 1982 (IWC Statistics 1959-1983). However, other estimates have included 436,000 individuals killed between 1800-1987 (Carretta et al. 2005). All of these estimates are likely underestimates due to illegal and inaccurate killings by Soviet whaling fleets between 1947-1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC (Yablokov et al. 1998), with smaller harvests in the Northern Hemisphere, primarily the North Pacific, that extirpated sperm whales from large areas (Yablokov and Zemsky 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender.

Following a moratorium on whaling by the IWC, significant whaling pressures on sperm whales were eliminated. However, sperm whales are known to have become entangled in commercial fishing gear and 17 individuals are known to have been struck by vessels (Jensen and Silber 2004b).

Whale-watching vessels are known to influence sperm whale behavior (Richter et al. 2006).

Contaminants have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location, with northern hemisphere individuals generally carrying higher burdens (Evans et al. 2004). Contaminants include dieldrin, chlordane, DDT, DDE, PCBs, hexachlorobenzene and hexachlorocyclohexane in a variety of body tissues (Aguilar 1983; Evans et al. 2004), as well as several heavy metals (Law et al. 1996). However, unlike other marine mammals, females appear to bioaccumulate toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Aguilar 1983; Wise et al. 2009). Chromium levels from sperm whales skin samples worldwide have varied from undetectable to 122.6 μg Cr/g tissue, with the mean (8.8 μg Cr/g tissue) resembling levels found in human lung tissue with chromium-induced cancer (Wise et al. 2009). Older or larger individuals do not appear to accumulate chromium at higher levels.

Ingestion of marine debris can have fatal consequences even for large whales. In 1989, a stranded sperm whale along the Mediterranean was found to have died from ingesting plastic that blocked its' digestive tract. A sperm whale examined in Iceland had a lethal disease thought to have been caused by the complete obstruction of the gut with plastic marine debris (Lambertsen 1990). The stomach contents of two sperm whales that stranded separately in California included extensive amounts of discarded fishing netting (NMFS 2009). A fifth individual from the Pacific was found to contain nylon netting in its stomach when it washed ashore in 2004 (NMFS 2009). In March 2012, a sperm whale stranded dead, apparently dying as a result of plastic ingestion (de Stephanis et al. 2013).

Critical habitat. The NMFS has not designated critical habitat for sperm whales.

6.7 Green sea turtle

Populations. Populations are distinguished generally by ocean basin and more specifically by nesting location (Table 8).

Table 8. Locations and most recent abundance estimates of threatened green sea turtles as annual nesting females (AF), annual nests (AN), annual egg production (EP), and annual egg harvest (EH).

Location	Most recent abundance	Reference
Western Atlantic Ocean		
Tortuguero, Costa Rica	17,402-37,290 AF	(Troëng and Rankin 2005)
Aves Island, Venezuela	335-443 AF	(Vera 2007)
Galibi Reserve, Suriname	1,803 AF	(Weijerman et al. 1998)
Isla Trindade, Brazil	1,500-2,000 AF	(Moreira and Bjorndal 2006)
Central Atlantic Ocean		
Ascension Island, UK	3,500 AF	(Broderick et al. 2006)
Eastern Atlantic Ocean		
Poilao Island, Guinea-Bissau	7,000-29,000 AN	(Catry et al. 2009)
Bioko Island, Equatorial Guinea	1,255-1,681 AN	(Tomas et al. 1999)
Mediterranean Sea		
Turkey	214-231 AF	(Broderick et al. 2002)
Cyprus	121-127 AF	(Broderick et al. 2002)
Israel / Palestine	1-3 AF	(Kuller 1999)
Syria	100 AN	(Rees et al. 2005)

Distribution. Green sea turtles have a circumglobal distribution, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters. Occurrence in the action area tends to be higher in continental shelf waters and highest in spring, although fall sightings have also been documented that taper down to their lowest levels during winter (IOC 2014; U.S. Navy 2008a; U.S. Navy 2008b).

Growth and reproduction. Most green sea turtles exhibit particularly slow growth rates, which have been attributed to their largely plant-eating diet (Bjorndal 1982). Growth rates of juveniles vary substantially among populations, ranging from <1 cm/year (Green 1993) to >5 cm/year (McDonald Dutton and Dutton 1998), likely due to differences in diet quality, duration of foraging season (Chaloupka et al. 2004), and density of turtles in foraging areas (Balazs and Chaloupka 2004; Bjorndal et al. 2000; Seminoff et al. 2002b). Hart et al. (2013a) found growth rates of green sea turtles in the U.S. Virgin Islands to range from 0-9.5 cm annually (mean of 4.1, SD 2.4). The largest growth rates were in the 30-39 cm class. If individuals do not feed sufficiently, growth is stunted and apparently does not compensate even when greater-than-needed resources are available (Roark et al. 2009). In general, there is a tendency for green sea turtles to exhibit monotonic growth (declining growth rate with size) in the Atlantic and non-monotonic growth (growth spurt in mid-size classes) in the Pacific, although this is not always the case (Balazs and Chaloupka 2004; Chaloupka and Musick 1997; Seminoff et al. 2002b). It is estimated that green sea turtles reach a maximum size just under 100 cm in carapace length (Tanaka 2009). A female-bias has been identified from studies of green sea turtles (Wibbels 2003).

Consistent with slow growth, age-to-maturity for green sea turtles appears to be the longest of any sea turtle species and ranges from ~20-40 years or more (Balazs 1982; Chaloupka et al. 2004; Chaloupka and Musick 1997; Frazer and Ehrhart 1985a; Hirth 1997; Limpus and Chaloupka 1997; Seminoff et al. 2002b; Zug et al. 2002; Zug and Glor 1998). Estimates of reproductive longevity range from 17 to 23 years (Carr et al. 1978; Chaloupka et al. 2004; Fitzsimmons et al. 1995). Considering that mean duration between females returning to nest ranges from 2 to 5 years (Hirth 1997), these reproductive longevity estimates suggest that a female may nest 3 to 11 seasons over the course of her life. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12-14 day intervals. Mean clutch size is highly variable among populations, but averages 110-115 eggs/nest. Females usually have 2-4 or more years between breeding seasons, whereas males may mate every year (Balazs 1983). Based on reasonable means of three nests per season and 100 eggs per nest (Hirth 1997), a female may deposit 9 to 33 clutches, or about 900 to 3,300 eggs, during her lifetime. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Once hatched, sea turtles emerge and orient towards a light source, such as light shining off the ocean. They enter the sea in a "frenzy" of swimming activity, which decreases rapidly in the first few hours and gradually over the first several weeks (Ischer et al. 2009; Okuyama et al. 2009). Factors in the ocean environment have a major influence on reproduction (Chaloupka 2001; Limpus and Nicholls 1988; Solow et al. 2002). It is also apparent that during years of heavy nesting activity, density dependent factors (beach crowding and digging up of eggs by nesting females) may impact hatchling production (Tiwari et al. 2005; Tiwari et al. 2006). Precipitation, proximity to the high tide line, and nest depth can also significantly affect nesting success (Cheng et al. 2009). Precipitation can also be significant in sex determination, with greater nest moisture resulting in a higher proportion of males (Leblanc and Wibbels 2009). Green sea turtles often return to the same foraging areas following nesting migrations (Broderick et al. 2006; Godley et al. 2002). Once there, they move within specific areas, or home ranges, where they routinely visit specific localities to forage and rest (Godley et al. 2003; Makowski et al. 2006; Seminoff and Jones 2006; Seminoff et al. 2002a; Taquet et al. 2006). It is also apparent that some green sea turtles remain in pelagic habitats for extended periods, perhaps never recruiting to coastal foraging sites (Pelletier et al. 2003).

In general, survivorship tends to be lower for juveniles and subadults than for adults. Adult survivorship has been calculated to range from 0.82-0.97 versus 0.58-0.89 for juveniles (Chaloupka and Limpus 2005; Seminoff et al. 2003; Troëng and Chaloupka 2007), with lower values coinciding with areas of human impact on green sea turtles and their habitats (Bjorndal et al. 2003; Campbell and Lagueux 2005).

Migration and movement. Green sea turtles are highly mobile and undertake complex movements through geographically disparate habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). The periodic migration between nesting sites and foraging areas by adults is a prominent feature of their life history. After departing as hatchlings and residing in a variety of marine habitats for 40 or more years (Limpus and Chaloupka 1997), green sea turtles make their way back to the same beach from which they hatched (Carr et al. 1978; Meylan et al. 1990). At approximately 20-25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas (Bjorndal 1997a). Green sea turtles spend the majority of their lives in coastal foraging grounds (MacDonald et al. 2012). These areas include both open coastline and protected bays and lagoons. While in these areas, green sea turtles rely on marine algae and seagrass as their primary dietary constituents, although some populations also forage heavily on invertebrates. Although green sea turtles in tropical areas seem to undergo a sudden, permanent switch in habitat from oceanic to neritic habitats, individuals in more temperate areas seem to utilize a wider array of habitats dependent upon oceanographic conditions (González Carman et al. 2012). There is some evidence that individuals move from shallow seagrass beds during the day to deeper areas at night (Hazel 2009). However, avoidance of areas of greater than 10 m when moderate depths of 5-10 m with sea grass beds has been found, with speed and displacement from capture locations being similar at night as during the daytime (Senko et al. 2010a). East Pacific adults migrate along coastal corridors between Central American nesting and foraging locations (Blanco et al. 2012).

Habitat. Green turtles appear to prefer waters that usually remain around 20º C in the coldest month, but may occur considerably north of these regions during warm-water events, such as El Niño. Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18º C. Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher prey densities that associate with flotsam. For example, in the western Atlantic Ocean, drift lines commonly containing floating *Sargassum* spp. are capable of providing juveniles with shelter (NMFS and USFWS 1998). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance. Available information indicates that green turtle resting areas are near feeding areas (Bjorndal and Bolten 2000). Strong site fidelity appears to be a characteristic of juvenile green sea turtles along the Pacific Baja coast (Senko et al. 2010b).

Feeding. While offshore and sometimes in coastal habitats, green sea turtles are not obligate plant-eaters as widely believed, and instead consume invertebrates such as jellyfish, sponges, sea pens, and pelagic prey (Godley et al. 1998; Hart et al. 2013b; Hatase et al. 2006; Heithaus et al. 2002; Parker and Balazs in press; Seminoff et al. 2002a). A shift to a more herbivorous diet occurs when individuals move into neritic habitats, as vegetable mater replaces an omnivorous diet at around 59 cm in carapace length off Mauritania (Cardona et al. 2009). This transition may occur rapidly starting at 30 cm carapace length, but animal prey continue to constitute an important nutritional component until individuals reach about 62 cm (Cardona et al. 2010). Foraging within seagrass ecosystems by green sea turtles can be significant enough to alter habitat and ecological parameters, such as species composition (Lal et al. 2010). Although populations can consume a variety of prey and be considered generalists as a whole, individuals maintain a highly-selective diet over long time frames (Vander Zanden et al. 2013).

Diving. Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, we presume that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed 7 m in depth (Hazel et al. 2009; NMFS and USFWS 1998). Recent data from Australia indicate green sea turtles rarely dive deep, staying in upper 8 m of the water column (Hazel et al. 2009). Here, daytime dives were shorter and shallower than were nighttime dives. Also, time spent resting and dive duration increased significantly with decreases in seasonal water temperatures. The maximum recorded dive depth for an adult green turtle was just over 106 m (Berkson 1967), while subadults routinely dive to 20 m for 9-23 min, with a maximum recorded dive duration of over 1 h (Brill et al. 1995; I-Jiunn 2009). Green sea turtles along Taiwan may rest during long, shallow dives (I-Jiunn 2009). Dives by females may be shorter in the period leading up to nesting (I-Jiunn 2009).

Vocalization and hearing. Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994a; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2012) found green sea turtle juveniles capable of hearing underwater sounds at frequencies of 50-1,600 Hz (maximum sensitivity at 200-400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994a). Based upon auditory brainstem responses green sea turtles have been measured to hear in the 50-1600 Hz range (Dow et al. 2008), with greatest response at 300 Hz (Yudhana et al. 2010); a value verified by Moein Bartol and Ketten (2006). Other studies have found greatest sensitivities are 200-400 Hz for the green turtle with a range of 100-500 Hz (Moein Bartol and Ketten 2006; Ridgway et al. 1969) and around 250 Hz or below for juveniles (Bartol et al. 1999). However, Dow et al. (2008) found best sensitivity between 50 and 400 Hz.

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3 kHz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 or 4 kHz (Patterson 1966).

Status and trends. Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are endangered (43 FR 32800).

Consideration of the status of populations outside of the action area is important under the present analysis to determine the how risk the risk to the affected population(s) bears on the status of the species as a whole. No trend data are available for almost half of important nesting sites, where numbers are based on recent trends and do not span a full green sea turtle generation, and impacts occurring over four decades ago that caused a change in juvenile recruitment rates may have yet to be manifested as a change in nesting abundance. The numbers also only reflect one segment of the population (nesting females), who are the only segment of the population for which reasonably good data are available and are cautiously used as one measure of the possible trend of populations.

Based on the mean annual reproductive effort, 108,761-150,521 females nest each year among 46 worldwide sites. Overall, of the 26 sites for which data enable an assessment of current trends, 12 nesting populations are increasing, 10 are stable, and four are decreasing. Long-term continuous datasets of 20 years are available for 11 sites, all of which are either increasing or stable. Despite the apparent global increase in numbers, the positive overall trend should be viewed cautiously because trend data are available for just over half of all sites examined and very few data sets span a full green sea turtle generation (Seminoff 2004a).

Long-term capture rates have increased exponentially for green sea turtles in the Laguna Madre of Texas from 1991-2010, although average size seems to be declining (Metz and Landry Jr. 2013). These trends may be due to increasing nest output from Mexican and Florida beaches, with juveniles recruiting into the neritic Texas coast (Metz and Landry Jr. 2013). Similarly, average turtle length has declined over the course of a long-term study along cape Canaveral, Florida, as has recapture rate, likely for the same reasons (Redfoot and Ehrhart 2013).

Atlantic Ocean. Primary sites for green sea turtle nesting in the Atlantic/Caribbean include: (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Achipelago, Guinea-Bissau (NMFS and USFWS 2007a). Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precludes a meaningful trend assessment for either site (NMFS and USFWS 2007a). Seminoff (2004b) reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic. Seminoff (2004b) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic. However, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007a).

By far, the most important nesting concentration for green sea turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS 2007a). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007a). The number of females nesting per year on beaches in the Yucatán, at Aves Island, Galibi Reserve, and Isla Trindade number in the hundreds to low thousands, depending on the site (NMFS and USFWS 2007a).

The vast majority of green sea turtle nesting within the southeastern U.S. occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995). Green sea turtle nesting in Florida has been increasing since 1989 (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute Index Nesting Beach Survey Database). Since establishment of index beaches in 1989, the pattern of green turtle nesting shows biennial peaks in abundance with a generally positive trend during the ten years of regular monitoring. This is perhaps due to increased protective legislation throughout the Caribbean (Meylan et al. 1995). A total statewide average (all beaches, including index beaches) of 5,039 green turtle nests were laid annually in Florida between 2001 and 2006, with a low of 581 in 2001 and a high of 9,644 in 2005 (NMFS and USFWS 2007a). Data from index nesting beaches substantiate the dramatic increase in nesting. In 2007, there were 9,455 green turtle nests found just on index nesting beaches, the highest since index beach monitoring began in 1989. The number fell back to 6,385 in 2008, further dropping under 3,000 in 2009, but that consecutive drop was a temporary deviation from the normal biennial nesting cycle for green turtles, as 2010 saw an increase back to 8,426 nests on the index nesting beaches (FWC Index Nesting Beach Survey Database). Nesting in 2010 and

2011 increased again, decreased in 2012, and greatly increased in 2013 to more than double the previous high in 2011 (roughly 10,000)(FWC Index Nesting Beach Survey Database). From 1989-2013, green sea turtle nest counts across Florida have increased approximately ten-fold from a low of 267 in the early 1990s to a high of 25,553 in 2013 (FWC Index Nesting Beach Survey Database).

Occasional nesting has been documented along the Gulf coast of Florida (Meylan et al. 1995). More recently, green turtle nesting occurred on Bald Head Island, North Carolina; just east of the mouth of the Cape Fear River; on Onslow Island; and on Cape Hatteras National Seashore. In 2010, a total of 18 nests were found in North Carolina, six nests in South Carolina, and six nests in Georgia (nesting databases maintained on www. seaturtle. org). Increased nesting has also been observed along the Atlantic coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Recent modeling by Chaloupka et al. (2008a) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%, and the Tortuguero, Costa Rica, population growing at 4.9%.

In Florida, index beaches were established to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green sea turtle nesting has generally shown biennial peaks in abundance with a positive trend during the 10 years of regular monitoring. According to data collected from Florida's index nesting beach survey from 1989-2012, green sea turtle nest counts across Florida have increased approximately ten-fold from a low of 267 in the early 1990s to a high of 25,553 in 2013. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in both 2010 and 2011, a decrease in 2012, and another increase in 2013. Modeling by Chaloupka et al. (2008b) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%.

There are no reliable estimates of the number of immature green sea turtles that inhabit coastal areas of the southeastern U.S. However, information on incidental captures of immature green sea turtles at the St. Lucie Power Plant in St. Lucie County, Florida, shows that the annual number of immature green sea turtles captured by their offshore cooling water intake structures has increased significantly. Green sea turtle annual captures averaged 19 for 1977-1986, 178 for 1987-1996, and 262 for 1997-2001 (Florida Power and Light Company St. Lucie Plant 2002). More recent unpublished data shows 101 captures in 2007, 299 in 2008, 38 in 2009 (power output was cut—and cooling water intake concomitantly reduced—for part of that year) and 413 in 2010. Ehrhart et al. (2007) documented a significant increase in in-water abundance of green turtles in the Indian River Lagoon area.

Natural threats. Herons, gulls, dogfish, and sharks prey upon hatchlings. Adults face predation primarily by sharks and to a lesser extent by killer whales. Predators (primarily of eggs and hatchlings) also include dogs, pigs, rats, crabs, sea birds, reef fishes, and groupers (Bell et al. 1994; Witzell 1981).

For unknown reasons, the frequency of a disease called fibropapillomatosis is much higher in green sea turtles than in other species and threatens a large number of existing subpopulations. Extremely high incidence has been reported in Hawaii, where affliction rates peaked at 47-69% in some foraging areas (Murakawa et al. 2000). A to-date unidentified virus may aid in the development of fibropapillomatosis (Work et al. 2009). Green sea turtles with an abundance of barnacles have been found to have a much greater probability of having health issues (Flint et al. 2009). The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* can kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can be lethal.

Anthropogenic threats. Major anthropogenic impacts to the nesting and marine environment affect green sea turtle survival and recovery. At nesting beaches, green sea turtles rely on intact dune structures, native vegetation, and normal beach temperatures for nesting (Ackerman 1997). Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to females, and may evoke a change in the natural behaviors of adults and hatchlings (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007). On the Pacific coast of Mexico in the mid-1970s, >70,000 green turtle eggs were harvested every night. Hundreds of mostly immature green sea turtles were killed between 2006 and 2008 due to bycatch and direct harvest along Baja California Sur (Senko et al. 2014). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991). In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats, particularly areas rich in seagrass and marine algae. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al. 1999; Lee Long et al. 2000; Waycott et al. 2005). Ingestion of plastic and other marine debris is another source of morbidity and mortality (Stamper et al. 2009). Green sea turtles stranded in Brazil were all found to have ingested plastics or fishing debris (n=34), although mortality appears to have resulted in three cases (Tourinho et al. 2009). Low-level bycatch has also been documented in longline fisheries (Petersen et al. 2009). Further, the introduction of alien algae species threatens the stability of some coastal ecosystems and may lead to the elimination of preferred dietary species of green sea turtles (De Weede 1996). Very few green sea turtles are bycaught in U.S. fisheries (Finkbeiner et al. 2011). However, a legal fishery operates in Madagascar that harvested about 10,000 green turtles annually in the mid-1990s. Green sea turtles are killed because they are seen as competitors for fishery resources in parts of India (Arthur et al. 2013).

Sea level rise may have significant impacts upon green turtle nesting. These low-lying, isolated locations could be inundated by rising water levels associated with global warming, eliminating nesting habitat (Baker et al. 2006; Fuentes et al. 2010). Fuentes et al. (2010) predicted that rising temperatures would be a much greater threat in the long term to the hatching success of sea turtles in general and green sea turtles along northeastern Australia particularly. Green sea turtles emerging from nests at cooler temperatures likely absorb more yolk that is converted to body tissue than do hatchlings from warmer nests (Ischer et al. 2009). Predicted temperature rises may approach or exceed the upper thermal tolerance limit of sea turtle incubation, causing widespread failure of nests (Fuentes et al. 2010). Although the timing of loggerhead nesting depends upon sea-surface temperature, green sea turtles do not appear to be affected (Pike 2009).

Green sea turtles have been found to contain the organochlorines chlordane, lindane, endrin, endosulfan, dieldrin, DDT and PCB (Gardner et al. 2003; Miao et al. 2001). Levels of PCBs found in eggs are considered far higher than what is fit for human consumption (Van de Merwe et al. 2009). The heavy metals copper, lead, manganese, cadmium, and nickel have also been found in various tissues and life stages (Barbieri 2009). Arsenic also occurs in very high levels in green sea turtle eggs (Van de Merwe et al. 2009). These contaminants have the potential to cause deficiencies in endocrine, developmental, and reproductive health, and depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007). Exposure to sewage effluent may also result in green sea turtle eggs harboring antibiotic-resistant strains of bacteria (Al-Bahry et al. 2009). DDE has not been found to influence sex determination at levels below cytotoxicity (Keller and McClellan-Green 2004; Podreka et al. 1998). To date, no tie has been found between pesticide concentration and susceptibility to fibropapillomatosis, although degraded habitat and pollution have been tied to the incidence of the disease (Aguirre et al. 1994; Foley et al. 2005). Flame retardants have been measured from healthy individuals (Hermanussen et al. 2008). It has been theorized that exposure to tumor-promoting compounds produced by the cyanobacteria *Lyngbya majuscule* could promote the development of fibropapillomatosis (Arthur et al. 2008). It has also been theorized that dinoflagellates of the genus *Prorocentrum* that produce the tumorogenic compound okadoic acid may influence the development of fibropapillomatosis (Landsberg et al. 1999).

Sea turtles are known to ingest and attempt to ingest tar balls, which can cause their jaws to become adhered or block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010; Vargo et al. 1986b; Vargo et al. 1986c; Vargo et al. 1986a). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010). Oil can also cause indirect effects to sea turtles through impacts to habitat and prey organisms. Seagrass beds may be particularly susceptible to oiling as oil contacts grass blades and sticks to them, hampering photosynthesis and gas exchange (Wolfe et al. 1988). If spill cleanup is attempted, mechanical damage to seagrass can result in further injury and long-term scarring. Loss of seagrass due to oiling would be important to green sea turtles, as this is a significant component of their diets (NOAA 2003). It is suspected that oil adversely impacted the symbiotic bacteria in the gut of herbivorous marine iguanas when the Galapagos Islands experienced an oil spill, contributing to a >60% decline in local populations the following year. The potential exists for green sea turtles to experience similar impacts, as they also harbor symbiotic bacteria to aid in their digestion of plant material (NOAA 2003).

Critical habitat. On September 2, 1998, critical habitat for green sea turtles was designated in coastal waters surrounding Culebra Island, Puerto Rico (63 FR 46693). Aspects of these areas that are important for green sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for green sea turtle prey. The proposed action does not co-occur with this critical habitat.

6.8 Hawksbill sea turtle

Populations. Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. For example, genetic analysis of hawksbill sea turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the western Atlantic, where the vast majority of nesting has been documented (McClellan et al. 2010; Monzon-Arguello et al. 2010). Hawksbills in the Caribbean seem to have dispersed into separate populations (rookeries) after a bottleneck roughly 100,000-300,000 years ago based upon genetic data (Leroux et al. 2012). Nesting in the northwestern Hawaiian Islands has been rarely found (partly stemming from poor observer effort), but is believed to have been greater historically (Van Houtan et al. 2012).

Distribution. The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific Oceans. Satellite tagged turtles have shown significant variation in movement and migration patterns. In the Caribbean, distance traveled between nesting and foraging locations ranges from a few kilometers to a few hundred kilometers (Byles and Swimmer 1994; Hillis-Starr et al. 2000; Horrocks et al. 2001; Lagueux et al. 2003; Miller et al. 1998; Prieto et al. 2001). Only 16 hawksbill sea turtle sighting have been reported off Virginia and North Carolina total, with the fewest during the time of the proposed seismic survey (IOC 2014; U.S. Navy 2008a; U.S. Navy 2008b).

Migration and movement. Upon first entering the sea, neonatal hawksbills in the Caribbean are believed to enter an oceanic phase that may involve long distance travel and eventual recruitment to nearshore foraging habitat (Boulon Jr. 1994). In the marine environment, the oceanic phase of juveniles (i.e., the "lost years") remains one of the most poorly understood aspects of hawksbill life history, both in terms of where turtles occur and how long they remain oceanic. Nesting site selection in the southwest Pacific appears to favor sites with higher wind and wave exposure, possibly as a means to aid hatchling dispersal (Garcon et al. 2010). Subadult hawksbill sea turtles satellite tracked in the Dry Tortugas National Park showed high-degrees of site fidelity for extended periods, although all three eventually moved to other areas outside the park (Hart et al. 2012). The same trend was found for adults tracked after nesting in the Dominican Republic, with some remaining for extended periods in the nesting area and other migrating to Honduras and Nicaragua (Hawkes et al. 2012). Satellite tracking for these individuals showed repeated returns to the same Dominican and Central American areas (Hawkes et al. 2012). Home ranges tend to be small (a few square kilometers; Berube et al. 2012).

Habitat. Hawksbill sea turtles are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Small juvenile hawksbills (5-21 cm straight carapace length) have been found in association with *Sargassum* spp. in both the Atlantic and Pacific Oceans (Musick and Limpus 1997) and observations of newly hatched hawksbills attracted to floating weed have been made (Hornell 1927; Mellgren and Mann 1996; Mellgren et al. 1994). Post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997), and mud flats (R. von Brandis, unpublished data in NMFS and USFWS 2007c). Eastern Pacific adult females have recently been tracked in saltwater mangrove forests along El Salvador and Honduras, a habitat that this species was not previously known to occupy (Gaos et al. 2011). Individuals of multiple breeding locations can occupy the same foraging habitat (Bass 1999; Bowen et al. 1996; Bowen et al. 2007; Diaz-Fernandez et al. 1999; Velez-Zuazo et al. 2008). As larger juveniles, some individuals may associate with the same feeding locality for more than a decade, while others apparently migrate from one site to another (Blumenthal et al. 2009a; Mortimer et al. 2003; Musick and Limpus 1997). Larger individuals may prefer deeper habitats than their smaller counterparts (Blumenthal et al. 2009a). Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Within U.S. Caribbean territories and dependencies, hawksbill sea turtles nest principally in Puerto Rico and the U.S. Virgin Islands, particularly on Mona Island and Buck Island. They also nest on other beaches on St. Croix, Culebra Island, and Vieques Island, mainland Puerto Rico, St. John, and St. Thomas. Within the continental United States, hawksbill sea turtles nest only on beaches along the southeast coast of Florida and in the Florida Keys.

Growth and reproduction. The best estimate of age at sexual maturity for hawksbill sea turtles is 20-40 years (Chaloupka and Limpus 1997; Crouse 1999). Reproductive females undertake periodic (usually non-annual) migrations to their natal beaches to nest. Movements of reproductive males are less well known, but are presumed to involve migrations to their nesting beach or to courtship stations along the migratory corridor (Meylan 1999). Females nest an average of 3-5 times per season (Meylan and Donnelly 1999; Richardson et al. 1999a). Clutch sizes are up to 250 eggs; larger than that of other sea turtles (Hirth 1980). Reproductive females may exhibit a high degree of fidelity to their nest sites.

The life history of hawksbills consists of a pelagic stage that lasts from hatching until they are approximately 22-25 cm in straight carapace length (Meylan 1988; Meylan and Donnelly 1999), followed by residency in coastal developmental habitats. Growth accelerates early on until turtles reach 65-70 cm in curved carapace length, after which it slows to negligible amounts after 80 cm (Bell and Pike 2012). As with other sea turtles, growth is variable and likely depends upon nutrition available (Bell and Pike 2012). Juvenile hawksbills along the British Virgin Islands grow at a relatively rapid rate of roughly 9.3 cm per year and gain 3.9 kg annually (Hawkes et al. 2014).

Feeding. Dietary data from oceanic stage hawksbills are limited, but indicate a combination of plant and animal material (Bjorndal 1997b). Sponges and octocorals are common prey off Honduras (Berube et al. 2012; Hart et al. 2013b).

Diving. Hawksbill diving ability varies with age and body size. As individuals increase with age, diving ability in terms of duration and depth increases (Blumenthal et al. 2009b). Studies of hawksbills in the Caribbean have found diurnal diving behavior, with dive duration nearly twice as long during nighttime (35-47 min) compared to daytime (19-26 min Blumenthal et al. 2009b; Van Dam and Diez 1997). Daytime dives averaged 5 m, while nighttime dives averaged 43 m (Blumenthal et al. 2009b). However, nocturnal differences were not observed in the eastern Pacific (Gaos et al. 2012).

Hawksbills have long dive durations, although dive depths are not particularly deep. Adult females along St. Croix reportedly have average dive times of 56 min, with a maximum time of 73.5 min (Starbird et al. 1999). Average day and night dive times were 34–65 and 42–74 min, respectively. Immature individuals have much shorter dives of 8.6–14 min to a mean depth of 4.7 m while foraging (Van Dam and Diez 1997).

Vocalization and hearing. Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994a; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2012) found hawksbill hatchlings capable of hearing underwater sounds at frequencies of 50-1,600 Hz (maximum sensitivity at 200-400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994a).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3 kHz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 or 4 kHz (Patterson 1966).

Status and trends. Hawksbill sea turtles received protection on June 2, 1970 (35 FR 8495) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. Although no historical records of abundance are known, hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS 2007c). Consideration of the status of populations outside of the action area is important under the present analysis to determine the how risk the risk to the affected population(s) bears on the status of the species as a whole. Worldwide, an estimated 21,212-28,138 hawksbills nest each year among 83 sites. Among the 58 sites for with historic trends, all show a decline during the past 20 to 100 years. Among 42 sites for which recent trend data are available, 10 (24%) are increasing, three (7%) are stable and 29 (69%) are decreasing. Encouragingly, nesting range along Mexico and Central America appears not to have contracted (Gaos et al. 2010). Genetics supports roughly 6,000-9,000 adult females within the Caribbean (Leroux et al. 2012).

Atlantic Ocean. Atlantic nesting sites include: Antigua (Jumby Bay), the Turks and Caicos, Barbados, the Bahamas, Puerto Rico (Mona Island), the U.S. Virgin Islands, the Dominican Republic, Sao Tome, Guadeloupe, Trinidad and Tobago, Jamaica, Martinique, Cuba (Doce Leguas Cays), Mexico (Yucatan Peninsula), Costa Rica (Tortuguero National Park), Guatemala, Venezuela, Bijagos Archipelago, Guinea-Bissau, and Brazil.

Population increase has been greater in the Insular Caribbean than along the Western Caribbean Mainland or the eastern Atlantic (including Sao Tomé and Equatorial Guinea). Nesting populations of Puerto Rico appeared to be in decline until the early 1990s, but have universally increased during the survey period. Mona Island now hosts 199-332 nesting females annually, and the other sites combined host 51-85 nesting females annually (R.P. van Dam and C.E. Diez, unpublished data in NMFS and USFWS 2007c and C. E. Diez, Chelonia, Inc., in lit. to J. Mortimer 2006)(C. E. Diez, Chelonia, Inc., in litt. to J. Mortimer 2006). At Buck Island Reef National Monument, protection has been in force since 1988, and during that time, hawksbill nesting has increased by 143% to 56 nesting females annually, with apparent spill over to beaches on adjacent St. Croix (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). However, St. John populations did not increase, perhaps due to the proximity of the legal turtle harvest in the British Virgin Islands (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). Populations have also been identified in Belize and Brazil as genetically unique (Hutchinson and Dutton 2007). An estimated 50-200 nests are laid per year in the Guinea-Bissau (Catry et al. 2009).

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can be lethal. The only other significant natural threat to hawksbill sea turtles is from hybridization of hawksbills with other species of sea turtles. This is especially problematic at certain sites where hawksbill numbers are particularly low (Mortimer and Donnelly in review). Predators (primarily of eggs and hatchlings) include dogs, pigs, rats, crabs, sea birds, reef fishes, groupers, feral cats, and foxes (Bell et al. 1994; Ficetola 2008). In some areas, nesting beaches can be almost completely destroyed and all nests can sustain some level of depredation (Ficetola 2008). The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* an kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Threats to hawksbill sea turtles are largely anthropogenic, both historically and currently. Impacts to nesting beaches include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). Because hawksbills prefer to nest under vegetation (Horrocks and Scott 1991; Mortimer 1982), they are particularly impacted by beachfront development and clearing of dune vegetation (Mortimer and Donnelly in review). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991). One of the most detrimental human threats to hawksbill sea turtles is the intensive harvest of eggs from nesting beaches. Between 1950 and 1992, approximately 1.3 million hawksbill shells were collected to supply tortoiseshell to the Japanese market, the world's largest. Japan stopped importing tortoiseshell in 1993 in order to comply with Convention on the International Trade of Endangered Species (Limpus and Miller 2008). The U.S. Virgin Islands have a long history of tortoiseshell trade (Schmidt 1916).

In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al. 1999; Lee Long et al. 2000; Waycott et al. 2005). Hawksbills are typically associated with coral reefs, which are among the world's most endangered marine ecosystems (Wilkinson 2000). Although primarily spongivorous, bycatch of hawksbill sea turtles in the swordfish fishery off South Africa occurs (Petersen et al. 2009). Finkbeiner et al. (2011) estimated that annual bycatch interactions total at least 20 individuals annually for U.S. Atlantic fisheries (resulting in less than ten mortalities) and no or very few interactions in U.S. Pacific fisheries.

Sea turtles are known to ingest and attempt to ingest tar balls, which can cause their jaws to become adhered or block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010; Vargo et al. 1986b; Vargo et al. 1986c; Vargo et al. 1986a). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010). Oil can also cause indirect effects to sea turtles through impacts to habitat and prey organisms. Seagrass beds may be particularly susceptible to oiling as oil contacts grass blades and sticks to them, hampering photosynthesis and gas exchange (Wolfe et al. 1988). If spill cleanup is attempted, mechanical damage to seagrass can result in further injury and long-term scarring. Loss of seagrass due to oiling would be important to green sea turtles, as this is a significant component of their diets (NOAA 2003). The loss of invertebrate communities due to oiling or oil toxicity would also decrease prey availability for hawksbill sea turtles (NOAA 2003).

Future impacts from climate change and global warming may result in significant changes in hatchling sex ratios. The fact that hawksbill turtles exhibit temperature-dependent sex determination (Wibbels 2003) suggests that there may be a skewing of future hawksbill cohorts toward strong female bias (since warmer temperatures produce more female embryos).

Critical habitat. On September 2, 1998, the NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico (63 FR 46693). Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey. No critical habitat occurs within the action area.

6.9 Kemp’s ridley sea turtle

Population. Kemp’s ridley sea turtles are considered to consist of a single population, although expansion of nesting may indicate differentiation.

Distribution. The Kemp's ridley was formerly known only from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000b). However, recent records support Kemp’s ridley sea turtles distribution extending into the Mediterranean Sea on occasion (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico. Kemp’s ridley sightings in the Mid-Atlantic Bight are largely over the continental shelf, with a few summer sightings over the continental shelf break near where seismic survey trackline (Belford et al. 2014; Danton and Prescott 1988; Frazier et al. 2007; IOC 2014; Morreale et al. 1989; Musick et al. 1994b). However, strandings occur most frequently in spring and fall (U.S. Navy 2008a; U.S. Navy 2008b).

Movement and migration. Tracking of post-nesting females from Rancho Nuevo and Texas beaches indicates that turtles move along coastal migratory corridors either to the north or south from the nesting beach (Byles 1989b; Byles and Plotkin 1994; Renaud 1995b; Renaud et al. 1996; Seney and Landry 2011; Shaver 1999; Shaver 2002) after remaining in the nesting area during the nesting period (Seney and Landry 2011). These migratory corridors appear to extend throughout the coastal areas of the Gulf of Mexico and most turtles appear to travel in waters less than roughly 50 m in depth. Turtles that headed north and east traveled as far as southwest Florida, whereas those that headed south and east traveled as far as the Yucatan Peninsula, Mexico (Morreale et al. 2007).

Kemp’s ridleys in south Florida begin to migrate northward during spring. With each passing month, the waters to the north become warmer and turtles migrate further to Long Island Sound and even Nova Scotia in late summer (Bleakney 1955). During winter, individuals return south in response to local water temperatures; the turtles in the northernmost areas begin their southward movement first. By early November, turtles from New York and New Jersey merge with turtles from the Chesapeake Bay (Byles 1988; Keinath 1993; Lutcavage and Musick 1985;

Renaud 1995b) and North Carolina inshore waters (Epperly et al. 1995a; Epperly et al. 1995b; Musick et al. 1994a).

Following migration, Kemp’s ridley sea turtles settle into resident feeding areas for several months (Byles and Plotkin 1994; Morreale et al. 2007). Females may begin returning along relatively shallow migratory corridors toward the nesting beach in the winter in order to arrive at the nesting beach by early spring.

During spring and summer, juvenile Kemp’s ridleys occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida. In the fall, most Kemp’s ridleys migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998a). As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2010). Satellite telemetry of males caught near Padre Island, Texas, indicates no migration, but year-round occurrence in nearshore waters less than 50 m deep (Shaver et al. 2005b). Many postnesting females from Rancho Nuevo migrate north to areas offshore of Texas and Louisiana (Marquez-M. 1994b). Farther south, some post-nesting females migrate from Rancho Nuevo to the northern and western Yucatán Peninsula in the southern Gulf of Mexico, which contains important seasonal foraging sites for adult females, such as the Bay of Campeche (Marquez-M. 1994b; Márquez 1990b; Pritchard and Marquez 1973).

Reproduction. Mating is believed to occur about three to four weeks prior to the first nesting (Rostal 2007), or late-March through early- to mid-April. It is presumed that most mating takes place near the nesting beach (Morreale et al. 2007; Rostal 2007). Females initially ovulate within a few days after successful mating and lay the first clutch approximately two to four weeks later; if a turtle nests more than once per season, subsequent ovulations occur within approximately 48 hours after each nesting (Rostal 2007).

Approximately 60% of Kemp's ridley nesting occurs along an 40 km stretch of beach near Rancho Nuevo, Tamaulipas, Mexico from April to July, with limited nesting to the north (100 nests along Texas in 2006) and south (several hundred nests near Tampico, Mexico in 2006 USFWS 2006). Nesting at this location may be particularly important because hatchlings can more easily migrate to foraging grounds (Putman et al. 2010). The Kemp's ridley sea turtle tends to nest in large aggregations or arribadas (Bernardo and Plotkin 2007). The period between Kemp's ridley arribadas averages approximately 25 days, but the precise timing of the arribadas is unpredictable (Bernardo and Plotkin 2007; Rostal et al. 1997). Like all sea turtles, Kemp's ridley sea turtles nest multiple times in a single nesting season. The most recent analysis suggests approximately 3.075 nests per nesting season per female (Rostal 2007). The annual average number of eggs per nest (clutch size) is 94 to 100 and eggs typically take 45 to 58 days to hatch, depending on temperatures (Marquez-M. 1994a; Rostal 2007; USFWS 2000; USFWS 2001; USFWS 2002; USFWS 2003; USFWS 2004; USFWS 2005; USFWS 2006). The period between nesting seasons for each female is approximately 1.8 to 2.0 years (Marquez et al. 1989; Rostal 2007; TEWG 2000b). The nesting beach at Rancho Nuevo may produce a "natural" hatchling sex ratio that is female-biased, which can potentially increase egg production as those turtles reach sexual maturity (Coyne and Landry Jr. 2007; Wibbels 2007).

Growth. Kemp's ridleys require approximately 1.5 to two (range 1-4) years to grow from a hatchling to a size of approximately 20 cm long, at which size they are capable of making a transition to a benthic coastal immature stage (Caillouet et al. 1995; Ogren 1989; Schmid 1998b; Schmid and Witzell 1997b; Snover et al. 2007b; TEWG 2000b; Zug et al. 1997). Based on the size of nesting females, it is assumed that turtles must attain a size of approximately 60 cm long prior to maturing (Marquez-M. 1994a). Growth models based on mark-recapture data suggest that a time period of seven to nine years would be required for this growth from benthic immature to mature size (Schmid and Witzell 1997b; Snover et al. 2007b). Currently, age to sexual maturity is believed to range from approximately 10 to 17 years for Kemp's ridleys (Caillouet Jr. et al. 1995; Schmid and Witzell 1997a; Snover et al. 2007a; Snover et al. 2007b). However, estimates of 10 to 13 years predominate in previous studies (Caillouet et al. 1995; Schmid and Witzell 1997b; TEWG 2000b).

Habitat. Stranding data indicate that immature turtles in this benthic stage are found in coastal habitats of the entire Gulf of Mexico and U.S. Atlantic coast (Morreale et al. 2007; TEWG 2000b). Developmental habitats for juveniles occur throughout the entire coastal Gulf of Mexico and U.S. Atlantic coast northward to New England (Morreale et al. 2007; Schmid 1998b; Wibbels et al. 2005). Key foraging areas in the Gulf of Mexico include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama; Cedar Keys, Florida; and Ten Thousand Islands, Florida (Carr and Caldwell 1956; Coyne et al. 1995; Ogren 1989; Schmid 1998b; Schmid et al. 2002; Witzell et al. 2005a). Foraging areas studied along the Atlantic coast include Pamlico Sound, Chesapeake Bay, Long Island Sound, Charleston Harbor, and Delaware Bay. Near-shore waters of 35 m or less provide the primary marine habitat for adults, although it is not uncommon for adults to venture into deeper waters (Byles 1989a; Mysing and Vanselous 1989; Renaud et al. 1996; Shaver et al. 2005a; Shaver and Wibbels 2007b).

Benthic coastal waters of Louisiana and Texas seem to be preferred foraging areas for Kemp’s ridley sea turtles (particularly passes and beachfronts), although individuals may travel along the entire coastal margin of the Gulf of Mexico (Landry and Costa 1999; Landry et al. 1996; Renaud 1995a). Sightings are less frequent during winter and spring, but this is likely due to lesser sighting effort during these times (Keinath et al. 1996; Shoop and Kenney 1992b).

Feeding. Kemp’s ridley diet consists mainly of swimming crabs, but may also include fish, jellyfish, and an array of mollusks. Immature Kemp’s ridleys off southwest Florida predate on benthic tunicates, a previously undocumented food source (Witzell and Schmid 2005).

Diving. Kemp’s ridley sea turtles can dive for well over 2.5 hours, although most dives are from 16 to 34 minutes (Mendonca and Pritchard 1986; Renaud 1995b). Individuals spend the vast majority of their time underwater; over 12-hour periods, 89% to 96% of their time is spent below the surface (Byles 1989b; Gitschlag 1996).

Vocalization and hearing. Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994a; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994a). Juvenile Kemp‘s ridleys can hear from 100 to 500 Hz, with a maximum sensitivity between 100 and 200 Hz at thresholds of 110 dB re 1 μPa (Moein Bartol and Ketten 2006).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3 kHz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 or 4 kHz (Patterson 1966).

Status and trends. The Kemp's ridley sea turtle was listed as endangered on December 2, 1970 (35 FR 18319). Internationally, the Kemp's ridley is considered the most endangered sea turtle (NRC 1990a; USFWS 1999).

During the mid-20th century, the Kemp's ridley was abundant in the Gulf of Mexico. Historic information indicates that tens of thousands of Kemp's ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). From 1978 through the 1980s, arribadas were 200 turtles or less, and by 1985, the total number of nests at Rancho Nuevo had dropped to approximately 740 for the entire nesting season, or a projection of roughly 234 turtles (TEWG 2000b; USFWS and NMFS 1992). Beginning in the 1990s, an increasing number of beaches in Mexico were being monitored for nesting, and the total number of nests on all beaches in Tamaulipas and Veracruz in 2002 was over 6,000; the rate of increase from 1985 ranged from 14-16% (Heppell et al. 2005; TEWG 2000b; USFWS 2002). In 2006, approximately 7,866 nests were laid at Rancho Nuevo with the total number of nests for all the beaches in Mexico estimated at about 12,000 nests, which amounted to about 4,000 nesting females based upon three nests per female per season (Rostal 2007; Rostal et al. 1997; USFWS 2006). Considering remigration rates, the population included approximately 7,000 to 8,000 adult female turtles at that time (Marquez et al. 1989; Rostal 2007; TEWG 2000b). The 2007 nesting season included an arribada of over 4,000 turtles over a three-day period at Rancho Nuevo (P. Burchfield, pers. comm. in NMFS and USFWS 2007b). The increased recruitment of new adults is illustrated in the proportion of first time nesters, which has increased from 6% in 1981 to 41% in 1994. Average population growth was estimated at 13% per year between 1991 and 1995 (TEWG 1998b). In 2008, there were 17,882 nests in Mexico (Gladys Porter Zoo 2008), and nesting in 2009 reached 21,144 (Burchfield 2010). In 2010, nesting declined significantly, to 13,302 but it is too early to determine if this is a one-time decline or if is indicative of a change in the trend. Preliminary estimates of 2011 and 2012 nesting supports 19,368 and 20,197 nests, respectively (back to 2009 levels)(Gallaway et al. 2013). Population modeling used by the TEWG (2000a) projected that Kemp's ridleys could reach the recovery plan's intermediate recovery goal of 10,000 nesters by the year 2015. Over one million hatchlings were released in 2011 and 2012 (Gallaway et al. 2013).

Nesting has also expanded geographically, with a Headstart program reestablishing nesting on South Padre Island starting in 1978. Growth remained slow until 1988, when rates of return started to grow slowly (Shaver and Wibbels 2007a). Nesting rose from 6 in 1996 to 128 in 2007, 195 in 2008, and 197 in 2009. Texas nesting then experienced a decline similar to that seen in Mexico for 2010, with 140 nests (National Park Service data, http://www.nps.gov/pais/naturescience/strp.htm), but nesting rebounded in 2011 with a record 199 nests (National Park Service data, http://www.nps.gov/pais/naturescience/current-season.htm).

Gallaway et al. (2013) estimated that nearly 189,000 female Kemp's ridley sea turtles over the age of two years were alive in 2012. Extrapolating based upon sex bias, the authors estimated that nearly a quarter million age two or older Kemp's ridleys were alive at this time.

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales (Pitman and Dutton 2004). All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects. Kemp's ridley sea turtles are particularly prone to this phenomenon along Cape Cod (Innis et al.

2009). From 2006-201), the number of cold-stunned turtles on Cape Cod beaches averaged 115 Kemp's ridleys. The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* an kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Population decline has been curtailed due to the virtual elimination of sea turtle and egg harvesting, as well as assistance in hatching and raising hatchlings (NOAA Headstart Program). However, habitat destruction remains a concern in the form of bottom trawling and shoreline development. Trawling destroys habitat utilized by Kemp's ridley sea turtles for feeding and construction activities can produce hazardous runoff. Bycatch is also a source of mortality for Kemp's ridley sea turtles (McClellan et al. 2009), with roughly three-quarters of annual mortality attributed to shrimp trawling prior to turtle excluder device (TED) regulations (Gallaway et al. 2013). However, this has dropped to an estimated one-quarter of total mortality nearly 20 years after TEDS were implemented in 1990 (Gallaway et al. 2013). In 2010, due to reductions in shrimping effort and TED use, shrimp-trawl related mortality appears to have dropped to 4% (1,884) of total mortality (65,505 individuals; Gallaway et al. 2013). This increased to 3,300 individuals in 2012 (20% of total mortality; Gallaway et al. 2013). Finkbeiner et al. (2011) estimated that annual bycatch interactions total at least 98,300 individuals annually for U.S. Atlantic fisheries (resulting in 2,700 mortalities or more). The vast majority of fisheries interactions with sea turtles in the U.S. are either Kemp's ridley's or loggerhead sea turtles (Finkbeiner et al. 2011).

Toxin burdens in Kemp's ridley sea turtles include DDT, DDE, PCBs, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), chlordane, and other organochlorines (Keller et al. 2005; Keller et al. 2004a; Lake et al. 1994; Rybitski et al. 1995). These contaminants have the potential to cause deficiencies in endocrine, developmental and reproductive health, and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007b). Along with loggerheads, Kemp's ridley sea turtles have higher levels of PCB and DDT than leatherback and green sea turtles (Pugh and Becker 2001b). Organochlorines, including DDT, DDE, and PCBs have been identified as bioaccumulative agents and in greatest concentration in subcutaneous lipid tissue (Rybitski et al. 1995). Concentrations ranged from 7.46 mu g/kg to 607 mu g/kg, with a mean of 252 mu g/kg in lipid tissue. Five PCB congeners composed most of the contaminants: 153/132, 138/158, 180, 118, and 187 in order of concentration. PCBs have also been identified in the liver, ranging in concentration from 272 ng/g to 655 ng/g of wet weight, values that are several fold higher than in other sea turtle species (Lake et al. 1994). However, concentrations are reportedly 5% of that which causes reproductive failure in snapping turtles. DDE was identified to range from 137 ng/g to 386 ng/g wet weight. Trans-nonachlor was found at levels between 129 ng/g and 275 ng/g wet weight. Blood samples may be appropriate proxies for organochlorines in other body tissues (Keller et al. 2004a). Perfluorinated compounds in the forms of PFOA and PFOS have been identified in the blood of Kemp's ridley turtles at concentrations of 39.4 ng/mL and 3.57 ng/mL, respectively (Keller et al. 2005). Perfluorinated carboxylic acids (PFCAs) have also been detected. It is likely that age and habitat are linked to perflourinated chemical (PFC) bioaccumulation.

Oil can also be hazardous to Kemp's ridley turtles, with fresh oil causing significant mortality and morphological changes in hatchlings, but aged oil having no detectable effects (Fritts and McGehee 1981). Sea turtles are known to ingest and attempt to ingest tar balls, which can cause their jaws to become adhered or block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010; Vargo et al. 1986b; Vargo et al. 1986c; Vargo et al. 1986a). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010). Oil can also cause indirect effects to sea turtles through impacts to habitat and prey organisms. Seagrass beds may be particularly susceptible to oiling as oil contacts grass blades and sticks to them, hampering photosynthesis and gas exchange (Wolfe et al. 1988). If spill cleanup is attempted, mechanical damage to seagrass can result in further injury and long-term scarring. Loss of seagrass due to oiling would be important to green sea turtles, as this is a significant component of their diets (NOAA 2003). The loss of invertebrate communities due to oiling or oil toxicity would also decrease prey availability for hawksbill, Kemp's ridley, and loggerhead sea turtles (NOAA 2003). Furthermore, Kemp's ridley and loggerhead sea turtles, which commonly forage on crustaceans and mollusks, may ingest large amounts of oil due oil adhering to the shells of these prey and the tendency for these organisms to bioaccumulate toxins found in oil (NOAA 2003). It is suspected that oil adversely impacted the symbiotic bacteria in the gut of herbivorous marine iguanas when the Galapagos Islands experienced an oil spill, contributing to a >60% decline in local populations the following year. The potential exists for green sea turtles to experience similar impacts, as they also harbor symbiotic bacteria to aid in their digestion of plant material (NOAA 2003).

Blood levels of metals are lower in Kemp's ridley sea turtles than in other sea turtles species or similar to them, with copper (215 ng/g to 1,300 ng/g), lead (0 to 34.3 ng/g), mercury (0.5 ng/g to 67.3 ng/g), silver (0.042 ng/g to 2.74 ng/g), and zinc (3,280 ng/g to 18,900 ng/g) having been identified (Innis et al. 2008; Orvik 1997). It is likely that blood samples can be used as an indicator of metal concentration. Mercury has been identified in all turtle species studied, but are generally an order of magnitude lower than toothed whales. The higher level of contaminants found in Kemp's ridley sea turtles are likely due to this species tendency to feed higher on the food chain than other sea turtles. Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

Critical habitat. NMFS has not designated critical habitat for Kemp's ridley sea turtle.

6.10 Leatherback sea turtle

Populations. Leatherbacks break into four nesting aggregations: Pacific, Atlantic, and Indian oceans, and the Caribbean Sea. Detailed population structure is unknown, but is likely dependent upon nesting beach location.

Atlantic Ocean. Previous genetic analyses of leatherbacks using only mitochondrial DNA (mtDNA) resulted in an earlier determination that within the Atlantic basin there are at least three genetically different nesting populations: the St. Croix nesting population (U.S. Virgin Islands), the mainland nesting Caribbean population (Florida, Costa Rica, Suriname/French Guiana), and the Trinidad nesting population (Dutton et al. 1999). Further genetic analyses using microsatellite markers in nuclear DNA along with the mtDNA data and tagging data has resulted in Atlantic Ocean leatherbacks now being divided into seven groups or breeding populations:

Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007b).

Caribbean Sea. Nesting occurs in Puerto Rico, St. Croix, Costa Rica, Panama, Colombia, Trinidad and Tobago, Guyana, Suriname, and French Guiana (Bräutigam and Eckert 2006; Márquez 1990a; Spotila et al. 1996).

Distribution. Leatherbacks range farther than any other sea turtle species, having evolved physiological and anatomical adaptations that allow them to exploit cold waters (Frair et al. 1972; Greer et al. 1973; USFWS 1995). High-latitude leatherback range includes in the Atlantic includes the North and Barents Seas, Newfoundland and Labrador, Argentina, and South Africa (Goff and Lien 1988; Hughes et al. 1998; Luschi et al. 2003; Luschi et al. 2006; Márquez 1990a; Threlfall 1978). Pacific ranges extend to Alaska, Chile, and New Zealand (Brito 1998; Gill 1997; Hodge and Wing 2000). About 10o leatherback sightings have occurred in the area near the seismic survey, with hundreds of others in waters surrounding it, all mostly during spring, summer, or fall (most common in summer) (Belford et al. 2014). Sightings are most common over the continental shelf to the shelf break, but sightings in deeper water are also frequent (Belford et al. 2014).

Leatherbacks also occur in Mediterranean and Indian Oceans (Casale et al. 2003; Hamann et al. 2006). Associations exist with continental shelf and pelagic environments and sightings occur in offshore waters of 7-27˚ C (CETAP 1982b). Juvenile leatherbacks usually stay in warmer, tropical waters >21˚ C (Eckert 2002). Males and females show some degree of natal homing to annual breeding sites (James et al. 2005).

Growth and reproduction. It has been thought that leatherbacks reach sexual maturity somewhat faster than other sea turtles (except Kemp's ridley), with an estimated range of 3-6 (Rhodin 1985) or 13-14 years (Zug and Parham 1996). However, recent research suggests otherwise, with western North Atlantic leatherbacks possibly not maturing until as late as 29 years of age (Avens and Goshe 2007; Avens and Goshe 2008; Avens et al. 2009). Female leatherbacks nest frequently (up to 13, average of 5-7 nests per year and about every 2-3 years; Eckert et al. 2012). The average number of eggs per clutch varies by region: Atlantic Ocean (85 eggs), western Pacific Ocean (85 eggs), eastern Pacific Ocean (65 eggs) and Indian Ocean (>100 eggs; Eckert et al. 2012). However, up to ~30% of the eggs can be infertile. Thus, the actual proportion of eggs that can result in hatchlings is less than this seasonal estimate. The eggs incubate for 55-75 days before hatching.

Habitat. Leatherbacks occur throughout marine waters, from nearshore habitats to oceanic environments (Grant and Ferrell 1993; Schroeder and Thompson 1987; Shoop and Kenney 1992a; Starbird et al. 1993). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011b; Collard 1990; Davenport and Balazs 1991; Frazier 2001; HDLNR 2002). Aerial surveys off the western U.S. support continental slope waters as having greater leatherback occurrence than shelf waters (Bowlby et al. 1994; Carretta and Forney 1993; Green et al. 1992; Green et al. 1993). Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Areas above 30º N in the Atlantic appear to be popular foraging locations (Fossette et al. 2009b). Northern foraging areas were proposed for waters between 35º and 50º N along North American, Nova Scotia, the Gulf of Saint-Laurent, in the western and northern Gulf Stream, the Northeast Atlantic, the Azores front and northeast of the Azores Islands, north of the Canary Islands. Southern foraging was proposed to occur between 5º and 15º N in the Mauritania upwelling, south of the Cape Verde islands, over the Guinea Dome area, and off Venezuela, Guyana and Suriname.

Migration and movement. Leatherback sea turtles migrate throughout open ocean convergence zones and upwelling areas, along continental margins, and in archipelagic waters (Eckert 1998; Eckert 1999; Morreale et al. 1994). In a single year, a leatherback may swim more than 11,000 km to nesting and foraging areas throughout ocean basins (Benson et al. 2007a; Benson et al. 2011b; Benson et al. 2007b; Eckert 1998; Eckert 2006; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; Sale et al. 2006). Much of this travel may be due to movements within current and eddy features, moving individuals along (Sale and Luschi 2009). Return to nesting beaches may be accomplished by a form of geomagnetic navigation and use of local cues (Sale and Luschi 2009). Leatherback females will either remain in nearshore waters between nesting events (generally within 100-300 km; Benson et al. 2011a; Eckert et al. 2012), or range widely, presumably to feed on available prey (Byrne et al. 2009; Fossette et al. 2009a).

Fossette et al. (2009b) identified three main migratory strategies in leatherbacks in the North Atlantic (almost all of studied individuals were female). One involved 12 individuals traveling to northern latitudes during summer/fall and returning to waters during winter and spring. Another strategy used by six individuals was similar to this, but instead of a southward movement in fall, individuals overwintered in northern latitudes (30-40º N, 25-30º W) and moved into the Irish Sea or Bay of Biscay during spring before moving south to between 5 and 10º in winter, where they remained or returned to the northwest Atlantic. A third strategy, which was followed by three females remaining in tropical waters for the first year subsequent to nesting and moving to northern latitudes during summer/fall and spending winter and spring in latitudes of 40-50º N. Individuals nesting in Caribbean Islands migrate to foraging areas off Canada (Richardson et al. 2012).

Genetic studies support the satellite telemetry data indicating a strong difference in migration and foraging fidelity between the breeding populations in the northern and southern hemispheres of the Atlantic Ocean (Dutton et al. 2013; Stewart et al. 2013). Genetic analysis of rookeries in Gabon and Ghana confirm that leatherbacks from West African rookeries migrate to foraging areas off South America (Dutton et al. 2013). Foraging adults off Nova Scotia, Canada, mainly originate from Trinidad and none are from Brazil, Gabon, Ghana, or South Africa (Stewart et al. 2013).

Leatherbacks occur along the southeastern U.S. year-round, with peak abundance in summer (TEWG 2007a). In spring, leatherback sea turtles appear to be concentrated near the coast, while other times of the year they are spread out at least to the Gulf Stream. From August 2009 through August 2010 off Jacksonville, Florida, surveys sighted 48 leatherback sea turtles, while simultaneous vessel surveys sighted four leatherback sea turtles (U.S. Department of the Navy 2010). Leatherbacks are most often found during spring and summer in the region of the action area, with lesser occurrence during fall and winter (CETAP 1982a; IOC 2014; Palka 2012; U.S. Navy 2008a; U.S. Navy 2008b).

Sex ratio. A significant female bias exists in all leatherback populations thus far studied. An examination of strandings and in-water sighting data from the U.S. Atlantic and Gulf of Mexico coasts indicates that 60% of individuals were female. Studies of Suriname nesting beach temperatures suggest a female bias in hatchlings, with estimated percentages of females hatched over the course of each season at 75.4, 65.8, and 92.2% in 1985, 1986, and 1987, respectively (Plotkin 1995). Binckley et al. (1998) found a heavy female bias upon examining hatchling gonad histology on the Pacific coast of Costa Rica, and estimated male to female ratios over three seasons of 0:100, 6.5:93.5, and 25.7:74.3. James et al. (2007) also found a heavy female bias (1.86:1) as well as a primarily large sub-adult and adult size distribution. Leatherback sex determination is affected by nest temperature, with higher temperatures producing a greater proportion of females (Mrosovsky 1994; Witzell et al. 2005b).

Feeding. Leatherbacks may forage in high-invertebrate prey density areas formed by favorable oceanographic features (Eckert 2006; Ferraroli et al. 2004). Although leatherbacks forage in coastal waters, they appear to remain primarily pelagic through all life stages (Heppell et al. 2003). The location and abundance of prey, including medusae, siphonophores, and salpae, in temperate and boreal latitudes likely has a strong influence on leatherback distribution in these areas (Plotkin 1995).

Diving. Leatherbacks are champion deep divers among sea turtles with a maximum-recorded dive of over 4,000 m (Eckert et al. 1989; López-Mendilaharsu et al. 2009). Dives are typically 50-84 m and 75-90% of time duration is above 80 m (Standora et al. 1984). Leatherbacks off South Africa were found to spend <1% of their dive time at depths greater than 200 m (Hays et al. 2009). Dive durations are impressive, topping 86 min, but routinely 1-14 min (Eckert et al. 1989; Eckert et al. 1996; Harvey et al. 2006; López-Mendilaharsu et al. 2009). Most of this time is spent traveling to and from maximum depths (Eckert et al. 1989). Dives are continual, with only short stays at the surface (Eckert et al. 1989; Eckert et al. 1986; Southwood et al. 1999). Off Playa Grande, Costa Rica, adult females spent 57–68% of their time underwater, diving to a mean depth of 19 m for 7.4 min (Southwood et al. 1999). Off St. Croix, adult females dove to a mean depth of 61.6 m for an average of 9.9 min, and spent an average of 4.9 min at the surface (Eckert et al. 1989). During shallow dives in the South China Sea, dives averaged 6.9–14.5 min, with a maximum of 42 min (Eckert et al. 1996). Off central California, leatherbacks dove to 20–30 m with a maximum of 92 m (Harvey et al. 2006). This corresponded to the vertical distribution if their prey (Harvey et al. 2006). Leatherback prey in the Gulf of Alaska are frequently concentrated in the deep-scattering layer (Hodge and Wing 2000). Mean dive and surface durations were 2.9 and 2.2 min, respectively (Harvey et al. 2006). In a study comparing diving patterns during foraging versus travelling, leatherbacks dove shallower (mean of 53.6 m) and moved more slowly (17.2 km/day) while in foraging areas while travelling to or from these areas (81.8 m and 51.0 km/day)(Fossette et al. 2009b).

Vocalization and hearing. Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994a; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2012) found leatherback hatchlings capable of hearing underwater sounds at frequencies of 50-1,200 Hz (maximum sensitivity at 100-400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994a).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3 kHz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 or 4 kHz (Patterson 1966).

Status and trends. Leatherback sea turtles received protection on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act and, since 1973, have been listed as endangered under the ESA, but declines in nesting have continued worldwide. Consideration of the status of populations outside of the action area is important under the present analysis to determine the how risk the risk to the affected population(s) bears on the status of the species as a whole. Breeding females were initially estimated at 29,000-40,000, but were later refined to ~115,000 (Pritchard 1971; Pritchard 1982). Spotila et al. (1996) estimated 34,500 females, but later issued an update of 35,860 (Spotila 2004a). The species as a whole is declining and local populations are in danger of extinction (NMFS 2001b; NMFS 2001a)(Table 9).

Table 9. Leatherback nesting population site location information where multiple-year surveys were conducted or trends are known (data type, years surveyed, annual number (nests, females, trend). Nesting population trend symbols: ▲ = increasing; ▼ = decreasing; ▬ = stable; ? = unknown.

Location	Data: Nests, Females	Years	Annual number	Trend	Reference
Atlantic					
United States (Florida)	Nests	1979 - 2008	63-754	▲	Stewart et al. (2011)
Puerto Rico (Culebra)	Nests	1993 - 2012	395-32	▼	{C. Diez, Department of Natural and Environmental Resources of Puerto Rico, unpublished data in NMFS and USFWS, 2013 #36241} Diez et al. (2010; Ramírez-Gallego et al. 2013)
Puerto Rico (other)	Nests	1993 - 2012	131-1,291	▲	C. Diez, Department of Natural and Environmental Resources of Puerto Rico, unpublished data in NMFS and USFWS (2013)
United States Virgin Islands (Sandy Point National Wildlife Refuge, St. Croix)	Nests	1986 - 2004	143-1,008	▲[1]	Dutton et. al. (2005); Turtle Expert Working Group (2007c)
British Virgin Islands	Nests	1986 - 2006	0-65	▲	McGowan et al. (2008) ;Turtle Expert Working Group (2007c)
Nicaragua	Nests	2008 - 2013	42-132	?[2]	{C. Laguex and C. Campbell, Wildlife Conservation Society, unpublished data in NMFS and USFWS, 2013 #36241}
Costa Rica (Tortuguero)	Nests	2007 - 2011	~281	▼	Gordon and Harrison (2012)

Location	Data: Nests, Females	Years	Annual number	Trend	Reference
Costa Rica (Gandoca)	Nests	1990 - 2004	~583	▼	Chacón and Eckert (2007); Turtle Expert Working Group (2007c)
Panama (Chiriqui Beach)	Nests	2004 - 2011	1,000-4,999	?	Meylan et al. (2013)
Colombia	Nests	2006 - 2007	1,653-2,871	?	Patino-Martinez et al. (2008)
Trinidad	Females	1994 - 2005	2,096	▲	Turtle Expert Working Group (2007c)
Guyana	Nests	2007 - 2010	377-1,722	▲	De Freitas and Pritchard (2008; 2009; 2010); Turtle Expert Working Group (2007c); Kalamandeen et al. (2007)
French Guiana	Nests		5,029-63,294	—	
Suriname	Nests		2,732-31,000	—	Fossette et al. (2008)
Brazil	Nests	1988 - 2004	6-527	▲	Thomé et al. (Thomé et al. 2007); Turtle Expert Working Group (2007c)
Equatorial Guinea (Bioko)	Nests	2000 - 2005	2,127-5,071	?	Rader et al. (2006)
Congo	Nests	2003 - 2006	70-148	?	Rentaura (2004; 2006)
Gabon	Nests	2002 - 2007	36,185-126,480	?	Witt et al. (2009)

[1] A more recent trend analysis was not found in the literature. However, trends since 2001 suggest the population may be declining, possibly due to a decrease in the number of new nesters, lowered productivity (number of clutches per season and lower hatch success), and an increase in remigration intervals (Garner 2012; Garner et al. 2012).

[2] The number of nests likely underrepresents the area because 22% of nesting activity was not surveyed from 2011-2013 due to military presence {Laguex and Campbell, Wildlife Conservation Society, unpublished data in NMFS and USFWS, 2013 #36241}.

[3] Based on 12.8 km index area in Maputaland and St. Lucia Marine Reserves, South Africa.

[4] Survey distance and time differed between the two surveys at Labu Tali, but the weight of evidence from the area indicates a declining population.

Nesting aggregations occur along Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida (Bräutigam and Eckert 2006; Márquez 1990a; Spotila et al. 1996). Widely dispersed but fairly regular African nesting also occurs between Mauritania and Angola (Fretey et al. 2007).

Many sizeable populations (perhaps up to 20,000 females annually) of leatherbacks are known to nest in West Africa (Fretey 2001a). The population of leatherbacks nesting on Gabon beaches has been suggested as being the world's largest, with 36,185-126,480 clutches being laid by 5,865-20,499 females annually from 2002-2007 (Witt et al. 2009). The total number of females utilizing Gabon nesting beaches is estimated to be 15,730- 41,373 (Witt et al. 2009). North Atlantic leatherbacks likely number 34,000-94,000 individuals, with females numbering 18,800 and the eastern Atlantic segment numbering 4,700 (TEWG 2007b). Trends and numbers include only nesting females and are not a complete demographic or geographic cross-section. In 1996, the entire Western Atlantic population was characterized as stable at best (Spotila et al. 1996), with roughly 18,800 nesting females. A subsequent analysis indicated that by 2000, the western Atlantic nesting population had decreased to about 15,000 nesting females (NMFS 2011). Spotila et al. (1996) estimated that the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, totaled approximately 27,600 nesting females, with an estimated range of 20,082-35,133. This is consistent with other estimates of 34,000-95,000 total adults (20,000-56,000 adult females; 10,000-21,000 nesting females)(TEWG 2007a). Nesting in Culebra, Puerto Rico has declined since 2004, has slowed in the U.S. Virgin Islands from 2001-2010, and increased by 10% annually in Florida from 1979-2008 (NMFS USFWS 2013).

The largest nesting aggregation in the western North Atlantic occurs in French Guiana and Suriname and likely belongs to a metapopulation whose limits remain unknown (Rivalan et al. 2006). For Suriname and French Guiana, historical estimates of the number of females nesting each year range from approximately 5,000 to 20,000 (Fossette et al. 2008). Suriname and French Guiana may represent over 40% of the world's leatherback population, although the magnitude of the West African rookery needs to be verified (Spotila et al. 1996). Heppell et al. (2003a) concluded that leatherbacks generally show less genetic structuring than green and hawksbill sea turtles. The French Guiana nesting aggregation has declined ~15% annually since 1987 (NMFS 2001a). However, from 1979-1986, the number of nests increased ~15% annually, possibly indicating the current decline may be linked with the erosion cycle of Guiana beaches (NMFS 2006e). Girondot et al. (2007a) analyzed nesting data collected between 1967 and 2002 from French Guiana and Suriname and found that the population can be classified as stable or slightly increasing. The Turtle Expert Working Group (2007c) analyzed nest numbers from 1967-2005 and found a positive population growth rate over the 39-year period for French Guiana and Suriname. Guiana nesting may have increased again in the early 2000s (NMFS 2006e). Suriname nesting numbers have recently increased from more than 10,000 nests annually since 1999 and a peak of 30,000 nests in 2001. Overall, Suriname and French Guiana nesting trends towards an increase (Girondot et al. 2007b; Hilterman and Goverse 2003). Florida (March-July) and U.S. Caribbean nesting since the early 1980s has increased ~0.3% and 7.5% per year, respectively, but lags behind the French Guiana coast and elsewhere in magnitude (NMFS/SEFSC 2001). This positive growth was seen within major nesting areas for the stock, including Trinidad, Guyana, and the combined beaches of Suriname and French Guiana (TEWG 2007a). Trinidad supports an estimated 7,000 to 12,000 leatherbacks nesting annually (Stewart et al. 2013), which represents more than 80% of the nesting in the insular Caribbean Sea (Fournillier and Eckert 1999). Using both Bayesian modeling and regression analyses, the TEWG (2007a) determined that the Southern Caribbean/Guianas stock had demonstrated a long-term, positive population growth rate (using nesting females as a proxy for population).

The Caribbean coast of Costa Rica and extending through Chiriquí Beach, Panama, represents the fourth largest known leatherback rookery in the world (Troeng et al. 2004). Examination of data from three index nesting beaches in the region (Tortuguero, Gandoca, and Pacuare in Costa Rica) using various Bayesian and regression analyses indicated that the nesting population likely was not growing during 1995-2005 (TEWG 2007a). Other modeling of the nesting data for Tortuguero indicates a 67.8% decline between 1995 and 2006 (Troëng et al. 2007).

In Puerto Rico, the primary nesting beaches are at Fajardo and on the island of Culebra. Nesting between 1978 and 2005 ranged between 469-882 nests, and the population has been growing since 1978, with an overall annual growth rate of 1.1% (TEWG 2007a). At the primary nesting beach on St. Croix, the Sandy Point National Wildlife Refuge, nesting has fluctuated from a few hundred nests to a high of 1,008 in 2001, and the average annual growth rate has been approximately 1.1% from 1986-2004 (TEWG 2007a). Overall increases are recorded for mainland Puerto Rico and St. Croix, as well as the U.S. Virgin Islands (Ramírez-Gallego et al. 2013). Trends since 2001 suggest the population may be declining, possibly due to a decrease in the number of new nesters, lowered productivity (number of clutches per season and lower hatch success), and an increase in remigration intervals (Garner 2012; Garner et al. 2012).

The Florida nesting stock comes ashore primarily along the east coast of Florida. This stock is of growing importance, with total nests between 800-900 per year in the 2000s following nesting totals fewer than 100 nests per year in the 1980s (NMFS 2011). Using data from the index nesting beach surveys, the TEWG (2007a) estimated a significant annual nesting growth rate of 1% between 1989 and 2005. Stewart et al. (2011) evaluated nest counts from 68 Florida beaches over 30 years (1979-2008) and found that nesting increased at all beaches with trends ranging from 3.1%-16.3% per year, with an overall increase of 10.2% per year. In 2007, a record 517 leatherback nests were observed on the index beaches in Florida, with 265 in 2008, and then an increase to a new record of 615 nests in 2009, and a slight decline in 2010 back to 552 nests (FWC Index Nesting Beach database). This up-and-down pattern is thought to be a result of the cyclical nature of leatherback nesting, similar to the biennial cycle of green turtle nesting.

The most recent population estimate for leatherback sea turtles from the North Atlantic as a whole is between 34,000-90,000 adult individuals (20,000-56,000 adult females)(TEWG 2007a).

Reliable estimates of survival or mortality at different life history stages are not easily obtained. The annual survival rate for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 0.654 for 1993-1994 and 0.65 for those that nested in 1994-1995 (Spotila et al. 2000). Rivalan et al. (2005) estimated the mean annual survival rate of adult leatherbacks in French Guiana to be 0.91. Pilcher and Chaloupka (2013) used capture-mark-recapture data for 178 nesting leatherbacks tagged at Lababia beach, Kamiali, on the Huon Coast of Papua New Guinea over a 10-year austral summer nesting period (2000-2009). Annual survival probability (ca.0.85) was constant over the 10-year period. Annual survival was lower than those estimated for Atlantic rookeries (Dutton et al. 2005; Rivalan et al. 2005). For the St. Croix, U.S. Virgin Islands population, the annual survival rate was approximately 0.893 (confidence interval = 0.87-0.92) for adult female leatherbacks at St. Croix (Dutton et al. 2005). Annual juvenile survival rate for St. Croix was estimated to be approximately 0.63, and the total survival rate from hatchling to first year of reproduction for a female hatchling was estimated to be between 0.004 and 0.02, given assumed age at first reproduction between 9 and 13 (Eguchi et al. 2006). In Florida, annual survival for nesting females was estimated to be 0.956 (Stewart 2007). Spotila et al. (1996)

estimated the first year (from hatching) of survival for the global population to be 0.0625.

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales (Pitman and Dutton 2004). Hatchlings are preyed upon by herons, gulls, dogfish, and sharks. Leatherback hatching success is particularly sensitive to nesting site selection, as nests that are overwashed have significantly lower hatching success and leatherbacks nest closer to the high-tide line than other sea turtle species (Caut et al. 2009b). The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* an kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Leatherback nesting and marine environments are facing increasing impacts through widespread development and tourism along nesting beaches (Hamann et al. 2006; Hernandez et al. 2007; Maison 2006; Santidrián Tomillo et al. 2007). Structural impacts to beaches include building and piling construction, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). In some areas, timber and marine debris accumulation as well as sand mining reduce available nesting habitat (Bourgeois et al. 2009; Chacón Chaverri 1999; Formia et al. 2003; Laurance et al. 2008). Lights on or adjacent to nesting beaches alter nesting adult behavior and are often fatal to emerging hatchlings as they are drawn to light sources and away from the sea (Bourgeois et al. 2009; Cowan et al. 2002; Deem et al. 2007; Witherington 1992; Witherington and Bjorndal 1991). Leatherbacks are much more likely to emerge and not nest on developed beaches and much more likely to emerge and nest on undeveloped stretches (Roe et al. 2013). One study found 37% of dead leatherback turtles had ingested various types of plastic and can block gastrointestinal tracts leading to death (Mrosovsky et al. 2009). Along the coast of Peru, 13% of 140 leatherback carcasses were found to contain plastic bags and film (Fritts 1982). A leatherback found stranded along the northern Adriatic had been weakened by plastic ingestion, likely leading to an infection that ultimately killed the individual (Poppi et al. 2012). Although global warming may expand foraging habitats into higher latitude waters, increasing temperatures may increase feminization of nests (Hawkes et al. 2007b; James et al. 2006; McMahon and Hays 2006; Mrosovsky et al. 1984). Rising sea levels may also inundate nests on some beaches. Egg collection is widespread and attributed to catastrophic declines, such as in Malaysia. Harvest of females along nesting beaches is of concern worldwide.

Bycatch, particularly by longline fisheries, is a major source of mortality for leatherback sea turtles (Crognale et al. 2008; Fossette et al. 2009a; Gless et al. 2008; Petersen et al. 2009). Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al. 2010); many of these turtles are expected to be leatherbacks. Donoso and Dutton (2010) found that 284 leatherbacks were bycaught between 2001 and 2005 as part of the Chilean longline fishery, with two individuals observed dead; leatherbacks were the most frequently bycaught sea turtle species. Observer coverage for this period ranged from 54 to 92%. Trinidad and Tobago's Institute for Marine Affairs estimated that more than 3,000 leatherbacks were captured incidental to gillnet fishing in the coastal waters of Trinidad in 2000. Half or more of the gravid turtles in Trinidad and Tobago waters may be killed (Lee Lum 2003), though many of the turtles do not die as a result of drowning, but rather because the fishermen butcher them in order to get them out of their nets (NMFS 2001b).

Leatherback sea turtles are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo et al. 1994; Graff 1995). Gillnets are one of the suspected causes for the decline in the leatherback turtle population in French Guiana (Chevalier et al. 1999), and gillnets targeting green and hawksbill turtles in the waters of coastal Nicaragua also incidentally catch leatherback turtles (Lagueux 1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alió-M 2000). An estimated 1,000 mature female leatherback turtles are caught annually off of Trinidad and Tobago with mortality estimated to be between 50-95% (Eckert and Lien 1999). There are known to be many sizeable populations of leatherbacks nesting in West Africa, possibly as many as 20,000 females nesting annually (Fretey 2001b). In Ghana, nearly two thirds of the leatherback turtles that come up to nest on the beach are killed by local fishermen.

Sea turtles are known to ingest and attempt to ingest tar balls, which can cause their jaws to become adhered or block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010; Vargo et al. 1986b; Vargo et al. 1986c; Vargo et al. 1986a). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010).

We know little about the effects of contaminants on leatherback sea turtles. The metals arsenic, cadmium, copper, mercury, selenium, and zinc bioaccumulate, with cadmium in highest concentration in leatherbacks versus any other marine vertebrate (Caurant et al. 1999; Gordon et al. 1998). Along with these, lead has also been reported in high concentrations, potentially to the detriment of the individual (Perrault et al. 2013; Poppi et al. 2012). A diet of primarily jellyfish, which have high cadmium concentrations, is likely the cause (Caurant et al. 1999).

Organochlorine pesticides have also been found (McKenzie et al. 1999). PCB concentrations are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500-530 ng/g wet weight Davenport et al. 1990; Oros et al. 2009).

Critical habitat. On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, U.S. Virgin Islands from the 183 m isobath to mean high tide level between 17° 42’12” N and 65°50’00” W (44 FR 17710). This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity. However, studies do not currently support significant critical habitat deterioration. This critical habitat does not co-occur with the action area.

6.11 Loggerhead sea turtle- Northwest Atlantic DPS

Populations. Five groupings represent loggerhead sea turtles by major sea or ocean basin: Atlantic, Pacific, and Indian oceans, as well as Caribbean and Mediterranean seas. As with other sea turtles, populations are frequently divided by nesting aggregation (Hutchinson and Dutton 2007). On September 22, 2011, the NMFS designated nine distinct population segments (DPSs) of loggerhead sea turtles: South Atlantic Ocean and southwest Indian Ocean as threatened as well as Mediterranean Sea, North Indian Ocean, North Pacific Ocean, northeast Atlantic Ocean, northwest Atlantic Ocean, South Pacific Ocean, and southeast Indo-Pacific Ocean as endangered (75 FR 12598). Recent ocean-basin scale genetic analysis supports this conclusion, with additional differentiation apparent based upon nesting beaches (Shamblin et al. 2014).

Western Atlantic nesting locations include The Bahamas, Brazil, and numerous locations from the Yucatán Peninsula to North Carolina (Addison 1997; Addison and Morford 1996; Marcovaldi and Chaloupka 2007). This group comprises five nesting subpopulations: Northern, Southern, Dry Tortugas, Florida Panhandle, and Yucatán. Additional nesting occurs on Cay Sal Bank (Bahamas), Cuba, the Bahamian Archipelago, Quintana Roo (Yucatan Peninsula), Colombia, Brazil, Caribbean Central America, Venezuela, and the eastern Caribbean Islands. Genetic studies indicate that, although females routinely return to natal beaches, males may breed with females from multiple populations and facilitate gene flow Bowen et al. (2005). In the eastern Atlantic, we know of five rookeries from Cape Verde, Greece, Libya, Turkey, and the western Africa coast.

Distribution. Loggerheads are circumglobal, occurring throughout the temperate and tropical regions of the Atlantic Ocean. Loggerheads are the most abundant species of sea turtle found in U.S. coastal waters. Loggerheads are sighted more frequently in the region than any other sea turtle species (Belford et al. 2014), with thousands of sightings off of Virginia and North Carolina (IOC 2014). Sightings are concentrated over the continental shelf, but are routine east over the shelf break and into deeper waters, particularly in summer (IOC 2014).

Reproduction and growth. Loggerhead nesting is confined to lower latitude temperate and subtropic zones but absent from tropical areas (NMFS and USFWS 1991b; NRC 1990c; Witherington et al. 2006b). The life cycle of loggerhead sea turtles can be divided into seven stages: eggs and hatchlings, small juveniles, large juveniles, subadults, novice breeders, first-year emigrants, and mature breeders (Crouse et al. 1987). Hatchling loggerheads migrate to the ocean (to which they are drawn by near ultraviolet light Kawamura et al. 2009), where they are generally believed to lead a pelagic existence for as long as 7-12 years (Avens et al. 2013; NMFS 2005a). Loggerheads in the Mediterranean, similar to those in the Atlantic, grow at roughly 11.8 cm/yr for the first six months and slow to roughly 3.6 cm/yr at age 2.5-3.5. As adults, individuals may experience a secondary growth pulse associated with shifting into neritic habitats, although growth is generally monotypic (declines with age Casale et al. 2009a; Casale et al. 2009b). Individually-based variables likely have a high impact on individual growth rates (Casale et al. 2009b). At 15-38 years, loggerhead sea turtles become sexually mature, although the age at which they reach maturity varies widely among populations (Casale et al. 2009b; Frazer and Ehrhart 1985b; Frazer et al. 1994; NMFS 2001b; Witherington et al. 2006). However, based on data from tag returns, strandings, and nesting surveys, NMFS (2001b) estimated ages of maturity ranging from 20-38 years and benthic immature stage lasting from 14-32 years. Notably, data from several studies showed decreased growth rates of loggerheads in U.S. Atlantic waters from 1997-2007, corresponding to a period of 43% decline in Florida nest counts (Bjorndal et al. 2013).

Loggerhead mating likely occurs along migration routes to nesting beaches, as well as in offshore from nesting beaches several weeks prior to the onset of nesting (Dodd 1988a; NMFS and USFWS 1998d). Females usually breed every 2-3 years, but can vary from 1-7 years (Dodd 1988a; Richardson et al. 1978). Females lay an average of 4.1 nests per season (Murphy and

Hopkins 1984), although recent satellite telemetry from nesting females along southwest Florida support 5.4 nests per female per season, with increasing numbers of eggs per nest during the course of the season (Tucker 2009). The authors suggest that this finding warrants revision of the number of females nesting in the region. The western Atlantic breeding season is March-August. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Nesting in the Gulf of Mexico does occur, although primarily in Florida, with rare nests along North and South Padre Island in Texas (Dodd 1988b; Hildebrand 1983).

Migration and movement. Loggerhead hatchlings migrate offshore and become associated with *Sargassum* spp. habitats, driftlines, and other convergence zones (Carr 1986). After 14-32 years of age, they shift to a benthic habitat, where immature individuals forage in the open ocean and coastal areas along continental shelves, bays, lagoons, and estuaries (Bowen et al. 2004; NMFS 2001b). Adult loggerheads make lengthy migrations from nesting beaches to foraging grounds (TEWG 1998c). In the Gulf of Mexico, larger females tend to disperse more broadly after nesting than smaller individuals, which tend to stay closer to their nesting locations (Girard et al. 2009). In the North Atlantic, loggerheads travel north during spring and summer as water temperatures warm and return south in fall and winter, but occur offshore year-round assuming adequate temperature. As water temperatures drop from October to December, most loggerheads emigrate from their summer developmental habitats to warmer waters south of Cape Hatteras, where they winter (Morreale and Standora 1998). For immature individuals, this movement occurs in two patterns: a north-south movement over the continental shelf with migration south of Cape Hatteras in winter and movement north along Virginia for summer foraging, and a not-so-seasonal oceanic dispersal into the Gulf Stream as far north as the 10-15˚ C isotherm (Mansfield et al. 2009). Wallace et al. (2009) suggested differences in growth rate based upon these foraging strategies. Long Island Sound, Core Sound, Pamlico Sound, Cape Cod Bay, and Chesapeake Bay are the most frequently used juvenile developmental habitats along the Northeast United States Continental Shelf Large Marine Ecosystem (Burke et al. 1991; Epperly et al. 1995a; Epperly et al. 1995b; Epperly et al. 1995c; Mansfield 2006; Prescott 2000; University of Delaware Sea Grant 2000). There is conflicting evidence that immature loggerheads roam the oceans in currents and eddies and mix from different natal origins or distribute on a latitudinal basis that corresponds with their natal beaches (Monzon-Arguello et al. 2009; Wallace et al. 2009). McCarthy et al. (2010) found that movement patterns of loggerhead sea turtles were more convoluted when sea surface temperatures were higher, ocean depths shallower, ocean currents stronger, and chlorophyll α levels lower. Satellite tracking of loggerheads from southeastern U.S. nesting beaches supports three dispersal modes to foraging areas: one northward along the continental shelf to the northeastern U.S., broad movement through the southeastern and mid-Atlantic U.S., and residency near breeding areas (Reina et al. 2012).

Sighting and stranding records support loggerhead sea turtles to be common, year-round residents of the Gulf of Mexico, although their abundance is much greater in the northeastern region versus the northwestern (Davis et al. 2000b; Fritts et al. 1983; Landry and Costa 1999). An estimated 12% of all western North Atlantic loggerhead sea turtles reside in the eastern Gulf of Mexico, with the vast majority in western Florida waters (Davis et al. 2000a; TEWG 1998a). Loggerheads may occur in both offshore habitats (particularly around oil platforms and reefs, where prey and shelter are available; (Davis et al. 2000b; Fritts et al. 1983; Gitschlag and

Herczeg 1994; Lohoefener et al. 1990; Rosman et al. 1987), as well as shallow bays and sounds (which may be important developmental habitat for late juveniles in the eastern Gulf of Mexico; (Davis et al. 2000b; Lohoefener et al. 1990; USAF 1996). Offshore abundance in continental slope waters increases during the winter in the eastern Gulf of Mexico, as cooler inshore waters force individuals into warmer offshore areas (Davis et al. 2000b).

Gender, age, and survivorship. Although information on males is limited, several studies identified a female bias, although a single study has found a strong male bias (Dodd 1988a; NMFS 2001b; Rees and Margaritoulis 2004). Nest temperature seems to drive sex determination. Along Florida, males primarily derive from earlier-season nests (LeBlanc et al. 2012). Here, nests ranged from an average sex ratio of 55% female to 85% (LeBlanc et al. 2012).

Additionally, little is known about longevity, although Dodd (1988a) estimated the maximum female life span at 47-62 years. Heppell et al. (2003a) estimated annual survivorship to be 0.81 (southeast U.S. adult females), 0.78-0.91 (Australia adult females), 0.68-0.89 (southeast U.S. benthic juveniles, and 0.92 (Australia benthic juveniles). Another recent estimate suggested a survival rate of 0.41 or 0.60 (C.I.s 0.20-0.65 and 0.40-0.78, respectively), depending upon assumptions within the study (Sasso et al. 2011). Survival rates for hatchlings during their first year are likely very low (Heppell et al. 2003a; Heppell et al. 2003).

Feeding. Loggerhead sea turtles are omnivorous and opportunistic feeders through their lifetimes (Parker et al. 2005). Hatchling loggerheads feed on macroplankton associated with *Sargassum* spp. communities (NMFS and USFWS 1991b). Pelagic and benthic juveniles forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988a; Wallace et al. 2009). Loggerheads in the deep, offshore waters of the western North Pacific feed on jellyfish, salps, and other gelatinous animals (Dodd Jr. 1988; Hatase et al. 2002). Sub-adult and adult loggerheads prey on benthic invertebrates such as gastropods, mollusks, and decapod crustaceans in hard-bottom habitats, although fish and plants are also occasionally eaten (NMFS and USFWS 1998d). Stable isotope analysis and study of organisms on turtle shells has recently shown that although a loggerhead population may feed on a variety of prey, individuals composing the population have specialized diets (Reich et al. 2010; Vander Zanden et al. 2010).

Diving. Loggerhead diving behavior varies based upon habitat, with longer surface stays in deeper habitats than in coastal ones. Off Japan, dives were shallower than 30 m (Sakamoto et al. 1993). Routine dives can last 4–172 min (Byles 1988; Renaud and Carpenter 1994; Sakamoto et al. 1990). The maximum-recorded dive depth for a post-nesting female was over 230 m, although most dives are far shallower (9-21 m (Sakamoto et al. 1990)). Loggerheads tagged in the Pacific over the course of five months showed that about 70% of dives are very shallow (<5 m) and 40% of their time was spent within 1 m of the surface (Polovina et al. 2003; Spotila 2004b). During these dives, there were also several strong surface temperature fronts that individuals were associated with, one of 20° C at 28° N latitude and another of 17° C at 32° N latitude. In the Mediterranean, dives of over 300 min have been recorded in association with depressed water temperatures and are proposed as an overwintering strategy (Luschi et al. 2013).

Vocalization and hearing. Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994a; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994a). Bartol et al. (1999) reported effective hearing range for juvenile loggerhead turtles is from at least 250-750

Hz. Both yearling and two-year old loggerheads had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re 1 μPa and two-year-olds: about 86 dB re 1 μPa), with thresholds increasing rapidly above and below that frequency (Moein Bartol and Ketten 2006).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3 kHz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 or 4 kHz (Patterson 1966).

Status and trends. Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead sea turtles (75 FR 12598).

There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size (Bjorndal et al. 2005). An important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates well. Adult nesting females often account for less than 1% of total population numbers. The global abundance of nesting female loggerhead turtles is estimated at 43,320–44,560 (Spotila 2004a).

The greatest concentration of loggerheads occurs in the Atlantic Ocean and the adjacent Caribbean Sea, primarily on the Atlantic coast of Florida, with other major nesting areas located on the Yucatán Peninsula of Mexico, Columbia, Cuba, and South Africa (EuroTurtle 2006 as cited in LGL Ltd. 2007; Márquez 1990a).

Among the five subpopulations, loggerhead females lay 53,000-92,000 nests per year in the southeastern U.S. and the Gulf of Mexico, and the total number of nesting females are 32,000-56,000. All of these are currently in decline or data are insufficient to assess trends (NMFS 2001b; TEWG 1998b). Loggerheads from western North Atlantic nesting aggregations may or may not feed in the same regions from which they hatch. Loggerhead sea turtles from the northern nesting aggregation, which represents about 9% of the loggerhead nests in the western North Atlantic, comprise 25-59% of individuals foraging from Georgia up to the northeast U.S. (Bass et al. 1998; Norrgard 1995; Rankin-Baransky 1997; Sears 1994; Sears et al. 1995). Loggerheads associated with the South Florida nesting aggregation occur in higher frequencies in the Gulf of Mexico (where they represent ~10% of the loggerhead captures) and the Mediterranean Sea (where they represent ~45% of loggerhead sea turtles captured). About 4,000 nests per year are laid along the Brazilian coast (Ehrhart et al. 2003).

The northern recovery unit along Georgia, South Carolina, and North Carolina has a forty-year time-series trend showing an overall decline in nesting, but the shorter comprehensive survey data (20 years) indicate a stable population (Georgia Department of Natural Resources, North Carolina Wildlife Resources Commission, and South Carolina Department of Natural Resources nesting data located at www.seaturtle.org). NMFS scientists have estimated that the northern subpopulation produces 65% males (NMFS 2001b).

The peninsular Florida recovery unit is the largest loggerhead nesting assemblage in the northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed a mean of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females annually (NMFS and USFWS 2008). The statewide estimated total for 2010 was 73,702 (FWRI nesting database). An analysis of index nesting beach data shows a 26% nesting decline between 1989 and 2008, and a mean annual rate of decline of 1.6% despite a large increase in nesting for 2008, to 38,643 nests (FWRI nesting database)(NMFS and USFWS 2008; Witherington et al. 2009). In 2009, nesting levels, while still higher than the lows of 2004, 2006, and 2007, dropped below 2008 levels to approximately 32,717 nests, but in 2010, a large increase was seen, with 47,880 nests on the index nesting beaches (FWRI nesting database). The 2010 index nesting number is the largest since 2000. With the addition of data through 2010, the nesting trend for the northwestern Atlantic DPS is slightly negative and not statistically different from zero (no trend)(NMFS and USFWS 2010).

Because of its size, the South Florida subpopulation of loggerheads may be critical to the survival of the species in the Atlantic, and in the past it was considered second in size only to the Oman nesting aggregation (NMFS 2006e; NMFS and USFWS 1991b). The South Florida population increased at ~5.3% per year from 1978-1990, and was initially increasing at 3.9-4.2% after 1990. An analysis of nesting data from 1989-2005, a period of more consistent and accurate surveys than in previous years, showed a detectable trend and, more recently (1998-2005), has shown evidence of a declining trend of approximately 22.3% (FFWCC 2007a; FFWCC 2007b; Witherington et al. 2009). This is likely due to a decline in the number of nesting females within the population (Witherington et al. 2009). Nesting data from the Archie Carr Refuge (one of the most important nesting locations in Southeast Florida) over the last 6 years shows nests declined from approximately 17,629 in 1998 to 7,599 in 2004, also suggesting a decrease in population size[4]. Loggerhead nesting is thought to consist of just 60 nesting females in the Caribbean and Gulf of Mexico (NMFS 2006c). Based upon the small sizes of almost all nesting aggregations in the Atlantic, the large numbers of individuals killed in fisheries, and the decline of the only large nesting aggregation, we suspect that the extinction probabilities of loggerhead sea turtle populations in the Atlantic are only slightly lower than those of populations in the Pacific.

Zurita et al. (2003) found a statistically significant increase in the number of nests on seven of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. However, nesting has declined since 2001, and the previously reported increasing trend appears to have been temporary (NMFS and USFWS 2008).

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects. In January 2010, an unusually large cold-stunning event occurred throughout the southeast U.S., with well over 3,000 sea turtles (mostly greens but also hundreds of loggerheads) found cold-stunned. Most survived, but several hundred were found dead or died after being discovered in a cold-stunned state. Eggs are commonly eaten by raccoons and ghost crabs along the eastern U.S. (Barton and Roth 2008). In the water, hatchlings are hunted by herons, gulls, dogfish, and sharks. Heavy loads of barnacles

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4 While this is a long period of decline relative to the past observed nesting pattern at this location, aberrant ocean surface temperatures complicate the analysis and interpretation of these data. Although caution is warranted in interpreting the decreasing nesting trend given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, the recent nesting decline at this nesting beach is reason for concern.

are associated with unhealthy or dead stranded loggerheads (Deem et al. 2009). Brevetoxin-producing algal blooms can result in loggerhead sea turtle death and pathology, with nearly all stranded loggerheads in affected areas showing signs of illness or death resulting from exposure (Fauquier et al. 2013). The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* an kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Anthropogenic threats impacting loggerhead nesting habitat are numerous: coastal development and construction, placement of erosion control structures, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Baldwin 1992; Margaritoulis et al. 2003; Mazaris et al. 2009b; USFWS 1998). Surprisingly, beach nourishment also hampers nesting success, but only in the first year post-nourishment before hatching success increases (Brock et al. 2009). Loggerhead sea turtles face numerous threats in the marine environment as well, including oil and gas exploration, marine pollution, trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries, underwater explosions, dredging, offshore artificial lighting, power plant entrapment, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, and poaching. At least in the Mediterranean Sea, anthropogenic threats appear to disproportionally impact larger (more fecund) loggerheads (Bellido et al. 2010).

Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al. 2010); many of these are expected to be loggerhead sea turtles. Shrimp trawl fisheries account for the highest number of captured and killed loggerhead sea turtles. Pacific bycatch is about 400 individuals annually in U.S. fisheries resulting in at least 20 mortalities (Finkbeiner et al. 2011). Each year, various fisheries capture about 2,000 loggerhead sea turtles in Pamlico Sound, of which almost 700 die. As a result of the 2006 and 2007 tri-national fishermen's exchanges in 2007 a prominent Baja California Sur fleet retired its bottom-set longlines (Peckham and Maldonado-Diaz 2012; Peckham et al. 2008). Prior to this closure, the longline fleet interacted with an estimated 1,160-2,174 loggerheads annually, with nearly all (89%) of the takes resulting in mortalities (Peckham et al. 2008). Offshore longline tuna and swordfish longline fisheries are also a serious concern for the survival and recovery of loggerhead sea turtles and appear to affect the largest individuals more than younger age classes (Aguilar et al. 1995; Bolten et al. 1994; Carruthers et al. 2009; Howell et al. 2008; Marshall et al. 2009; Petersen et al. 2009; Tomás et al. 2008).

Marine debris ingestion is a widespread issue for loggerhead sea turtles. More than one-third of loggerheads found stranded or bycaught had injected marine debris in a Mediterranean study, with possible mortality resulting in some cases (Lazar and Gračan 2010). Marine debris consumption has been shown to depress growth rates in post-hatchling loggerhead sea turtles, elongating the time required to reach sexual maturity and increasing predation risk (McCauley and Bjorndal 1999). Another study in the Tyrrhenian Sea found 71% of stranded and bycaught sea turtles had plastic debris in their guts (Campani et al. 2013). Another threat marine debris poses is to hatchlings on beaches escaping to the sea. Two thirds of loggerheads contacted marine debris on their way to the ocean and many became severely entangled or entrapped by it (Triessnig et al. 2012).

Climate change may also have significant implications on loggerhead populations worldwide. In addition to potential loss of nesting habitat due to sea level rise, loggerhead sea turtles are very sensitive to temperature as a determinant of sex while incubating. Ambient temperature increase by just 1º-2º C can potentially change hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al. 2007a). Over time, this can reduce genetic diversity, or even population viability, if males become a small proportion of populations (Hulin et al. 2009). Sea surface temperatures on loggerhead foraging grounds correlate to the timing of nesting, with higher temperatures leading to earlier nesting (Mazaris et al. 2009a; Schofield et al. 2009). Increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability. This has been proposed as partial support for reduced nesting abundance for loggerhead sea turtles in Japan; a finding that could have broader implications for other populations in the future if individuals do not shift feeding habitat (Chaloupka et al. 2008c). Warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al. 2009). Pike (2014) estimated that loggerhead populations in tropical areas produce about 30% fewer hatchlings than do populations in temperate areas. Historical climactic patterns have been attributed to the decline in loggerhead nesting in Florida, but evidence for this is tenuous (Reina et al. 2013).

Tissues taken from loggerheads sometimes contain very high levels of organochlorines chlorobiphenyl, chlordanes, lindane, endrin, endosulfan, dieldrin, PFOS, PFOA, DDT, and PCB (Alava et al. 2006; Corsolini et al. 2000; Gardner et al. 2003; Guerranti et al. 2013; Keller et al. 2005; Keller et al. 2004a; Keller et al. 2004b; McKenzie et al. 1999; Monagas et al. 2008; Oros et al. 2009; Perugini et al. 2006; Rybitski et al. 1995; Storelli et al. 2007a). It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller et al. 2004c; Keller et al. 2006; Oros et al. 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007a). It is likely that the omnivorous nature of loggerheads makes them more prone to bioaccumulating toxins than other sea turtle species (Godley et al. 1999; McKenzie et al. 1999).

Sea turtles are known to ingest and attempt to ingest tar balls, which can cause their jaws to become adhered or block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010; Vargo et al. 1986b; Vargo et al. 1986c; Vargo et al. 1986a). PAH pollution from petroleum origins has been found in Cape Verde loggerheads, where marine oil and gas extraction is not undertaken (Camacho et al. 2012). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010). Oil can also cause indirect effects to sea turtles through impacts to habitat and prey organisms. The loss of invertebrate communities due to oiling or oil toxicity would also decrease prey availability for loggerhead sea turtles (NOAA 2003). Furthermore, loggerhead sea turtles, which commonly forage on crustaceans and mollusks, may ingest large amounts of oil due oil adhering to the shells of these prey and the tendency for these organisms to bioaccumulate toxins found in oil (NOAA 2003).

Heavy metals, including arsenic, barium, cadmium, chromium, iron, lead, nickel, selenium, silver, copper, zinc, and manganese, have also been found in a variety of tissues in levels that increase with turtle size (Anan et al. 2001; Fujihara et al. 2003; Garcia-Fernandez et al. 2009; Gardner et al. 2006; Godley et al. 1999; Saeki et al. 2000; Storelli et al. 2008). These metals likely pass to turtles from plants and seem to have high transfer coefficients (Anan et al. 2001; Celik et al. 2006; Talavera-Saenz et al. 2007). Loggerhead sea turtles have higher mercury levels than any other sea turtle studied, but concentrations are an order of magnitude less than many toothed whales (Godley et al. 1999; Pugh and Becker 2001a). Arsenic occurs at levels several fold more concentrated in loggerhead sea turtles than marine mammals or seabirds.

Also of concern is the spread of antimicrobial agents from human society into the marine environment. Loggerhead sea turtles may harbor antibiotic-resistant bacteria, which may have developed and thrived as a result of high use and discharge of antimicrobial agents into freshwater and marine ecosystems (Foti et al. 2009).

Critical habitat. On July 10, 2014, NMFS finalized a rule designating critical habitat for Northwest Atlantic Ocean DPS loggerhead sea turtles (79 FR 39855). This includes *Sargassum*, winter, and migratory habitat areas that co-occur with the proposed seismic surveys in offshore areas. Although *Sargassum* and winter habitats are not considered in the *Effects Analysis*, migratory habitat is. The primary constituent elements of migratory habitat include: 1) Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways and 2) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. The loggerhead migratory corridor off North Carolina serves as a concentrated migratory pathway for loggerheads transiting to neritic foraging areas in the north, and back to winter, foraging, and/ or nesting areas in the south. The majority of loggerheads will pass through this migratory corridor in the spring (April to June) and fall (September to November), but loggerheads are also present in this area from April through November and, given variations in water temperatures and individual turtle migration patterns, these time periods are variable. The designation of critical habitat in the North Carolina and southern Florida migratory corridors will help conserve loggerhead sea turtles by 1) preserving passage conditions to and from important nesting, breeding, and foraging areas, and 2) protecting the habitat in a narrowly confined area of the continental shelf with documented high use by loggerheads.

7 ENVIRONMENTAL BASELINE

By regulation, the environmental baseline for ESA section 7 consultation includes the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR §402.02). The *Environmental Baseline* for this Opinion includes the effects of several activities affecting the survival and recovery of ESA-listed species in the action area.

7.1 Climate change

We primarily discuss climate change as a threat common to all species addressed in this Opinion, rather than in each of the species-specific narratives. As we better understand responses to climate change, we will address these effects in the relevant species-specific section.

In general, based on forecasts made by the Intergovernmental Panel on Climate Change, climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the near future (IPCC 2002; IPCC 2014). From 1906 to 2006, global surface temperatures have risen 0.74º C and continue at an accelerating pace; 11 of the 12 warmest years on record since 1850 have occurred since 1995 (Poloczanska et al. 2009). Furthermore, the Northern Hemisphere (where a greater proportion of ESA-listed species occur) is warming faster than the Southern Hemisphere, although land temperatures are rising more rapidly than over the oceans (Poloczanska et al. 2009). The direct effects of climate change will result in increases in atmospheric temperatures, changes in sea surface temperatures, patterns of precipitation, and sea level. Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe as well as an increase in the mass of the Antarctic and Greenland ice sheets, although the magnitude of these changes remain unknown. Species that are shorter-lived, larger body size, or generalist in nature are liable to be better able to adapt to climate change over the long term versus those that are longer-lived, smaller-sized, or rely upon specialized habitats (Brashares 2003; Cardillo 2003; Cardillo et al. 2005; Issac 2009; Purvis et al. 2000). Climate change is most likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2008). As such, we expect the risk of extinction to ESA-listed species to rise with the degree of climate shift associated with global warming.

Indirect effects of climate change would result from changes in the distribution of temperatures suitable for whale calving and rearing, the distribution and abundance of prey, and abundance of competitors or predators. For species that undergo long migrations, individual movements are usually associated with prey availability or habitat suitability. If either is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott. 2009). With warming temperatures and decreasing sea ice, humpback and fin whales have been found in increasing numbers at the northern extreme of their Pacific range and are regularly found now in the southern Chukchi Sea (Clarke et al. 2013). We do not know if this is due to range expansion owing to species recovery, or due to altered habitat associated with climate change (Clarke et al. 2013). Climate change can influence reproductive success by altering prey availability, as evidenced by high success of northern elephant seals during El Niño periods, when cooler, more productive waters are associated with higher first year pup survival (McMahon and Burton. 2005).

Reduced prey availability resulting from increased sea temperatures has also been suggested to explain reductions in Antarctic fur seal pup and harbor porpoise survival (Forcada et al. 2005; Macleod et al. 2007). Polygamous marine mammal mating systems can also be perturbed by rainfall levels, with the most competitive grey seal males being more successful in wetter years than in drier ones (Twiss et al. 2007). Sperm whale females were observed to have lower rates of conception following unusually warm sea surface temperature periods (Whitehead 1997). Marine mammals with restricted distributions linked to water temperature may be particularly exposed to range restriction (Issac 2009; Learmonth et al. 2006). MacLeod (2009) estimated that, based upon expected shifts in water temperature, 88% of cetaceans would be affected by climate change, 47% would be negatively affected, and 21% would be put at risk of extinction. Of greatest concern are cetaceans with ranges limited to non-tropical waters and preferences for shelf habitats (Macleod 2009). Modeling of North Atlantic cetacean species found that three of four odontocete species would likely undergo range contraction while one would expand its range (Lambert et al. 2014). Kaschner et al. (2011) modeled marine mammal species richness, overlaid with projections of climate change and found that species in lower-latitude areas would likely be more affected than those in higher-latitude regions. Variations in the recruitment of krill and the reproductive success of krill predators correlate to variations in sea-surface temperatures and the extent of sea-ice cover during winter months. Although the Intergovernmental Panel on Climate Change (2001) did not detect significant changes in the extent of Antarctic sea-ice using satellite measurements, Curran et al. (2003) analyzed ice-core samples from 1841 to 1995 and concluded Antarctic sea ice cover had declined by about 20% since the 1950s.

Roughly 50% of the Earth's marine mammal biomass occurs in the Southern Ocean, with all baleen whales feeding largely on a single krill species, *Euphausia superba*, here and feeding virtually nowhere else (Boyd 2002). However, Atkinson et al. (2004) found severe decreases in krill populations over the past several decades in some areas of the Antarctic, linked to sea ice loss. Reid and Croxall (2001) analyzed a 23-year time series of the reproductive performance of predators (Antarctic fur seals, gentoo penguins, macaroni penguins, and black-browed albatrosses) that depend on krill for prey and concluded that these populations experienced increases in the 1980s followed by significant declines in the 1990s accompanied by an increase in the frequency of years with reduced reproductive success. The authors concluded that macaroni penguins and black-browed albatrosses had declined by as much as 50% in the 1990s, although incidental mortalities from longline fisheries probably contributed to the decline of the albatross. However, these declines resulted, at least in part, from changes in the structure of the krill population, particularly reduced recruitment into older krill age classes, which lowered the number of predators krill could sustain. The authors concluded that the biomass of krill within the largest size class was sufficient to support predator demand in the 1980s but not in the 1990s. By 2055, severe reductions in fisheries catch due to climate change have been suggested to occur in the Indo-Pacific, Red Sea, Mediterranean Sea, Antarctic, and tropical areas worldwide while increased catches are expected in the Arctic, North Pacific, North Atlantic, and northern portions of the Southern Ocean (Cheung et al. 2010).

Climate-mediated changes in the distribution and abundance of keystone prey species like krill and climate-mediated changes in the distribution of cephalopod populations worldwide is likely to affect marine mammal populations as they re-distribute throughout the world's oceans in search of prey. If sea ice extent decreases, then larval krill may not be able to survive without access to underice algae to feed on. This may be a cause of decreased krill abundance in the northwestern Antarctic Peninsula during the last decade (Fraser and Hofmann 2003). Meltwaters have also reduced surface water salinities, shifting primary production along the Antarctic Peninsula (Moline et al. 2004). Blue whales, as predators that specialize in eating krill, are likely to change their distribution in response to changes in the distribution of krill (Clapham et al. 1999; Payne et al. 1986; Payne et al. 1990b). If they did not change their distribution or could not find the biomass of krill necessary to sustain their population numbers, their populations would likely experience declines similar to those observed in other krill predators, including dramatic declines in population size and increased year-to year variation in population size and demographics. These outcomes would dramatically increase the extinction probability of baleen whales. Edwards et al. (2007) found a 70% decrease in one zooplankton species in the North Sea and an overall reduction in plankton biomass as warm-water species invade formerly cold-water areas. However, in other areas, productivity may increase, providing more resources for local species (Brown et al. 2009). This has been proposed to be the case in the eastern North Pacific, where a poleward shift in the North Pacific Current that would likely continue under global warming conditions would enhance nutrient and planktonic species availability, providing more prey for many higher trophic level species (Sydeman et al. 2011). Species such as gray whales may experience benefits from such a situation (Salvadeo et al. 2013). In addition, reductions in sea ice may alleviate "choke points" that allow some marine mammals to exploit additional habitats (Higdon and Ferguson 2009). Similar scenarios may play out in the action area.

Foraging is not the only potential aspect that climate change could influence. Acevedo-Whitehouse and Duffus (2009) proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. An example of this is the altered sex ratios observed in sea turtle populations worldwide (Fuentes et al. 2009a; Mazaris et al. 2008; Reina et al. 2008; Robinson et al. 2008). This does not appear to have yet affected population viabilities through reduced reproductive success, although nesting and emergence dates of days to weeks in some locations have changed over the past several decades (Poloczanska et al. 2009). Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Schumann et al. 2013; Simmonds and Eliott. 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott. 2009).

Sims et al. (2001) found the timing of squid peak abundance in the English Channel advanced by 120-150 days in the warmest years compared with the coldest. Bottom water temperatures correlated with the extent of squid movement, and temperature increases over the five months before and during the month of peak squid movement did not differ between early and late years. These authors concluded that the temporal variation in peak abundance of squid seen off Plymouth represents temperature-dependent movement, which climatic changes association with the North Atlantic Oscillation mediate. Cephalopods dominate the diet of sperm whales, who would likely re-distribute following changes in the distribution and abundance of their prey. If, however, cephalopod populations collapse or decline dramatically, sperm whales would likely decline as well. Long-term shifts of sperm whale prey in the California Current have also been attributed to the re-distribution of their prey resulting from climate-based shifts in oceanographic variables (Salvadeo et al. 2011). Similar changes have also been suggested for sardines and anchovy in the California Current (Salvadeo et al. 2011), which are important prey for humpback and fin whales, among others.

Climate change has been linked to changing ocean currents as well. Rising carbon dioxide levels have been identified as a reason for a poleward shift in the Eastern Australian Current, shifting warm waters into the Tasman Sea and altering biotic features of the area (Johnson et al. 2011; Poloczanska et al. 2009). Similarly, the Kuroshio Current in the western North Pacific (an important foraging area for juvenile sea turtles) has shifted southward as a result of altered long-term wind patterns over the Pacific Ocean (Poloczanska et al. 2009). Ocean temperatures around Iceland are linked with alterations in the continental shelf ecosystem there, including shifts in minke whale diet (Víkingsson et al. 2014).

Apart from species-specific impacts identified in the *Status of Listed Resources*, changes in global climatic patterns will likely have profound effects on the coastlines of every continent by increasing sea levels and the intensity, if not the frequency, of hurricanes and tropical storms (Wilkinson and Souter 2008). A half degree Celsius increase in temperatures during hurricane season from 1965-2005 correlated with a 40% increase in cyclone activity in the Atlantic. Sea levels have risen an average of 1.7 mm/year over the 20th century due to glacial melting and thermal expansion of ocean water; this rate will likely increase. Based on computer models, these phenomena would inundate nesting beaches of sea turtles, change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and would increase the number of turtle nests destroyed by tropical storms and hurricanes (Wilkinson and Souter 2008). The loss of nesting beaches, by itself, would have catastrophic effects on sea turtle populations globally if they are unable to colonize new beaches that form or if the beaches do not provide the habitat attributes (sand depth, temperature regimes, refuge) necessary for egg survival. In some areas, increases in sea level alone may be sufficient to inundate sea turtle nests and reduce hatching success (Caut et al. 2009a). Storms may also cause direct harm to sea turtles, causing "mass" strandings and mortality (Poloczanska et al. 2009). Increasing temperatures in sea turtle nests alters sex ratios, reduces incubation times (producing smaller hatchling), and reduces nesting success due to exceeded thermal tolerances (Fuentes et al. 2009b; Fuentes et al. 2010; Fuentes et al. 2009c). Smaller individuals likely experience increased predation (Fuentes et al. 2009b).

Climactic shifts also occur due to natural phenomena. In the North Atlantic, this primarily concerns fluctuations in the North Atlantic Oscillation, which results from changes in atmospheric pressure between a semi-permanent high pressure feature over the Azores and a subpolar low pressure area over Iceland (Curry and McCartney 2001; Hurrell 1995; Stenseth et al. 2002a). This interaction affects sea surface temperatures, wind patterns, and oceanic circulation in the North Atlantic (Stenseth et al. 2002a). The North Atlantic Oscillation shifts between positive and negative phases, with a positive phase having persisted since 1970 (Hurrell 1995). North Atlantic conditions experienced during positive North Atlantic Oscillation phases include warmer than average winter weather in central and eastern North America and Europe and colder than average temperatures in Greenland and the Mediterranean Sea (Visbeck 2002). Effects are most pronounced during winter (Taylor et al. 1998). The North Atlantic Oscillation is significant for North Atlantic right whales due to its influence on the species primary prey, zooplankton of the genus *Calanus*, which are more abundant in the Gulf of Maine during positive North Atlantic Oscillation years (Conversi et al. 2001b; Greene and Pershing 2004; Greene et al. 2003a). This subsequently impacts the nutritional state of North Atlantic right whales and the rate at which sexually mature females can produce calves (Greene et al. 2003a).

7.2 Habitat degradation

A number of factors may be directly or indirectly affecting ESA-listed species in the action area by degrading habitat. These include ocean noise and fisheries impacts.

Natural sources of ambient noise include: wind, waves, surf noise, precipitation, thunder, and biological noise from marine mammals, fishes, and crustaceans. Anthropogenic sources of ambient noise include: transportation and shipping traffic, dredging, construction activities, geophysical surveys, and sonars. In general, it has been asserted that ocean background noise levels have doubled every decade for the last six decades in some areas, primarily due to shipping traffic (IWC 2004). The acoustic noise that commercial traffic contributes to the marine environment is a concern for ESA-listed species because it may impair communication between individuals (Hatch et al. 2008), among other effects (Eriksen and Pakkenberg 2013; Francis and

Barber 2013). For species inhabiting Arctic waters, vessel and industrial noise may become much more problematic as oil and gas development and commercial shipping lanes through ice-free areas expand and intensify (Reeves et al. 2014). Vessels pose not only a risk of ship strike, but also impede the ability of whales to communicate. Hatch et al. (2012) estimated that roughly two-thirds of a right whales' communication space may be lost due to current ocean noise levels, which have greatly increased due to shipping noise. Shipping noise is also linked with increased stress levels in right whales (Rolland et al. 2012b).

Marine debris is another significant concern for ESA-listed species and their habitats. Marine debris has been discovered to be accumulating in gyres throughout the oceans. Law et al. (2010) presented a time series of plastic content at the surface of the western North Atlantic Ocean and Caribbean Sea from 1986 to 2008. More than 60% of 6,136 surface plankton net tows collected small, buoyant plastic pieces. The data identified an accumulation zone east of Bermuda that is similar in size to the accumulation zone in the Pacific Ocean. Over half of cetacean species (including humpback, fin, sei, and sperm whales) are known to ingest marine debris (mostly plastic), with up to 31% of individuals in some populations containing marine debris in their guts and being the cause of death for up to 22% of individuals found stranded on shorelines (Baulch and Perry 2014).

For sea turtles, marine debris is a problem due primarily to individuals ingesting debris and blocking the digestive tract, causing death or serious injury (Laist et al. 1999; Lutcavage et al. 1997a). Gulko and Eckert (2003) estimated that between one-third and one-half of all sea turtles ingest plastic at some point in their lives; this figure is supported by data from Lazar and Gracan (Lazar and Gračan 2010), who found 35% of loggerheads had plastic in their gut. Plastic is possibly ingested out of curiosity or due to confusion with prey items; for example, plastic bags can resemble jellyfish (Milton and Lutz 2003). Sea turtles can also become entangled and die in marine debris, such as discarded nets and monofilament line (Laist et al. 1999; Lutcavage et al. 1997a; NRC 1990b; O'Hara et al. 1988). This fundamentally reduces the reproductive potential of affected populations, many of which are already declining (such as loggerhead and leatherback sea turtle populations in the action area).

7.3 Dredging

Marine dredging vessels are common within U.S. coastal waters. Although the underwater noises from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effect on sea turtles or marine mammals. Hopper dredges in the dredging mode are capable of moving relatively quickly compared to sea turtle swimming speed and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge overtakes the resting or swimming turtle. Entrained sea turtles rarely survive. Relocation trawling frequently occurs in association with dredging projects to reduce the potential for dredging to injure or kill sea turtles (Dickerson et al. 2007).

7.4 Seismic surveys

During October and November 2003, the NSF undertook a seismic survey over the mid-Atlantic Ridge. No marine mammals or sea turtles were observed during the cruise, which had airgun operations for six days (Holst 2004). The airgun array discharge size was 8,760 in^3.

There have also been numerous prior seismic surveys from 1979 to 2002. These include surveys with a 6-airgun, 1,350-in^3 array in 1990; a single, 45-in^3 GI gun in 1996 and 1998; and two 45-in^3 GI guns in 2002 (NSF 2014). Impacts to ESA-listed species were not identified.

From June to August 2014, another smaller seismic survey was being conducted by the *Langseth* along the New Jersey coast using an airgun array of 700-1,400 in^3. However, this survey ended after roughly 20 hours of active airgun use due to mechanical issues. No data are yet available as to impacts of the survey on ESA-listed resources.

Even with the likelihood of previous exposures to seismic surveys, we have little information as to what response individuals would have to future exposures to seismic sources. Based upon the little information available to us for marine mammals (none available for sea turtles), if prior exposure produces a learned response, then this response would likely be similar to or less than prior responses to other stressors where the individual experienced a stress response associated with the novel stimuli and responded behaviorally as a consequence (such as moving away and reduced time budget for activities otherwise undertaken) (Andre and Jurado 1997; André et al. 1997; Gordon et al. 2006). We do not believe sensitization would occur based upon the lack of severe responses previously observed in marine mammals and sea turtles exposed to seismic sounds that would be expected to produce a more intense, frequent, and/or earlier response to subsequent exposures (see *Response Analysis*).

At the time of consultation, a seismic survey was being conducted by the U.S. Geological Survey and L-DEO aboard the *Langseth* along the U.S. eastern seaboard. This seismic survey was using a 6,600 in^3 airgun array as well as the same multibeam echosounder and sub-bottom profiler as described for the proposed seismic survey. No information was available at the time of consultation to indicate marine mammal or sea turtle sightings, ramp-downs, shutdowns, individual responses, or documented exposures to inform the analysis for this consultation (Holly Smith, NSF, pers. comm. 2014).

7.5 Vessel traffic

Vessel noise could affect marine animals in the study area. Shipping and seismic noise generally dominates ambient noise at frequencies from 20 to 300 Hz (Andrew et al. 2002; Hildebrand 2009; Richardson et al. 1995c). Background noise has increased significantly in the past 50 years as a result of increasing vessel traffic, and particularly shipping, with increases of as much as 12 dB in low frequency ranges; background noise may be 20 dB higher now versus preindustrial periods (Hildebrand 2009; Jasny et al. 2005; McDonald et al. 2006; NRC 1994; NRC 2003; NRC 2005; Richardson et al. 1995a). Over the past 50 years, the number of commercial vessels has tripled, carrying an estimated six times as much cargo (requiring larger, more powerful vessels)(Hildebrand 2009). According to the NSF's environmental assessment, over 50 commercial vessels travel through the action area monthly during the time frame of the proposed seismic survey as well as several dozen recreational or personal watercraft.

Seismic signals emanating from sources a great distance from the action area also contribute to the low frequency ambient sound field (Hildebrand 2009). Baleen whales may be more sensitive to sound at those low frequencies than are toothed whales. Masking of acoustic information can result (Simard et al. 2013); an important issue for marine mammals that rely primarily on sound as a sense. Dunlop et al. (2010) found that humpback whales shifted from using vocal communication (which carries relatively large amounts of information) to surface-active communication (splashes; carry relatively little information) when low-frequency background noise increased due to increased sea state. Other coping mechanisms include shifting the frequency or amplitude of calls, increasing the redundancy or length of calls, or waiting for a quieter period in which to vocalize (Parks et al. 2013) (Boness et al. 2013; Holt et al. 2013). Increases in vessel traffic and marine industrial construction is associated with decreases in the presence of minke whales and gray seals, presumably due to increased noise in the area (Anderwald et al. 2013). Sonars and small vessels also contribute significantly to mid-frequency ranges (Hildebrand 2009).

7.6 U.S. Navy training and testing activities

The U.S. Navy conducts training and testing activities in multiple ranges along the U.S. east coast. A biological opinion completed in 2013 estimated the number of exposures of ESA-listed species to those activities that are expected to occur annually (Table 11).

Table 10. Anticipated incidental take of ESA-listed species within U.S. Navy East Coast Training Range Complexes (NMFS 2013).

Whale or sea turtle species	Operating area							
	Northeast		Virginia Capes		Cherry Point		Jacksonville	
	Harass	Harm	Harass	Harm	Harass	Harm	Harass	Harm
Blue	0	0	0	0	0	0	0	0
Fin	0	0	2	0	0	0	0	0
Humpback	0	0	2	0	0	0	0	0
North Atlantic right	0	0	0	0	0	0	0	0
Sei	0	0	0	0	0	0	0	0
Sperm	0	0	2	0	0	0	0	0
Hardshell sea turtles	0	0	300	2	0	0	11	1
Kemp’s ridley	0	0	555	5	0	0	2	0
Leatherback	0	0	9	0	0	0	11	1
Northwest Atlantic loggerhead	0	0	466	8	0	0	19	1

Anticipated impacts from these exposures include changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures and, therefore, would represent significant disruptions of the normal behavioral patterns of the animals that have been exposed. Behavioral responses that result from stressors associated with these training activities are expected to be temporary and would not affect the reproduction, survival, or recovery of these species. Instances of harm identified generally represent animals that would have been exposed to underwater detonations at 205 dB re μPa^2-s or 13 psi, which corresponds to an exposure in which 50% of exposed individuals would be expected to experience rupture of their tympanic membrane, an injury that correlates with measures of permanent hearing impairment (Ketten 1998c).

Training activities occurring within their Northeast, Virginia Capes, Cherry Point and Jacksonville Range Complexes that anticipated annual levels of take of ESA-listed species incidental to those training activities through 2014. U.S. Navy aerial bombing training in the ocean off the southeast U.S. involving live ordnance (500 and 1,000-lb bombs) has been estimated to have injured or killed 84 loggerhead, 12 leatherback, and 12 green or Kemp's ridley sea turtles (NMFS 1997). From 2009- 2012, NMFS issued a series of biological opinions to the U.S. Navy for training activities occurring within their Northeast, Virginia Capes, Cherry Point and Jacksonville Range Complexes that anticipated annual levels of take of ESA-listed species incidental to those training activities through 2014. During the proposed activities 2 fin whales, 2 humpback whales, 2 sperm whales, 344 hardshell sea turtles (any combination of green hawksbill, Kemp's ridley or Northwest Atlantic loggerhead sea turtles), 644 Kemp's ridley sea turtles, 21 leatherback sea turtles and 530 Northwestern Atlantic loggerhead sea turtles per year are expected to be harassed as a result of their behavioral responses to mid- and high frequency active sonar transmissions Another six Kemp's ridley and five Northwestern Atlantic loggerhead turtles per year are expected to be injured during exposure to underwater detonations.

7.7 U.S. Marine Corps training in the Cherry Point Range Complex

Table 12 identifies the likely take associated with Marine Corps activities in the Cherry Point Range Complex.

Table 11. Incidental take associated with U.S. Marine Corps training in the Cherry Point Range Complex that is currently authorized.

<table>
<tr><th rowspan="4">Species</th><th colspan="7">MCAS Cherry Point water ranges</th></tr>
<tr><th colspan="2">Boat maneuvers (BT-9 & BT-11)</th><th colspan="2">Ordnance/munitions delivery (BT-9 & BT-11)</th><th colspan="3">Underwater explosions (BT-9 only)</th></tr>
<tr><th rowspan="2">Harass</th><th rowspan="2">Harm (injury, mortality) from vessel strike</th><th rowspan="2">Harass</th><th rowspan="2">Harm (injury, mortality) from direct strike</th><th rowspan="2">Harass (TTS and other behavioral impacts)</th><th colspan="2">Harm</th></tr>
<tr><th>Injury</th><th>Mortality</th></tr>
<tr><td>Green sea turtle</td><td rowspan="4">10 of any species per year</td><td rowspan="4">1 of any species over a 10-year period</td><td rowspan="4">10 of any species per year</td><td rowspan="4">2 of any species over a 10-year period</td><td rowspan="4">23 per year</td><td rowspan="4">1 per year (PTS)</td><td rowspan="4">1 over a 10-year period</td></tr>
<tr><td>Kemp's ridley sea turtle</td></tr>
<tr><td>Leatherback sea turtle</td></tr>
<tr><td>Northwest Atlantic DPS Loggerhead sea turtle</td></tr>
</table>

7.8 Entrapment and entanglement in fishing gear

Fisheries interactions are a significant problem for several marine mammal species and particularly so for humpback whales, as well as sea turtles. Between 1970 and 2009, two-thirds of mortalities of large whales in the northwestern Atlantic were attributed to human causes, primarily ship strike and entanglement (Van der Hoop et al. 2013). In excess of 97% of entanglement is caused by derelict fishing gear (Baulch and Perry 2014). Aside from the potential of entrapment and entanglement, there is also concern that many marine mammals that die from entanglement in commercial fishing gear tend to sink rather than strand ashore, thus making it difficult to accurately determine the frequency of mortalities. Entanglement may also make whales more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada. A total of 595 humpback whales were reported captured in coastal fisheries in those two provinces between 1969 and 1990, of which 94 died (Lien 1994; Perkins and Beamish 1979). Along the Atlantic coast of the U.S. and the Maritime Provinces of Canada, there were 160 reports of humpback whales being entangled in fishing gear between 1999 and 2005 (Cole et al. 2005c; Nelson et al. 2007c). Of these, 95 entangled humpback whales were confirmed, with 11 whales sustaining injuries and nine dying of their wounds. Waring et al. (2007) reported four fin whales in the western North Atlantic having died or were seriously injured in fishing gear

Of the current threats to North Atlantic right whales, entanglement in commercial fishing gear poses one of the greatest threats (Figure 7). Along the Atlantic coast of the U.S. and the Maritime Provinces of Canada, there were 46 confirmed reports of North Atlantic right whales entangled in fishing gear between 1990 and 2007 (Cole et al. 2005a; Nelson et al. 2007a; Waring et al. 2009). Of the 39 reports that NMFS could confirm, North Atlantic right whales were injured in five of the entanglements and killed in four entanglements. Three of the 24 entangled whales between 2004 and 2008 died and one other resulted in serious injury (Glass et al. 2009). Recent efforts to disentangle right whales have met with success (Anonmyous. 2009).

Figure 9. A North Atlantic right whale entangled in fisheries gear off Florida, with Georgia Department of Natural Resources and Coastwise Consulting staff attempting to cut rope off (Credit: EcoHealth Alliance and Georgia Department of Natural Resources, ESA permit number 932-1905).

Nine instances of entanglement were recorded between 2006 and 2010, two of which were disentangled (Waring et al. 2013). From 1970-2010, 74 instances of entanglement have been documented (Waring et al. 2013). Scars examined between 1980 and 2002 revealed that 75% of 447 individuals examined showed scarring from fishing gear (Waring et al. 2013). It is also estimated that 14 and 51% of right whales are entangled on an annual basis (Knowlton et al. 2005). Another study assessing photographs of right whales from 1980-2009 found 626 individuals having 1,032 entanglement scars (Knowlton et al. 2012). This included 83% having at least one scar and 59% having multiple scars, with juveniles being entangled at higher rates than adults and the sexes entangling equally (Knowlton et al. 2012). Scars also became more abundant over the study period, suggesting entanglement rates are increasing (Knowlton et al. 2012). In August 1993, a dead sperm whale, with longline gear wound tightly around the jaw, was found floating about 32 km off Maine.

Fishery interaction remains a major factor in sea turtle recovery and, frequently, the lack thereof. Wallace et al. (2010) estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries. NMFS (2002a) estimated that 62,000 loggerhead sea turtles have been killed as a result of incidental capture and drowning in shrimp trawl gear. Although TEDs and other bycatch reduction devices have significantly reduced the level of bycatch to sea turtles and other marine species in U.S. waters, mortality still occurs. The fisheries that have the most significant demographic effect on sea turtles are the Gulf of Mexico shrimp trawl fisheries. The estimated annual number of interactions and mortalities between sea turtles and shrimp trawls in the Gulf shrimp fisheries (state and federal) are believed to have declined versus prior regulations (Epperly et al. 2002; Nance et al. 2008) (Table 13). Although participants in this and other fisheries are required to use Turtle Exclusion Devices, which are estimated to reduce the number of sea turtles trawlers capture by as much as 97%, each year these fisheries are expected to capture about 185,000 sea turtles annually and kill about 5,000 of them. Loggerhead sea turtles account for most of these: capturing about 163,000 loggerhead sea turtles, killing almost 4,000 of them. However, more recent estimates suggest interactions and mortality has decreased from pre-regulatory periods, with a conservative estimate of 26,500 loggerheads captured annually in U.S. Atlantic fisheries causing mortality to 1,400 individuals per year (Finkbeiner et al. 2011). These are followed by green sea turtles: about 18,700 green sea turtles are expected to be captured each year with more than 500 of them dying as a result of their capture (NMFS 2002b). Each year, various fisheries capture about 2,000 loggerhead sea turtles in Pamlico Sound, of which almost 700 die (Finkbeiner et al. 2011). The action area and its surrounding region appears to be a location of moderate sea turtle longline bycatch relative to long-term global levels (Lewison et al. 2014).

Table 12. Estimated annual interactions between sea turtles and shrimp trawls in the Gulf of Mexico shrimp fisheries associated estimated mortalities based on 2007 Gulf effort data taken from Nance et al. (2008).

Species	Estimated interactions	Estimated mortalities
Leatherback	520	15
Loggerhead	23,336	647
Kemp's ridley	98,184	2,716
Green	11,311	319

Mortality of leatherbacks in the U.S. shrimp fishery is now estimated at 54 turtles per year. Data collected by the Northeast Fisheries Science Center Fisheries Observer Program from 1994 through 1998 (excluding 1997) indicate that a total of 37 leatherbacks were incidentally captured (16 lethally) in drift gillnets set in offshore waters from Maine to Florida during this period. Observer coverage for this period ranged from 54 to 92%. Trinidad and Tobago's Institute for Marine Affairs estimated that more than 3,000 leatherbacks were captured incidental to gillnet fishing in the coastal waters of Trinidad in 2000.

Portions of the Atlantic pelagic fisheries for swordfish, tuna, shark, and billfish also operate in the action area and capture and kill the second highest number of sea turtles along the Atlantic coast. These fisheries include purse seine fisheries for tuna, harpoon fisheries for tuna and swordfish, commercial and recreational rod and reel fisheries, gillnet fisheries for shark, driftnet fisheries, pelagic longline fisheries, and bottom longline fisheries. Lewison et al. (2004) estimated that 30,000-60,000 leatherbacks were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries, as well as others). Between 1986 and 1995, this fishery captured and killed one North Atlantic right whale, two humpback whales, and two sperm whales. Between 1992 and 1998, the longline components of these fisheries are estimated to have captured more than 10,000 sea turtles (4,585 leatherback sea turtles and 5,280 loggerhead sea turtles), killing 168 of these, disincluding sea turtles that might have died after being released (Johnson et al. 1999; Yeung 1999). Since then, all components of these fisheries are estimated to capture about 1,350 sea turtles each year, killing 345. Finkbeiner et al. (2011) estimated that annual bycatch interactions total 1,400 leatherbacks annually for U.S. Atlantic fisheries (resulting in roughly 40 mortalities).

On 4 July 2004, NMFS published a final rule to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (6979 FR 40734). The management measures include mandatory circle hook and bait requirements and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. This is expected to have significantly reduced sea turtle mortality from pelagic longlines.

In 2008, the Southeast Fisheries Science Center observer programs and subsequent analyses indicated that the overall amount and extent of incidental take for sea turtles specified in the incidental take statement of the 2005 opinion on the reef fish fishery had been severely exceeded by the bottom longline component of the fishery (approximately 974 captures and at least 325 mortalities estimated for the period July 2006-2007). The Gulf of Mexico Fishery Management Council developed a long-term management strategy via a new amendment (Amendment 31 to the Reef Fish FMP). The amendment included a prohibition on the use of bottom longline gear in the Gulf of Mexico reef fish fishery, shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida, from June through August; a reduction in the number of bottom longline vessels operating in the fishery via an endorsement program and a restriction on the total number of hooks that may be possessed onboard each Gulf of Mexico reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing. These changes are expected to greatly reduce the mortality of loggerhead sea turtles resulting from the operation of this fishery.

Observation of the directed highly migratory shark fisheries has been ongoing since 1994, but a mandatory program was not implemented until 2002. Neritic juvenile and adult loggerhead sea turtles are the primary species taken, but leatherback sea turtles have also been observed caught. From 1994-2002, observers covered 1.6% of all hooks, observing bycatch of 31 loggerhead, 4 leatherback, and 8 unidentified sea turtles with estimated annual average take levels of 30, 222, and 56, respectively (NMFS 2003).

In addition to commercial bycatch, recreational hook-and-line interaction also occurs. Cannon and Flanagan (1996) reported that from 1993 to 1995, at least 170 Kemp's ridley sea turtles were hooked or tangled by recreational hook-and-line gear in the northern Gulf of Mexico. Of these, 18 were dead stranded turtles, 51 were rehabilitated turtles, five died during rehabilitation, and 96 were reported as released by fishermen.

7.9 Wind energy

Efforts to develop wind energy facilities offshore of the U.S. east coast have increased over the past several years. The Bureau of Ocean Energy Management assumed that the entire area of each Mid-Atlantic Wind Energy Area would be leased based on the expressions of commercial wind energy interest received (BOEM 2012). Leases could be issued and site characterization and assessment activities started as early as 2012 (BOEM 2012). Site characterization and assessment activities would occur over a period of about 5.5 years per lease (BOEM 2012). Several leases have been issued that would allow for testing and investigation of wind resources at various sites (BOEM 2012). Significant ocean noise and vessel activity is associated with construction of facilities such as these, which numerous studies have shown to displace marine mammals from the area, but who generally return post-construction. It is not known whether migratory species deflect to avoid facilities such as these once constructed.

7.10 Oil and gas activities

In addition, the Bureau of Ocean Energy Management has drafted a programmatic environment impact statement that includes the action area and surrounding regions of the U.S. East Coast. Although activities are not expected to begin until 2017, activities occurring under this program could include seismic surveys and sampling activities.

7.11 Entrainment in power plants

Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants. A comprehensive biological opinion that covers all power plant cooling water intakes was issued by the Services in May 2014, but does not identify the amount or extent of ESA-listed species expected to be taken. This evaluation will be undertaken on a case-by-case basis for each power plant.

7.12 Ship-strikes

Ship-strike is a significant concern for the recovery of ESA-listed whales and, to a lesser degree, sea turtles. Between 1970 and 2009, two-thirds of mortalities of large whales in the northwestern Atlantic were attributed to human causes, primarily ship strike and entanglement (Van der Hoop et al. 2013). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the U.S. Atlantic coast and Canada's Maritime Provinces (Cole et al. 2005c; Nelson et al. 2007c). Two of these ship strikes were reported as having resulted in death. An update (unpublished data 1995–2011) ship strike inventory for the eastern seaboard indicates the following percentage of strikes by species: North Atlantic right whale (19%), humpback whale (28%), sei whale (6%), fin whale (17%), sperm whale (2%), and unknown species (16%). Based on the records available, large whales have been struck by ships off almost every coastal state in the U.S., although ship strikes are most common along the Atlantic Coast. More than half (56%) of the recorded ship strikes from 1975-2002 occurred off the coasts of the northeastern U.S. and Canada, while the mid-Atlantic and southeastern areas each accounted for 22% (Jensen and Silber 2003). According to Waring et al. (2007), five fin whales were killed or injured as a result of ship strikes between January 2000 and December 2004. Between 1999-2005, there were 15 reports of fin whales strikes by vessels along the U.S. and Canadian Atlantic coasts (Cole et al. 2005a; Nelson et al. 2007a). Of these, 13 were confirmed, resulting in the deaths of 11 individuals. Of 123 humpback whales that stranded along the Atlantic coast of the U.S. between 1975 and 1996, 10 (8.1%) showed evidence of collisions with ships (Laist et al. 2001).

In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are expected to reduce the chance of humpback whales being hit by ships by 9%, fin whales by 42%, right whales by 62%, and sei whales by 17%; the same rule applies from November through April from Brunswick, Georgia to Jacksonville, Florida, where North Atlantic right whales go for calving and breeding. Speed rules also apply to medium and large ports along the eastern seaboard during this time frame when right whales migrate to and from northern feeding and southern breeding areas. Nearly a dozen shipping lanes transect through coastal waters of the southeastern U.S. from the North-South Carolina to Cape Canaveral, Florida. Modeling efforts suggest voluntary changes in "areas to be avoided" suggested by the International Maritime Organization will reduce right whale strikes over the Scotian Shelf from one lethal strike every 0.78-2.07 years to one every 41 years (Hoop et al. 2012). Part of the susceptibility of North Atlantic right whales to ship strike may be its propensity to remain just below the surface, invisible to vessels, but at significant risk to ship strike (Parks et al. 2011b).

We believe the vast majority of ship-strike mortalities go unnoticed, and that actual mortality is higher than currently documented; Kraus et al. (2005) estimated that 17% of ship strikes are actually detected. The magnitude of the risks commercial ship traffic pose to large whales in the proposed action areas has been difficult to quantify or estimate. We struggle to estimate the number of whales that are killed or seriously injured in ship strikes within the U.S. EEZ and have virtually no information on interactions between ships and commercial vessels outside of U.S. waters. With the information available, we know those interactions occur but we cannot estimate their significance to whale species.

Ship strikes are the largest single contributor to North Atlantic right whale deaths, accounting for approximately 35% of all known mortalities, even though right whales should be able to hear the sound produced by vessels (Ketten 1998a; Knowlton and Kraus 2001a; Laist et al. 2001; Richardson et al. 1995a). Some information suggests right whales respond only within very close proximity to ships (Nowacek et al. 2004a). Various types and sizes of vessels have been involved in ship strikes with large whales, including container/cargo ships/freighters, tankers, steamships, U.S. Coast Guard vessels, Navy vessels, cruise ships, ferries, recreational vessels, fishing vessels, whale-watching vessels, and other vessels (Jensen and Silber 2004a). Injury is generally caused by the rotating propeller blades, but blunt injury from direct impact with the hull also occurs. There have been 18 reports of North Atlantic right whales being struck by vessels between 1999 and 2005 (Cole et al. 2005b; Nelson et al. 2007b). Of the 17 reports that NMFS could confirm, right whales were injured in two of the ship strikes and killed in nine. Recent records show that from 2004-2008, there were 17 confirmed reports of North Atlantic right whales being struck with eight whales dying of their wounds and two additional right whales sustaining serious injuries (Glass et al. 2009). Deaths of females are especially deleterious to the ability of the North Atlantic right whale population to recover. For instance, in 2005, mortalities included six adult females, three of which were carrying near-term fetuses and four of which were just starting to bear calves, thereby representing a lost reproductive potential of as many as 21 individuals over the short term (Kraus et al. 2005). Between 1999 and 2006, ships are confirmed to have struck 22 North Atlantic right whales, killing 13 of these whales (Jensen and Silber 2003; Knowlton and Kraus 2001b; NMFS 2005c). From 1999 to 2003, an average of 2.6 right whales were killed per year from various types of anthropogenic factors, but mostly from ship-strike (Waring et al. 2010a). From 2000 to 2004, this increased to 2.8 annually and increased again from 2001 to 2005 to an average of 3.2 right whales (Waring et al. 2010a). The most recent estimate of anthropogenic mortality and serious injury available showed a rate of 3.8

right whales per year from 2002 to 2006. Of these, 2.4 were attributed to ship strikes (Glass et al. 2008). Based on records collected between 1970 and 1999, about 60% of the right whales struck by ships along the Atlantic Coast of the U.S., 20% occurred in waters off the northeast states and 20% occurred in waters off the mid-Atlantic or southeast states (Knowlton and Kraus 2001b). Over the same time interval (1970 to 1999), these authors identified 25 (45%) unconfirmed serious injuries and mortalities from ship strikes. Of these, 16 were fatal interactions; two possibly fatal; and seven nonfatal. Based on these confirmed mortalities, ships are responsible for more than one-third (16 out of 45, or 36%) of all confirmed right whale mortalities (a confirmed mortality is one observed under specific conditions defined by NMFS).[5]. Part of the susceptibility of this species to ship strike may be its propensity to remain just below the surface, invisible to vessels, but at significant risk to ship strike (Parks et al. 2011b).

Another study conducted over a similar period (1970 to 2002) examined 30 (18 adults and juveniles, and 12 calves) out of 54 reported right whale mortalities from Florida to Canada (Moore et al. 2005). Human interaction (ship strike or gear entanglement) was evident in 14 of the 18 adults examined, and trauma, presumably from vessel collision, was apparent in 10 out of the 14 cases. Trauma was also present in four of the 12 calves examined, although the cause of death was more difficult to determine in these cases. In 14 cases, the assumed cause of death was vessel collision; an additional four deaths were attributed to entanglement. In the remaining 12 cases, the cause of death was undetermined (Moore et al. 2005).

Sea turtle ship strikes are a poorly-studied threat to sea turtles, but has the potential to be highly-significant (Work et al. 2010). All sea turtles must surface to breath and several species are known to bask at the surface for long periods, including loggerhead sea turtles. Although sea turtles can move rapidly, sea turtles apparently are not well able to move out of the way of vessels moving at more than 4 km/hr; most vessels move far faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010). This, combined with the massive level of vessel traffic in the Gulf of Mexico and coastal Atlantic, has the potential to result in frequent injury and mortality to sea turtles in the region (MMS 2007). Hazel et al. (2007) suggested that green sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases. Overall, ship strike is likely highly underestimated as a source of injury or mortality to sea turtles in the action area.

7.13 Commercial whaling

Large whale population numbers in the action areas were impacted by commercial exploitation historically, mainly in the form of whaling. Between 1969-1990, 14 fin whales were captured in coastal fisheries off Newfoundland and Labrador; of these seven are known to have died because of capture (Lien 1994; Perkins and Beamish 1979). Commercial whaling no longer occurs within the action area.

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5 There are four main criteria used to determine whether serious injury or mortality resulted from ship strikes: (1) propeller cut(s) or gashes that are more than approximately 8 cm in depth; (2) evidence of bone breakage determined to have occurred premortem; (3) evidence of hematoma or hemorrhaging; and (4) the appearance of poor health in the ship-struck animal

Knowlton, A. R., and S. D. Kraus. 2001b. Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. Journal of Cetacean Research and Management Special Issue 2:193-208..

7.14 Scientific and research activities

Scientific research permits issued by the NMFS currently authorize studies of ESA-listed species in the North Atlantic Ocean, some of which extend into portions of the action area for the proposed project. Authorized research on ESA-listed whales includes close vessel and aerial approaches, biopsy sampling, tagging, ultrasound, and exposure to acoustic activities, and breath sampling. Authorized research on ESA-listed sea turtles includes capture, handling, and restraint, satellite, sonic, and passive integrated transponder (PIT) tagging, blood and tissue collection, lavage, ultrasound, captive experiments, laparoscopy, and imaging. Research activities involve "takes" by harassment, with some resulting mortality. Additional "take" is likely to be authorized in the future as additional permits are issued. It is noteworthy that although the numbers tabulated below represent the maximum number of "takes" authorized in a given year, monitoring and reporting indicate that the actual number of "takes" rarely approach the number authorized. Therefore, it is unlikely that the level of exposure indicated below has or will occur in the near term. However, our analysis assumes that these "takes" will occur since they have been authorized. It is also noteworthy that these "takes" are distributed across the Atlantic Ocean, mostly from Florida to Maine, and in the eastern Gulf of Mexico. Although whales and sea turtles are generally wide-ranging, we do not expect many of the authorized "takes" to involve individuals who would also be "taken" under the proposed research.

Tables 14-23 describe the cumulative number of takes for each ESA-listed species in the action area authorized in scientific research permits.

Table 13. Blue whale takes in the North Atlantic.

Year	Approach	Biopsy	Suction cup tagging	Implantable tagging	Exhalation sampling	Acoustic playback
2009	655	25	90	45	0	2
2010	720	25	90	45	0	0
2011	620	25	90	45	0	0
2012	730	25	90	45	0	0
2013	6,300	630	1,255	540	80	0
2014	5,715	630	1,165	495	80	0
2015	5,715	630	1,165	495	80	0
Total	20,455	1,990	3,645	1,710	240	2

Permit numbers: 633-1778, 775-1875, 1036-1744, 1058-1733, 10014, 14451, 14856, 15575, 16109, 16239, 16325, 16388, and 17355.

Table 14. Fin whale takes in the North Atlantic.

Year	Approach	Biopsy	Suction cup tagging	Implantable tagging	Exhalation sampling	Acoustic playback
2009	1,671	170	75	0	0	2
2010	1,876	170	45	0	0	0
2011	1,776	170	45	0	0	0
2012	2,846	170	45	0	0	0
2013	9,551	1,215	1,315	495	340	0
2014	8,727	1,165	1,290	495	340	0
2015	8,727	1,165	1,290	495	340	0
Total	32,174	4,225	4,105	1,485	1,020	2

Permit numbers: 10014, 605-1904, 775-1875, 948-1692, 981-1707, 1036-1744, 1058-1733, 14
14451, 14586, 14856, 15575, 16109, 16239, 16325, 16388, 16473, and 17355.

Table 15. Humpback whale takes in the North Atlantic.

Year	Approach	Biopsy	Suction cup tagging	Implantable tagging	Belt tag	Exhalation sampling	Acoustic playback
2009	5,260	415	173	45	0	0	624
2010	5,568	415	173	45	0	0	600
2011	8,653	1,040	723	95	0	0	600
2012	8,419	1,040	723	95	125	0	600
2013	17,925	1,980	1,465	395	125	2,410	600
2014	16,800	1,880	1,440	395	125	2,410	600
2015	16,155	1,880	1,440	395	125	2,410	0
Total	78,780	8,650	6,137	1,465	500	7,230	3,624

Permit numbers: 605-1904, 633-1778, 775-1875, 948-1692, 981-1707, 1036-1744, 1058-1733, 1121-1900, 1128-1922, 10014, 13927, 14118, 14245, 14451, 14586, 14856, 15575, 15682, 16109, 16325, 16388, 16473, and 17355.

Table 16. Sei whale takes in the North Atlantic.

Year	Approach	Biopsy	Suction cup tagging	Implantable tagging	Exhalation sampling	Acoustic playback
2009	1,604	50	158	45	0	2
2010	1,604	50	158	45	0	0
2011	1,504	50	158	45	0	0
2012	1,664	50	158	45	0	0
2013	8,227	1,735	773	390	160	0
2014	6,933	1,735	640	345	160	0
2015	6,933	1,735	640	345	160	0
Total	28,469	5,405	2,685	1,260	480	2

Permit numbers: 605-1904, 633-1778, 775-1875, 1058-1733, 10014, 14118, 14451, 14856, 15575, 16109, 16239, 16325, 16388, 16473, and 17355.

Table 17. Sperm whale takes in the North Atlantic.

Year	Approach	Biopsy	Suction cup tagging	Implantable tagging	Exhalation sampling	Acoustic playback
2009	5,560	375	820	0	0	920
2010	4,110	400	520	0	0	120
2011	4,010	425	520	0	0	120
2012	1,950	125	10	0	0	0
2013	8,789	990	720	450	80	0
2014	7,789	890	710	450	80	0
2015	7,789	890	710	450	80	0
Total	32,086	4,095	4,010	1,350	240	1,160

Permit numbers: 633-1778, 775-1875, 909-1719, 948-1692, 981-1707, 1036-1744, 1121-1900, 10014, 14451, 14586, 14856, 15575, 16109, 16239, 16325, 16473, 17312, and 17355.

Table 18. Green sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	3,093	3,093	3,009	1,860	555	66	74	72	6
2010	3,753	3,753	3,669	2,480	555	66	74	72	6
2011	4,255	4,255	3,505	2,990	564	66	74	72	20
2012	3,354	3,354	2,622	2,210	704	66	74	72	18.2
2013	5,001	5,001	4,325	3,654	1,903	91	398	396	4.2
2014	4,236	4,236	3,560	3,004	1,408	65	324	324	4.2
2015	4,210	4,210	3,540	3,004	1,408	65	324	324	4.2
Total	27,902	27,902	24,230	19,202	7,097	485	1,046	1,332	62.8

Permit numbers: 1450, 1462, 1501, 1506, 1507, 1518, 1522, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 10014, 10022, 13306, 13307, 13543, 13544, 13573, 14506, 14508,14622, 14655, 14726, 14949, 15112, 15135, 15552, 15556, 15575, 15606, 15802, 16134, 16146, 16174, 16194, 16253, 16556, 16598, 16733, 17183, 17304, 17355, 17381, and 17506.

Table 19. Kemp's ridley sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	1,394	1,394	1,195	425	371	56	53	53	5
2010	1,402	1,402	1,203	426	371	56	53	53	5
2011	2,210	2,210	1,368	976	400	56	53	53	9
2012	2,229	2,219	1,561	972	450	56	53	53	7.2
2013	2,836	2,852	2,190	1,627	990	116	213	218	3.2
2014	2,460	2,476	1,814	1,256	619	60	160	165	3.2
2015	2,283	2,299	1,669	1,256	619	60	160	165	3.2
Total	14,814	14,852	11,000	6,938	3,820	460	745	548	35.8

Permit numbers: 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 10014, 10022, 13306, 13543, 13544, 14508, 14726, 14506, 14622, 14655, 14726, 15112, 15135, 15552, 15566, 15575, 15606, 15802, 16134, 16194, 16253, 16556, 16598, 16733, 17183, 17304, 17355, 17381, and 17506.

Table 20. Leatherback sea turtle takes in the North Atlantic Ocean.

Year	Capture/handling/restraint	Satellite, sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Imaging	Laparoscopy	Mortality
2009	1,357	1,357	1,331	197	188	0	0	2
2010	1,421	1,421	1,394	197	188	0	0	1
2011	1,709	1,709	1,682	197	189	0	0	3.4
2012	736	736	709	187	189	0	0	2.6
2013	842	835	808	312	254	65	65	1.6
2014	653	646	620	135	66	65	65	1.6
2015	647	640	620	135	66	65	65	1.6
Total	7,365	7,344	7,164	1,360	1,140	195	195	13.8

Permit numbers: 1506, 1527, 1540, 1544, 1551, 1552, 1557, 1570, 1571, 1576, 10014, 13543, 14506, 14586, 14655, 14726, 15112, 15552, 15556, 15575, 15672, 15802, 16109, 16194, 16253, 16556, 16733, 17355, and 17506.

Table 21. Loggerhead sea turtle takes in the North Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	5,462	5,462	5,044	1,165	1,322	200	109	123	111
2010	5,464	5,464	5,046	1,205	1,322	200	109	116	111
2011	7,165	7,165	6,097	1,420	1,667	200	148	114	122.2
2012	4,791	4,791	3,741	1,370	1,429	200	161	114	29.8
2013	5,909	5,909	4,859	2,609	2,519	305	401	354	24.8
2014	4,762	4,762	3,712	1,495	1,543	105	292	240	24.8
2015	4,635	4,635	3,635	1,495	1,543	105	292	240	7.8
Total	38,188	38,188	32,134	10,759	11,345	1,315	1,512	1,301	431.4

Permit numbers: 1450, 1462, 1501, 1506, 1507, 1522, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 1599, 10014, 10022, 13306, 13307, 13543, 13544, 14249, 14622, 14506, 14508, 14622, 14655, 14726, 15112, 15552, 15566, 15575, 15606, 15802, 16134, 16146, 16194, 16253, 16556, 16598, 16733, 17183, 17304, 17355, 17381, and 17506.

Table 22. Hawksbill sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	1,088	1,088	1,081	464	254	0	0	0	3
2010	1,424	1,424	1,417	534	254	0	0	0	3
2011	1,959	1,959	1,955	914	255	0	0	0	4.4
2012	1,462	1,456	1,452	904	255	0	0	0	3.6
2013	1,423	1,417	1,415	844	320	39	0	0	1.6
2014	1,114	1,108	1,106	550	66	39	0	0	1.6
2015	1,032	1,026	1,026	550	66	39	0	0	1.6
Total	9,502	9,484	9,452	4,760	1,470	117	0	0	18.8

Permit numbers: 1462, 1501, 1506, 1507, 1518, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 1599, 10014, 10022, 13306, 13307, 13543, 13544, 14272, 14508, 14726, 14506, 14508, 14622, 14655, 14726, 14949, 15112, 15135, 15552, 15566, 15575, 15606, 15802, 16134, 16146, 16194, 16253, 16598, 16733, 17183, 17304, 17355, 17381, and 17506.

7.15 Physical and oceanographic features

The presence of key habitat features, such as shelter or foraging opportunities, are the primary reasons why listed individuals occur where they do. In the marine environment, this is fundamentally built upon local physical and oceanographic features that influence the marine environment. As such, we describe the physical and oceanographic environment here to establish a rationale for why listed species occur in the action area at the levels we observe or expect.

The Blake Plateau is the largest physical feature of the region, shaped by the largest oceanographic feature, the Gulf Stream. The continental margin off North Carolina extends over 300 km from shore (Newton et al. 1971). The continental shelf, known as the Florida-Hatteras Shelf south of Cape Hatteras, is narrow at its northern extent (about 45 km) but broadens steadily to about 105 km off Cape Fear (Newton et al. 1971). The shelf break off North Carolina ranges in depth from 55-180 m. The continental slope in the region is relatively smooth and splits in two on either side of the Blake Plateau. The eastern half of the slope merges with the Blake Escarpment while the western slope follows the coastline (Emery and Uchupi 1972; Tucholke 1987).

The North Atlantic Oscillation (NAO) affects sea surface temperatures, wind conditions, and ocean circulation throughout the North Atlantic Ocean (Stenseth et al. 2002b). The NAO is an intensity alteration of the atmospheric pressure between the semi-permanent high pressure center over the Azores Islands and the subpolar low-pressure center over Iceland (Curry and McCartney 2001; Stenseth et al. 2002b). Sea-level atmospheric pressure in the two regions tends to vary inversely, creating “positive” and “negative” phases. However, these phases are stable for years to decades. The NAO was generally positive from 1900 to 1950, mainly negative in the 1960s and 1970s, and mainly positive since 1970 (Hurrell et al. 2001).

The NAO also influences the latitude of the Gulf Stream Current and is largely responsible for its variable location. During positive NAO years, the Gulf Stream is farther east (Taylor and Stephens 1998). The flow rate of the Gulf Stream is also affected; during negative NAO years, the Gulf Stream System is not only shifted southward but weakened by up to 25-33% (Curry and McCartney 2001). The upper slope-water system off the U.S. east coast is affected by the NAO (Pershing et al. 2001). During low NAO periods, the Labrador Current intensifies, leading to the advance of cold slope water along the continental shelf as far south as the Mid Atlantic Bight (Pershing et al. 2001). Intensity variability in another regionally important current, the Labrador Current, is linked to the effects of winter temperatures in Greenland and its surrounding waterways, sea-ice formation, and the relative balance between the formation of deep and intermediate water masses and surface currents. Although the NAO influences the northern North Atlantic most, its effects remain significant south through the Outer Banks (Hurrell et al. 2001).

The NAO strongly affects trophic groups in North Atlantic marine ecosystems (Drinkwater et al. 2003; Fromentin and Planque 1996). *Calanus* copepod temporal and spatial patterns are linked to the phases of the NAO (Fromentin and Planque 1996; Stenseth et al. 2002b); positive NAO indices are associated with increased *Calanus* copepod abundance in the Gulf of Maine and the corollary in negative NAO index years (Conversi et al. 2001a; Greene et al. 2003b). This has secondary effects, such as prey availability for North Atlantic right whales, which feeds principally on *Calanus finmarchicus*. High *Calanus finmarchicus* abundance is linked to increased North Atlantic right whale calving rates (Greene et al. 2003b). Negative NAO indices are associated with abundances of cod, herring, and sardines: species that are important to other listed mysticetes (Drinkwater et al. 2003).

The Gulf Stream Current is a powerful surface current, carrying warm water into the cooler North Atlantic through the action area and separates the warm, tropical/subtropical waters found to the south from the cool, temperate waters found to the north (Pickard and Emery 1990; Verity et al. 1993). Cape Hatteras is considered to be the dividing point between the oceanic provinces of the South Atlantic Bight and the Middle Atlantic Bight (Newton et al. 1971; Pickard and Emery 1990). Surface velocities range from 2-5 nautical miles per hour and the temperature is generally 25° to 28° C (Mann and Lazier 1991). The Gulf Stream is usually sharply defined on its west and north side but much less so on its east or south sides (Pickard and Emery 1990).

In general, the Gulf Stream flows parallel to shore from the Florida Straits to Cape Hatteras, where it flows northeastward past the Grand Banks away from land. While stratification of the water column and other factors may play a role, climactic factors such as the NAO likely cause it's variation in position (Pershing et al. 2001; Schmeits and Dijkstra 2000). Wave-like meandering begins to occur at Cape Hatteras and increases as the current progresses offshore. North of Cape Hatteras, small gyres form that separate from the Gulf Stream as either warm- or cold-core rings (Mann and Lazier 1991). Between three and eleven warm-core rings are formed per year, each about 100 km across (García-Moliner and Yoder 1994), 1,000 m in height (Mann and Lazier 1991), and lasting 11-399 days (García-Moliner and Yoder 1994; Pickard and Emery 1990). Warm-core rings bring warm water and associated plankton to colder inshore areas. Cold-core rings form when a cyclonic loop pinches off from the Gulf Stream, resulting in a counterclockwise rotating ring of cool slope water in the warm Sargasso Sea (Pickard and Emery 1990). Twice as many cold-core rings are formed as warm-core rings every year (Pickard and Emery 1990). They are larger (100-300 km across) and longer lasting (months to years) than warm-core rings (Pickard and Emery 1990). Frontal eddies commonly occur over the continental shelf, forming south of the action area and moving north and enclosing cold, nutrient rich upwelled water (Mann and Lazier 1991; Yoder et al. 1981). This leads to temporary, locally enhanced primary production that can support zooplankton and larger listed sea turtle and marine mammal foraging. The Gulf Stream region acts to facilitate transport of some species (through entrainment in its flow) and restrict it for others (bounding cold-water and warm-water species from moving further south or north, respectively)(Wishner et al. 1988b).

In addition to the Gulf Stream, a longshore current moves south along the coast consisting of cold, less saline, but nutrient-rich water from the Chesapeake Bay (Dzwonkowski and Yan 2005; Gangopadhyay et al. 2005; Lentz et al. 2003; Marmorino et al. 2002; Shen et al. 2000).

Upwelling, which replaces warm, generally nutrient poor water with deeper, colder, relatively nutrient rich water, occurs frequently in association with the Gulf Stream moving over the Florida-Hatteras Shelf (Lee et al. 1991; Savidge 2004). During fall, winter, and spring in the South Atlantic Bight, upwelling is usually restricted to the outer shelf of the Gulf Stream, but in summer, upwelled water intrudes onto the continental shelf under the warmer, less dense shelf water, leading to upwelling and resultant increases in productivity (Atkinson and Yoder 1984; Lee et al. 1991).

Primary productivity fluctuates little in the region. Important nutrient sources include discharge from the Pamlico and Neuse rivers (although movement into the marine environment is limited by Pamlico Sound) and the Chesapeake Bay (Lohrenz et al. 2003). Chlorophyll α concentrations decrease quickly away from the coast to less than 1 mg m-3 beyond the shelf break in all seasons. However, transient upwelling events associated with intrusion of Gulf Stream waters onto the Florida-Hatteras Shelf can support phytoplankton increases (Flierl and Davis 1993; García-Moliner and Yoder 1994; Lohrenz et al. 1993).

While exact estimates of enhanced productivity vary with the life of each cold-core ring, primary production is approximately 50% greater in cold-core rings than in the Sargasso Sea (Mann and Lazier 1996). Warm-core rings vary in their physical, chemical, and biological composition over their lifetime, either by entrainment from surrounding water masses or in situ changes (García-Moliner and Yoder 1994). Entrainment of both warm water from the Gulf Stream and cold water from the shelf/slope causes an increase in primary production (García-Moliner and Yoder 1994).

Diatoms, cyanobacteria, cryptophytes, and prasinophytes make up most of the phytoplankton community in the action area, although haptophytes and dinoflagellates are more common closer to shore (Lohrenz et al. 2003). Assemblages depend greatly on highly-variable currents (Lohrenz et al. 2003). Coccolithophores and pyrrhophyceans predominate in Gulf Stream waters, and are generally least abundant in winter.

Zooplankton, the next higher level in the marine food chain from phytoplankton and the prey of several listed whales and sea turtles, are generally higher in slope water versus other locations (Wiebe et al. 1987). Spring is a time of higher abundance temporally, particularly within the upper 200 m of the water column (Wiebe et al. 1987). Zooplankton concentrate in areas of increased primary productivity, such as along Gulf Stream frontal boundaries and eddy peripheries (Oschlies and Garcon 1998). Zooplankton abundance changes with seasons, phytoplankton abundance, and oceanographic conditions, but is generally higher in cold-core eddies and along fronts (Quattrini et al. 2005; Wormuth et al. 2000). When shelf water intrudes over slope water, high nutrient concentrations and a shallow mixed layer will give rise to enhanced primary production, which then fuels an increase in zooplankton biomass or secondary production.

7.16 Impacts of the Environmental Baseline on Listed Species

Listed resources are exposed to a wide variety of past and present state, Federal or private actions and other human activities that have already occurred or continue to occur in the action area. Federal projects in the action area that have already undergone formal or early section 7 consultation, and state or private actions that are contemporaneous with this consultation also impact listed resources. However, the impact of those activities on the status, trend, or the demographic processes of threatened and endangered species remains largely unknown. To the best of our ability, we summarize the effects we can determine based upon the information available to us in this section.

Cetaceans

Climate change has wide-ranging impacts, so of which can be experienced by ESA-listed whales in the action area. Climate change has been demonstrated to alter major current regimes and may alter those in the action area as they are studied further. Considering the sensitivity that North Atlantic right whales have to warm water temperatures during their southbound migration, warming water temperatures may delay their migratory movements. The availability and quality of prey outside the action area in northern feeding areas can also influence the body condition of individuals in the action area, and potentially reduce the number of individuals that undertake migration through the action area. Changes in the timing of North Atlantic right whales, bowhead whales, and gray whales have been observed and may be partly or largely due to these climactic factors.

Acoustic effects from anthropogenic sources, whether they are vessel noise, seismic sound, military activities, oil and gas activities, or wind energy, could also have biologically significant impacts to ESA-listed whales in the action area. These activities increase the level of background noise in the marine environment, making communication more difficult over a variety of ranges. We expect that this increased collective noise also reduces the sensory information that individuals can gather from their environment; an important consideration for species that gather information about their environment primarily through sound. At closer ranges to some of anthropogenic sound sources, behavioral responses also occur, including deflecting off migratory paths and changing vocalization, diving, and swimming patterns. At even higher received sound levels, physiological changes are likely to occur, including temporary or permanent loss of hearing and potential trauma of other tissues. Although this is a small fraction of the total exposure individuals receive, it is expected to occur in rare instances.

High levels of morbidity and mortality occur as a result of shipstrike (particularly for North Atlantic right whales and humpback whales) and entanglement in fishing gear (right whales). Ship-strike and entanglement occur broadly along the U.S. East Coast, including (in all likelihood) in the action area itself. These two factors are the greatest known source of mortality and impairment to recovery for North Atlantic right whales and represent known mortality sources for all other ESA-listed whales in the action area. Reductions in speed through portions of the action area as well as seasonal or brief closings of areas to fishing are underway to reduce these impacts, but data are not yet available to demonstrate the long-term effectiveness of these strategies. However, these measures are likely reducing the severity and frequency of these interactions.

Authorized research on ESA-listed whales can have significant consequences for these species, particularly when viewed in the collective body of work that has been authorized. Researchers have noted changes in respiration, diving, swimming speed, social exchanges, and other behavior correlated with the number, speed, direction, and proximity of vessels. Responses were different depending on the age, life stage, social status of the whales being observed (i.e., males, cows with calves) and context (feeding, migrating, etc.). Beale and Monaghan (2004) concluded that the significance of disturbance was a function of the distance of humans to the animals, the number of humans making the close approach, and the frequency of the approaches. These results would suggest that the cumulative effects of the various human activities in the action area would be greater than the effects of the individual activity. Several investigators reported behavioral responses to close approaches that suggest that individual whales might experience stress responses. Baker *et al.* (1983)described two responses of whales to vessels, including: (1) "horizontal avoidance" of vessels 2,000 to 4,000 meters away characterized by faster swimming and fewer long dives; and (2) "vertical avoidance" of vessels from 0 to 2,000 meters away during which whales swam more slowly, but spent more time submerged. Watkins *et al.* (1981) found that both fin and humpback whales appeared to react to vessel approach by increasing swim speed, exhibiting a startled reaction, and moving away from the vessel with strong fluke motions. Other researchers have noted changes in respiration, diving, swimming speed, social exchanges, and other behavior correlated with the number, speed, direction, and proximity of vessels.

Results were different depending on the social status of the whales being observed (single males when compared with cows and calves), but humpback whales generally tried to avoid vessels when the vessels were 0.5 to 1.0 kilometer from the whale. Smaller pods of whales and pods with calves seemed more responsive to approaching vessels (Bauer 1986; Bauer and Herman 1986). These stimuli are probably stressful to the humpback whales in the Action Area, but the consequences of this stress on the individual whales remains unknown (Baker and Herman 1987; Baker et al. 1983). Studies of other baleen whales, specifically bowhead and gray whales, document similar patterns of behavioral disturbance in response to a variety of actual and simulated vessel activity and noise (Malme et al. 1983; Richardson et al. 1985). For example, studies of bowhead whales revealed that these whales oriented themselves in relation to a vessel when the engine was on, and exhibited significant avoidance responses when the vessel's engine was turned on even at a distance of about 900 m (3,000 ft). Jahoda *et al.* (2003) studied the response of 25 fin whales in feeding areas in the Ligurian Sea to close approaches by inflatable vessels and to biopsy samples. They concluded that close vessel approaches caused these whales to stop feeding and swim away from the approaching vessel. The whales also tended to reduce the time they spent at surface and increase their blow rates, suggesting an increase in metabolic rates that might indicate a stress response to the approach. In their study, whales that had been disturbed while feeding remained disturbed for hours after the exposure ended. They recommended keeping vessels more than 200 meters from whales and having approaching vessels move at low speeds to reduce visible reactions in these whales. Although these responses are generally ephemeral and behavioral in nature, populations within the action area can be exposed to several thousand instances of these activities per year, with some species having so many authorized activities that if they were all conducted, every individual in the population would experience multiple events. This can collectively alter the habitat use of individuals, or make what would normally be rare, unexpected effects (such as severe behavioral responses or infection from satellite or biopsy work) occur on a regular basis.

Sea turtles

Several of the activities described in this *Environmental Baseline* have significant and adverse consequences for nesting sea turtle aggregations whose individuals occur in the Action Area. In particular, the commercial fisheries annually capture substantial numbers of green, hawksbill, Kemp's ridley, leatherback, and Northwest Atlantic loggerhead sea turtles.

Climate change has and will continue to impact sea turtles throughout the action area as well as throughout the range of the populations. Sex ratios of several species are showing a bias, sometimes very strongly, towards females due to higher incubation temperatures in nests. We expect this trend will continue and possibly may be exacerbated to the point that nests may become entirely feminized, resulting in severe demographic issues for affected populations in the future. Hurricanes may become more intense and/or frequent, impacting the nesting beaches of sea turtles and resulting in increased loss of nests over wide areas. Disease and prey distributions may well shift in response to changing ocean temperatures or current patterns, altering the morbidity and mortality regime faced by sea turtles and the availability of prey.

Although only small percentages of these sea turtles are estimated to have died as a result of their capture during research or incidental to fisheries, the actual number could be substantial if considered over the past 5 – 10 years. When we add the percentage of sea turtles that have suffered injuries or handling stress sufficient to have caused them to delay the age at which they reach maturity or the frequency at which they return to nesting beaches, the consequences of these fisheries on nesting aggregations of sea turtles would be greater than we have estimated.

Even with TED measures in place, in 2002, NMFS (2002) expected these fisheries to capture about 323,600 sea turtles each year and kill about 5,600 (~1.7%) of the turtles captured. Loggerhead sea turtles account for most of this total: 163,000 captured, killing almost 4,000 (~2.5%) of them. Kemp's ridleys account for the second-most interactions: 155,503 captures with 4,200 (~2.7%) deaths. These are followed by green sea turtles: about 18,700 captured with more than 500 (~2.7%) dying as a result of capture. Leatherback sea turtle interactions were estimated at 3,090 captures with 80 (~2.6%) deaths as a result (NMFS 2002b). Since 2002, however, effort in the Atlantic shrimp fisheries has declined from a high of 25,320 trips in 2002 to approximately 13,464 trips in 2009., roughly 47% less effort. Since sea turtle takes are directly linked to fishery effort, these takes are expected to decrease proportionately. However, hundreds too a possible few thousand sea turtle interactions are expected annually, with hundreds of deaths (NMFS 2012).

Recent data regarding the three largest subpopulations that comprise the Northwest Atlantic loggerhead DPS indicated either that these subpopulations do not show a nesting decline significantly different from zero (Peninsular Florida and The Greater Caribbean subpopulation) or are showing possible signs of stability in nest numbers (Northern subpopulation). These trends were recently declining. Additional mortalities each year along with other impacts remain a threat to the survival and recovery of this species and could slow recovery green, Kemp's ridley, hawksbill, leatherback and Northwest Atlantic loggerhead sea turtles.

8 Effects of the Proposed Actions

Pursuant to section 7(a)(2) of the ESA, federal agencies must insure, through consultation with NMFS, that their activities are not likely to jeopardize the continued existence of any ESA-listed species or result in the destruction or adverse modification of critical habitat. The proposed use of the *Langseth* and issuance of the incidental harassment authorization by the Permits and Conservation Division for "takes" of marine mammals during the seismic studies would expose ESA-listed species to seismic airgun pulses, as well as sound emitted from a multi-beam bathymetric echosounder and sub-bottom profiler and other stressors. In this section, we describe the potential physical, chemical, and biotic stressors associated with the proposed actions, the probability of individuals of ESA-listed species being exposed to these stressors, and the probable responses of those individuals (given probable exposures) based on the best scientific and commercial evidence available. As described in the *Approach to the Assessment* section, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment would thenconsider the risk posed to the viability of the population(s) those individuals comprise and to the ESA-listed species those populations represent. The purpose of this assessment and, ultimately, of the Opinion is to determine if it is reasonable to expect the proposed action to have effects on ESA-listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral and physiological disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences. The proposed action would authorize non-lethal "takes" by harassment as defined by the MMPA of ESA-listed species during seismic survey activities. The ESA neither defines harassment nor has the NMFS defined the term pursuant to the ESA through regulation. The MMPA defines harassment as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal population in the wild or has the potential to disturb a marine mammal or marine mammal population in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [16 U.S.C. 1362(18)(A)]. The latter portion of this definition (that is, "... causing disruption of behavioral patterns including... migration, breathing, nursing, breeding, feeding, or sheltering") is similar to the US Fish and Wildlife Service's regulatory definition of "harass"[6] pursuant to the ESA. For this Opinion, we define harassment similarly: an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents.

Our analysis considers that behavioral harassment or disturbance is not limited to the 160 dB acoustic "take" definition for marine mammals and may in fact occur in many ways. Fundamentally, if our analysis leads us to conclude that an individual changes its behavioral state (for example, from resting to traveling away from the airgun source or from traveling to evading), we consider the individual to have been harassed or disturbed, regardless of whether it has been exposed to acoustic sources at levels that define "take" as long as it creates the probability of injury. In addition, individuals may respond in a variety of ways, some of which have more significant fitness consequences than others. For example, quick evasion of a seismic source would be more significant than slow travel away from the same stressor due to increased metabolic demands, stress responses, and potential for calf abandonment that this response could or would entail. As described in the *Approach to the Assessment*, the universe of likely responses is considered in evaluating the fitness consequences to the individual and (if appropriate), the affected population and species as a whole to determine the likelihood of jeopardy.

8.1 Potential Stressors

The assessment for this consultation identified several possible stressors associated with the proposed seismic activities, including:

1. pollution by oil or fuel leakage;
2. acoustic interference from engine noise;
3. ship-strikes;
4. entanglement in towed hydrophone cable;
5. sound fields produced by airguns;
6. sub-bottom profiler, multibeam echosounder, or ADCP;

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6 An intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3)

7. OBS release signals; and
8. land-based explosions.

Stressors Not Considered Further in this Opinion

Based on a review of available information, we determined which of these possible stressors would be likely to occur and which would be discountable or insignificant.

The potential for fuel or oil leakages is extremely unlikely. The former would likely pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately, to the extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the *Langseth* or its smaller counterparts is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the vessel) that would expose ESA-listed species directly or their food sources. Given this, we expect that oil leakages to be discountable, and they will not be considered further in this Opinion.

Vessel noise has the potential to affect ESA-listed species. The propulsion system of the *Langseth* is designed to be very quiet compared to other vessels to reduce interference with seismic activities. The *Endeavor* and chase vessel are not designed with these features. Although noise originating from vessel propulsion will propagate into the marine environment, this amount would be small, particularly in comparison to the amount of vessel noise normally encountered within this region. The *Langseth* will be traveling at generally slow speeds (7.8-8.3 km/h), reducing the amount of noise produced by the propulsion system. The *Endeavor* will frequently stop or move short distances at relatively slow speeds. The chase vessel's role is to assist these vessels and is also expected to remain at slow speed, as it will typically be stationed relative to the *Langseth*. The *Langseth'*s, *Endeavor*'s, or chase vessel's passage past a whale or sea turtle would be brief and not likely to be significant in impacting any individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of whales to move away from vessels, either as a result of engine noise, the physical presence of the vessel, or both (Lusseau 2006). Given this, we expect that engine noise to be insignificant, and they will not be considered further in this Opinion.

Ship-strike of ESA-listed species is a possibility whenever vessels are used. The slow speed of the *Langseth*, *Endeavor*, and chase vessel reduces the possibility of a ship-strike by this vessel (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Our expectation of ship strike is sufficiently small to be discountable due to the hundreds of thousands of kilometers the *Langseth* and *Endeavor* have traveled without a ship strike, general expected movement of marine mammals away or parallel to the *Langseth* and chase vessel, as well as the generally slow movement of the *Langseth* and chase vessel during most of its travels (Hauser and Holst 2009; Holst 2009; Holst 2010; Holst and Smultea 2008a). Therefore, ship-strikes are not likely to adversely affect ESA-listed species and are not considered further in this Opinion.

ESA-listed species could interact directly with the towed hydrophone streamers and these interactions have been documented. An example of an interaction with a seismic survey occurred during a 2011 survey in the eastern tropical Pacific. During this survey, a dead olive ridley sea turtle was recovered from the foil of towed seismic gear; it is unclear whether the sea turtle became lodged in the foil pre- or post mortem (Spring 2011). Observations of sea turtles investigating streamers and not becoming entangled is also available (Hauser et al. 2008; Holst and Smultea 2008a; Holst et al. 2005a; Holst et al. 2005b). Although the towed hydrophone streamers could come in direct contact with an ESA-listed species, entanglements are highly unlikely and considered highly improbable based upon investigation into the use of these devices during the activities of other oceanographic activities. Given this, we expect that the risk of entanglement in towed hydrophone cable so low as to be discountable, and they will not be considered further in this Opinion. Therefore, it is not likely to adversely affected ESA-listed species and will not be considered further in this Opinion.

OBSs will release from the ocean floor via acoustic signals exchanged with the *Endeavor*. Although these signals are expected to be audible to ESA-listed whales, we do not expect whales to respond to these signals. The transmissions are also expected to be so brief as to not risk masking other acoustic information relevant to ESA-listed whales. Given this, we expect that OBS interrogation transmissions to be insignificant, and they will not be considered further in this Opinion. Therefore, OBS signals are not likely to adversely affected ESA-listed species and will not be considered further in this Opinion.

Land-based detonations of charges are planned as part of the seismic survey. Two of these will occur within a few kilometers of estuarine and/or marine habitats where ESA-listed sea turtles may be found. The NSF provided documentation in addition to their environmental assessment on the expected dissipation of energy through the ground that may potentially reach areas where these species may occur. Based upon this, the levels of energy reaching estuarine and/or marine environments (<0.2 inches per second peak particle velocity) would either be unlikely to be discernable above baseline sound levels or be so low as to not elicit a response in individual sea turtles that are exposed. Given this, we expect that land-based detonations to be insignificant, and they will not be considered further in this Opinion. Therefore, it is not likely to adversely affected ESA-listed species and will not be considered further in this Opinion.

Stressors Considered Further in this Opinion

This consultation focused on the following stressors produced by the proposed seismic activities that are likely to adversely affect ESA-listed species: (1) acoustic energy introduced into the marine environment by the airgun array; and (2) acoustic energy introduced by both the sub-bottom profiler, multibeam echosounder sonars, and ADCP.

8.2 Exposure Analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the action area in space and time and identify the nature of that co-occurrence. The *Exposure Analysis* identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions' effects and the population(s) or subpopulation(s) those individuals represent.

The Permits and Conservation Division applies acoustic thresholds to help determine at what point during exposure to seismic airguns (and other acoustic sources) marine mammals are "harassed," under the MMPA. For this consultation, we adopted the same thresholds to estimate the number of exposures ESA-listed marine mammals (i.e., blue, sei, fin, humpback, North Atlantic right, and sperm whales) that would be exposed to seismic airguns at a level that would be harassment under the ESA. These thresholds help to develop exclusion radii around a source and the necessary power-down or shut-down criteria. Our exposure analysis for green, hawksbill, leatherback, loggerhead, and Kemp's ridley sea turtles assumed that exposure to received levels greater than 166 dB re 1 μPa_{rms} would result in "take" by harassment pursuant to the ESA.

The NSF and NMFS's Permits and Conservation Division estimated the number of ESA-listed whales exposed to received levels ≥160 dB re 1 μPa_{rms}. This method was based upon the product of animal density and ensonified area. The ESA Interagency Cooperation Division and Permits and Conservation Division identified an additional data source and method to estimate the number of ESA-listed marine mammals and sea turtles that would be exposed to received levels that we would consider take (≥160 dB re 1 μPa_{rms} for marine mammals and 166 dB re 1 μPa_{rms} for sea turtles). We present each approach below, as well as their relative strengths, weaknesses, and resulting take estimates. Maximum radii associated with seismic airgun isopleth modeling were established at the maximum diving depth for listed species (2,000 m). As all other ESA-listed species do not dive to this depth and, for those that do, we expect that individuals will rarely be found at this depth, the isopleth distance from the source array is likely to overestimate the exposure ESA-listed individuals are expected to experience.

Although the action area includes the region ensonified by airguns to the point which the anthropogenic sound decreases to ambient levels, we expect part of this area to have more significant effects. We expect responses to seismic sound sources by ESA-listed marine mammals occur within the 160 dB re 1 μPa_{rms} isopleths (modeled to be up to 1.097, 0.675, or 0.45 km from the *Langseth*'s 18-airgun array in shallow, intermediate, and deep water depths, respectively; 5.780, 8.67, or 22.6 km from the *Langseth*'s 36-airgun array in shallow, intermediate, and deep water depths, respectively). This increases the area ensonified to at least 160 dB re 1 μPa_{rms} along the trackline to roughly 63,367 km^2 total (13867 km^2 in shallow, 6,159 km^2 in intermediate, and 43,341 km^2 in deep water depths, respectively).

We expect responses to seismic sound sources by ESA-listed sea turtles occur within the 166 dB isopleths. This was modeled to be 6.95 km in shallow, 3.291 km in intermediate, and 2.194 km in deep water depths from the *Langseth*'s seismic array, respectively, for the 18-airgun array and 11.1 km in shallow, 5.61 km in intermediate, and 3.74 km in deep water depths, respectively for the 36-airgun array. This increases the area ensonified to at least 166 dB re 1 μPa_{rms} along the trackline to 4,666 km^2 in shallow, 1,993 km^2 in intermediate, and 17,304 km^2 in deep water depths, respectively (23,963 km^2 total). The transect lines are generally not close to one another, meaning that very few areas will be re-ensonified at high levels multiple times. We also assessed the transit to and from port for potential effects.

Evaluation of density data

The NSF (for humpback, fin, and sperm whales), NMFS's Permits and Conservation Division (for humpback and sperm whales), as well the ESA Interagency Cooperation Division (for humpback and sperm whales) used data from the Navy Operating Area density estimates detailed in DoN (2007), which are based upon NMFS Northeast and Southeast regional sighting surveys from 1998-2007 conducted during the same seasons (spring and/or summer) as the proposed seismic survey. The NSF imported a shapefile of the study area into the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) online database to estimate marine mammal densities in the action area. The NSF overlaid the seismic survey study area to overlap where OBIS-SEAMAP provided density estimates and calculated a mean density for this area for each marine mammal species expected to occur in the study area. Fall data were selected and separate density estimates were developed for shallow, intermediate, and deep regions by importing shapefiles for these respective regions into OBIS-SEAMAP. Densities are the mean values within each region.

Strengths in OBIS-SEAMAP approach include:

- Substantially higher density resolution based exclusively upon data obtained from robustly designed biological surveys through the region conducted over extended periods (Best et al. 2012; Ropert-Coudert et al. 2010).
- Allows for calculation of mean and variance based upon a larger data sample size.
- Uses relatively robust habitat modeling in addition to the direct sighting data it incorporates.
- The modeling process produces sharp changes in density in some locations that are not expected based upon species occurrence, but rather are artifacts of habitat modeling components of OBIS-SEAMAP. However, these are not as apparent in the study area as in locations outside this region (these artifacts are much more apparent in the other approach we evaluated).

Weaknesses in the OBIS-SEAMAP approach include:

- Does not extend beyond the U.S. EEZ, where a small fraction of the seismic survey track line occurs.
- Little survey effort is incorporated into OBIS-SEAMAP through much of the study area, which makes up a major component of data used to determine overall density (Ropert-Coudert et al. 2010).
- The NSF included the area within the U.S. EEZ that overlapped a broad "study area" in calculating density estimates. Although this increases the region considered in calculating density and reduces variance associated with small area sample size incorporating relatively high or low regions that can unnaturally skew overall estimates, it also incorporates area that is not necessarily a part of the action area.

For blue, North Atlantic right, and sei whales, the NSF did not appear to use an OBIS-SEAMAP density estimate, but (for blue and North Atlantic right whales) assumed individuals would not be present to be exposed or (for sei whales), assumed that a single individual would be exposed.

The ESA Interagency Cooperation Division and Permits and Conservation Division identified an additional density data source worth consideration. As part of its environmental compliance efforts, the U.S. Navy developed the Navy Marine Species Density Database (NMSDD) that were ultimately adopted by both the ESA Interagency Cooperation Division and Permits and Conservation Division as density estimates for blue, fin, sei, and North Atlantic right whales. This database utilizes the same data incorporated into OBIS-SEAMAP, and additional habitat-based modeling datasets that provide density estimates that encompass the entire action area of the proposed seismic survey. We worked with the NMFS's Permits and Conservation Division during technical assistance to develop an analytical approach to determining density using NMSDD data.

Although the data themselves are not available for this consultation to allow for reproducing the outputs, these data and the NMSDD outputs of them have been evaluated and incorporated into U.S. Navy actions consulted on by the ESA Interagency Cooperation Division, where agreement with the U.S. Navy has allowed for close inspection and analysis. A technical report detailing the analytical process by which NMSDD density estimates were determined, as well as output maps of the densities themselves for the seismic survey action area are also available (http://aftteis.com/DocumentsandReferences/AFTTDocuments/SupportingTechnicalDocuments.aspx). The NMSDD database also models density for all ESA-listed whale species expected to occur in the area ensonified to 160 dB re 1 μPa$_{rms}$, including those that were not available or conducted through OBIS-SEAMAP. Leatherback, loggerhead, Kemp's ridley, and hardshell (green and hawksbill) sea turtle density data were also available for analysis.

As the data themselves were not available for independent modeling, we used the maps generated for each species (available on a monthly, seasonal, or annual basis, depending upon species) (Figure 10). We used the season (September represents summer and October represents fall in NMSDD maps) that would yield the highest density estimate for each species, respectively, for density estimates. For NMSDD density maps estimated on a monthly rather than seasonal basis, we used the map that would produce the highest density of all possible months that the trackline could be undertaken so that exposure and subsequent effects would not be underestimated. Maps were downloaded and georeferenced in ArcGIS 10.2. We then imported shape files, provided by the NSF, for the 160 (marine mammals) and 166 (sea turtles) dB re 1 μPa$_{rms}$ isopleth around the planned seismic survey trackline. This was overlaid onto the georeferenced NMSDD map for each species. The maps with ensonified area were then divided into three components representing area ensonified in shallow, intermediate, and deep water depths, respectively. For each, the ensonified area was divided into 12 segments and the darkest color (corresponding to a density range) was identified in each. The minimum and maximum values within the ranges were used to generate mean densities for these segments in shallow, intermediate, and deep locations. The Permits and Conservation Division used the lowest in the range to estimate density within action area. Because using the minimum values risks underestimating the effect of the action, the ESA Interagency Cooperation Division used the highest values within the ranges while the ensonified area so as not to underestimate exposure or effect of the action. Within this ensonified region, the highest density estimated to occur was determined and that density assigned as the expected density for the species.

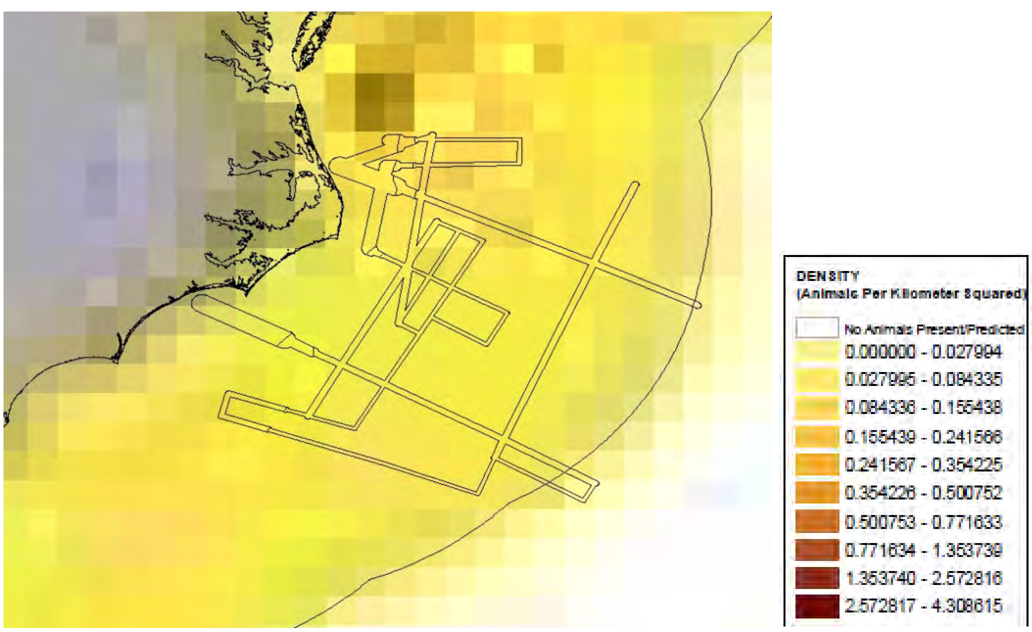

Figure 10. NMSDD summer loggerhead sea turtle density estimate map georeferenced in ArcGIS 10.2 with area ensonified to at least 166 dB re 1 μPa$_{rms}$. Color shades (lightest to

darkest) represent ranges of increasing density modeled within 10-40 km^2 squares from NMSDD.

Strengths in the NMSDD approach include:

- All ESA-listed species of concern in this consultation are part of the database (marine mammals and sea turtles).
- More recent estimates of sightability and detectability of marine mammals.
- Although both datasets rely upon the same modeled data from within the U.S. EEZ, the NMSDD modeling extends density estimates through the entire ensonfieid area.
- By assigning the highest value in a given range to a segment estimate, we do not risk underestimating the potential density and subsequent exposure or take given this density uncertainty.

Weaknesses in the NMSDD approach include:

- The U.S. Navy itself expressed opinion that use of the NMSDD maps alone was not appropriate in a recent ESA Section 7 consultation on another similar project.
- The spatial resolution of the maps is gross (10-40 km^2 and likely somewhat more due to the use of PDF maps) and could result in more subjectivity in the analysis.
- Density estimates outside the U.S. EEZ frequently show a sharp density gradient compared to values inside the U.S. EEZ. This is an artifact of the modeling process and is unlikely to reflect actual density.
- A degree of subjectivity is inherent in differentiating different color shades corresponding to density ranges on NMSDD maps, as shades can be difficult to distinguish at times.
- Map densities are represented as value ranges (generally two-to four fold difference between high and low values within a range) as opposed to pixel-based single value estimates, making estimates less accurate than OBIS-SEAMAP values in the U.S. EEZ.

We considered both approaches to estimate the number of ESA-listed animals that might be exposed to the seismic survey in this analysis.

The NSF estimated the exposure radii around the proposed *Langseth* operations using empirical data gathered in the Gulf of Mexico in 2007-2008 aboard the *Langseth* and modeling based upon these data. The maximum distances from airguns where received levels might reach 160 and 166 dB re 1 μPa_{rms} (single airgun, 18-airgun array, and 36-airgun array) at 2,000 m depth (maximum depth at which ESA-listed species are expected to occur) in shallow, intermediate, and deep water at 6 and/or 9 m tow depth are summarized in Table 1 on page 11. A thorough review of available literature (see *Response Analysis*) supports these as average received levels at which baleen whales and sea turtles tend to show some avoidance response to received seismic sound.

The NSF's assumption that individuals will move away if they experience sound levels high enough to cause significant stress or functional impairment is also reasonable (see *Response Analysis*). Isopleth modeling tends to overestimate the distance to which various isopleths will propagate and expose ESA-listed individuals because most exposure will likely occur at depths shallower than 2,000 m, where received sound levels should be reduced (see Figures 2 and 3). Because we are unable to know where individuals will be in the water column at the time of exposure, we accept this assumption. In addition, the 160 and 166 dB re 1 μPa_{rms} radius will not always reach these distances, as shorter radii will occur during the use of smaller numbers of airguns (e.g., the use of a single airgun during power-down procedures).

Visual monitoring as a mitigation measure

A major mitigation factor proposed by the NSF (and L-DEO) is visual monitoring, especially for marine mammals, which should reduce exposure of ESA-listed whales and sea turtles at levels sufficient to cause sound harassment (160 and 166 dB dB re 1 μPa_{rms}, respectively). However, visual monitoring has several limitations. Although regions ensonified by 160, 166, 177, and 180 dB re 1 μPa_{rms} propagation distances are mostly within the visual range of the *Langseth* and its observers, it is unlikely that all ESA-listed species are easily visible at the surface at these distances. On their own, power-down and shut-down procedures are unlikely to be completely effective at eliminating the co-occurrence of listed individuals within the sound field ≥160 dB re 1 μPa_{rms}. Other measures such as vessel turns and minimizing airgun source levels, seek to further minimize exposure at certain levels of sound protected species will experience. Ramp-up was effective in reducing hearing-related effects in sonar systems (Von Benda-Beckmann et al. 2014) and we also expect reduced or less intense exposure in application of airgun ramp-up. When combined with the other proposed mitigation and monitoring measures, we conclude that the probability of listed individuals being exposed to the sound field ≥160dB re 1 μPa_{rms} is reduced by the use of ramp-ups and shut-downs, although we cannot quantify by how much. Vessel platforms are subject to some limitations such as that even under good sighting conditions observers have limited ability to sight and identify protected species during their brief time at the surface. Vocalizations by protected species will also help in identifying the presence of cetaceans in the action area. PAM will only detect the presence of marine mammals if they vocalize. Further ability to identify bearing, distance, and abundance is limited.

Re-exposure

For all ESA-listed species, the NSF provided a rationale in its environmental assessment for their assumption that each exposure would generally be a unique animal rather than re-exposure of the same animal multiple times. This rationale is that there is little overlap in one trackline's ensonified area with another (the amount of area ensonified with overlap is somewhat less than twice the area without overlap, largely due to re-shooting the same trackline with the same airgun array). NSF considered this to mean that a very limited potential of re-ensonifying the same location within the survey area exists.

It is reasonable to expect, based upon review of observed effects of seismic sound exposure to marine mammals that some individuals will move a distance of several hundred to tens of kilometers away due to individual or situational sensitivity or other rationale for why whales move (ex. feeding, migration, or breeding opportunities unrelated to effects of the proposed action). As such, it is reasonable to expect that some individuals will receive a single exposure and vacate the action area by moving away from the immediate area of the sound field. Other individuals may move, but to locations where re-exposure could occur, either due to the direction or short distance they travel. Observations from previous seismic surveys support the likelihood that individuals will be re-exposed is very low, if at all. We also expect that at least some individuals would return to the area once the seismic activity has ceased. We expect the only occasions when re-exposure may occur is when individuals move away and happen to place themselves on another portion of the seismic survey trackline. This is particularly significant given that marine mammals tend to return to specific areas for foraging and breeding, or use particular migratory corridors. However, based upon observations from previous seismic surveys and our professional judgment, the likelihood that individuals will be re-exposed several times is low. We consider this is unlikely to happen in other than random, rare cases and we expect the vast majority of animals would only be exposed once. We also considered that ESA-listed whales would likely be generally migrating or traveling through the region and not consistently occurring in the same place. For those that do remain in place (potentially individuals socializing or pursuing foraging opportunities), these individuals will also, in most cases, be moving with relatively constant and rapid current features. The *Langseth*, however, will utilize GPS technology to follow the exact path in reshooting lines. This means that animals would, actively, or passively through drift, move from their previous location and not be re-exposed in the same way they were initially. However, given that some locations within the region may be ensonified to levels that may cause biologically-meaningful responses (160 dB dB re 1 μPa_{rms} or higher) up to three times, we expect that a single individual may be exposed up to three times to this level or higher.

The Permits and Conservation Division articulated a separate interpretation of re-exposure that is reflected in their estimates. Several seismic tracklines hundreds of kilometers long will be transected with active airgun arrays a second time as a part of the proposed seismic survey, anywhere from a few hours to several days after the initial transect. The Permits and Conservation Division acknowledges that this will likely involve additional exposure, but not necessarily to the same individuals that were previously exposed. To account for this re-exposure to the same individuals, the Permits and Conservation Division multiplied the area ensonified to at least 160 dB re 1 μPa_{rms} excluding areas of overlap (roughly 23,000 km^2 less than the area with overlap) times density for a given species. The Permits and Conservation Division then assumed that 25% of the individuals that received an initial exposure would be re-ensonified to at least 160 dB re 1 μPa_{rms} (75% of the individuals would vacate the ensonified region, either due to natural or anthropogenic factors). This is based upon study of mysticetes off the U.S. west coast (Barlow et al. 2009) and similar assumptions made in association with a seismic survey that was proposed to be undertaken there (Wood et al. 2012). The Permits and Conservation Division multiplied the initial number of exposures it calculated by 0.54 to calculate the number of exposures in the area excluding overlap and then that number by 1.25, rounded that value to the next whole number, to identify the number of individuals it expects to be ensonified to at least 160 dB re 1 μPa_{rms} during the proposed seismic survey. Rounding was not done for North Atlantic right whales due to additional mitigation measures in place for that species.

Marine Mammals

Exposure of Listed Mammals to Airguns. NSF exposure estimates (Table 24), Permits and Conservation Division exposure estimates (reflecting only number of individuals exposed; Table 25), and ESA Interagency Cooperation Division (reflecting number of total exposures; Table 26) were calculated by using the density per 1,000 km^2 in shallow, intermediate, and deep water depths, respectively. These densities were multiplied by the ensonified area in the same respective depth categories (9,735 km^2 in shallow, 4,066 km^2 in intermediate, and 27,167 km^2 in deep water ensonified to the 160 dB re 1 μPa_{rms} level excluding overlap; 13,867 km^2 in shallow, 6,159 km^2 in intermediate, and 43,341 km^2 in deep water ensonified to the 160 dB re 1 μPa_{rms} level including overlap) to obtain the total number of exposures (rounded to the next whole number). Based upon the quality of the data, the ESA Interagency Cooperation Division believes that the use of OBIS-SEAMAP density data is appropriate to use for humpback and sperm whales and the use of NMSDD density data is appropriate for blue, fin, sei, and North Atlantic right whales. Therefore, we used the same density estimates as the Permits and Conservation Division in determining exposure estimates greater than 160 dB re 1 μPa_{rms}.

Table 23. Estimated exposure of ESA-listed whales to sound levels $\geq$160 dB re 1 μPa_{rms} during the proposed seismic activities developed from OBIS-SEAMAP and group size data provided by the NSF.

Whale density per 1,000 km^2	# of exposures to listed whales	# of whales exposed to proposed activities	Population size	% of population exposed	Population/ location
Blue-n/a	1[1]	Up to 1	440	Up to 0.23%	Northwest Atlantic[2]
Fin-0.01	1	Up to 1	3,522	Up to 0.03%	Northwest Atlantic[2]
Sei-n/a	0	Up to 0	357	Up to 0.00%	Nova Scotia stock[2]
Humpback-0.68 (<100 m), 0.56 (100-1,000 m), 1.06 (>1,000 m)	60	Up to 60	11,600	Up to 0.52%	Northwestern Atlantic[3]
North Atlantic right-n/a	0	Up to 0	455	Up to 0.00%	North Atlantic[1]
Sperm-0.06 (<100 m), 0.98 (100-1,000 m), 3.07 (>1,000 m)	144	Up to 144	13,190	Up to 1.09%	Northeast Atlantic, Faroe Islands, Iceland, and northeastern U.S. coast[4]
Total	206	--	--	--	--

[1] *Based upon group size*
[2] *Waring et al. (2014)*
[3] *IWC (2014)*
[4] *Whitehead (2002)*

Table 24. Estimated exposure of ESA-listed whales to sound levels $\geq$160 dB re 1 μPa_{rms} during the proposed seismic activities developed from OBIS-SEAMAP and NMSDD data provided by the Permits and Conservation Division. Number of exposures reflect number of individuals exposed.

Whale density per 1,000 km^2	# of exposures to listed whales	Population size	% of population exposed	Population/ location
Blue-0.003 (<100 m), 0.02 (100-1,000 m), 0.04 (>1,000 m)	3	440	Up to 0.68%	Northwest Atlantic[1]
Fin-0.978 (<100 m), 0.477 (100-1,000 m), 0.143 (>1,000 m)	19	3,522	Up 054%	Northwest Atlantic[1]
Sei-1.687 (<100 m), 2.244 (100-1,000 m), 2.195 (>1,000 m)	98	357	Up 27.45%	Nova Scotia stock[1]
Humpback-6.387 (<100 m), 6.387 (100-1,000 m), 6.387 (>1,000 m)	44	11,600	Up to 0.38%	Northwestern Atlantic[2]
North Atlantic right-0.134 (<100 m), 0.006 (100-1,000 m), 0.001 (>1,000 m)	5	455	Up to 1.10%	North Atlantic[1]
Sperm-18.998 (<100 m), 18.998 (100-1,000 m), 18.998 (>1,000 m)	91	13,190	Up to 0.69%	Northeast Atlantic, Faroe Islands, Iceland, and northeastern U.S. coast[3]

Whale density per 1,000 km^2	# of exposures to listed whales	Population size	% of population exposed	Population/ location
Total	260	--	--	--

[1] *Waring et al. (2014)*
[2] *IWC (2014)*
[3] *Whitehead (2002)*

Table 25. Estimated exposure of ESA-listed whales to sound levels $\geq$160 dB re 1 μPa_{rms} during the proposed seismic activities developed from OBIS-SEAMAP and NMSDD data conducted by the ESA Interagency Cooperation Division.

Whale density per 1,000 km^2	# of exposures to listed whales	# of whales exposed to proposed activities	Population size	% of population exposed	Population/ location
Blue-0.01 (<100 m), 0.02 (100-1,000 m), 0.04 (>1,000 m)	2	Up to 2	440	Up to 0.45%	Northwest Atlantic[1]
Fin-1.57 (<100 m), 0.72 (100-1,000 m), 0.47 (>1,000 m)	47	Up to 47	3,522	1.33%	Northwest Atlantic[1]
Sei-2.42 (<100 m), 3.19 (100-1,000 m), 3.12 (>1,000 m)	189	Up to 189	357	Up 52.94%	Nova Scotia stock[1]
Humpback-6.387 (<100 m), 6.387 (100-1,000 m), 6.387 (>1,000 m)	405	Up to 405	11,600	Up to 3.49%	Northwestern Atlantic[2]
North Atlantic right-7.27 (<100 m), 0.017 (100-	102	Up to 102	455	Up to 22.42%	North Atlantic[1]

Whale density per 1,000 km^2	# of exposures to listed whales	# of whales exposed to proposed activities	Population size	% of population exposed	Population/ location
1,000 m), 0.006 (>1,000 m)					
Sperm-18.998 (<100 m), 18.998 (100-1,000 m), 18.998 (>1,000 m)	1,204	Up to 1,204	13,190	Up to 8.64%	Northeast Atlantic, Faroe Islands, Iceland, and northeastern U.S. coast[3]
Total	1,588	--	--	--	--

[1] *Waring et al. (2014)*

[2] *IWC (2014)*

[3] *Whitehead (2002)*

Whales of all age classes are likely to be exposed. Based upon our understanding of ESA-listed whale life history presented in the *Status of Listed Resources*, ESA-listed whales are expected to be feeding, traveling, or migrating in the area and some females would have young-of-the-year accompanying them. We would normally assume that sex distribution is even for whales and sexes are exposed at a relatively equal level. However, sperm whales in the area likely consist of groups of adult females and their offspring and generally consist of more females than males in the group. Therefore, we expect a female bias to sperm whale exposure. Exposure to adult males is expected to be much lower than to other age and sex class combinations.

Exposure of ESA-listed whales to multibeam echosounder, sub-bottom profiler, and ADCP.

Three additional acoustic systems will operate during the proposed *Langseth* cruise, as well as from the chase vessel: the multibeam echosounder, sub-bottom profiler, and the ADCP. These systems have the potential to expose listed species to sound above the 160 dB re 1 μPa_{rms} threshold. All systems operate at generally higher frequencies than airgun operations (10.5-13 kHz for the multibeam echosounder, 3.5 kHz for the sub-bottom profiler, and 70 kHz for the ADCP). As such, their frequencies will attenuate more rapidly than those from airgun sources. Listed individuals would experience higher levels of airgun noise well before either multibeam echosounder, sub-bottom profiler, or ADCP noise of equal amplitude would reach them. When airguns are not operational, sonars would still be active while not transiting to or from port. For sonars that are audible, the slow movement of the Langseth and continuous operation of the sonars would alert ESA-listed whales to the vessel's presence and, if the Langseth approaches more closely, continually serve as a notice of the vessel's movement. As with airguns, if received sound levels begin to reach levels that are physiologically challenging, we expect a stress response may be initiated and animals to move away.

As with the *Langseth*, the chase vessel and *Endeavor* are expected to avoid close whale approaches, which reduces the chance of exposure to high levels of sonar emissions as well. While airguns are not operational, marine mammal observers will remain on duty to collect sighting data. If ESA-listed whales were to closely approach the vessel, the *Langseth* would take evasive actions to avoid a ship-strike as well as lessen exposure to very high source levels. We rule out high-level ensonification of listed whales (multibeam echosounder source level = 242 dB re 1 μPa_{rms}; ADCP source level <224 dB re 1μPa · m; sub-bottom profiler source level = 204 dB re 1 μPa_{rms}). Boebel et al. (2006) and Lurton and DeRuiter (2011) concluded that multibeam echosounders and sub-bottom profilers similar to those to be used during the proposed activities presented a low risk for auditory damage or any other injury, and that an individual would require exposure to 250–1,000 pulses from a sub-bottom profiler to be at risk for a temporary threshold shift (TTS). To be susceptible to TTS, a whale would have to pass at very close range and match the vessel's speed; we expect a very small probability of this during the proposed study. An individual would have to be well within 100 m of the vessel to experience a single multibeam echosounder pulse that could result in TTS (LGL Ltd. 2008). The same result could only occur at even closer ranges for sub-bottom profiler signals, because the signals are weaker. Furthermore, we expect both multibeam echosounder and sub-bottom profiler systems to operate continuously with duty cycles of 1-20 s. It is possible, however, that some small number of listed whales (fewer than those exposed to airguns) could experience low-level multibeam echosounder, sub-bottom profiler, and/or ADCP sound. We are unable to quantify the level of exposure, but do not expect any exposure to result to occur at high levels.

Sea Turtles

Exposure of ESA-listed turtles to airguns. The NSF did not estimate the number or extent of exposure that would be expected for sea turtle species. We attempted to estimate exposure using the NMSDD density data maps previously described for whales and applied the same analytical process. However, we used the area ensonified to the 166 dB re 1 μPa_{rms} level instead of the 160 dB re 1 μPa_{rms} level (McCauley et al. 2000a; McCauley et al. 2000b). Based upon information presented in the *Response Analysis*, we expect all exposures at the 166 dB re 1 μPa_{rms} level and above to constitute "take" for sea turtles, not 160 dB re 1 μPa_{rms} as for whales. Also, NMSDD did not identify density for green or hawksbill sea turtles, as these species are difficult to differentiate at sea. NMSDD density estimates group green and olive ridley (not expected to occur in the action area), hawksbill sea turtles as "hardshell turtles" as a common estimate. We used the density value calculated for "hardshell sea turtles" to determine density for hawksbill and green sea turtles. We assigned a 11/13th proportion of exposures to green sea turtles and 2/13th proportion to hawksbill sea turtles based upon the number of species-specific sightings in the study area during the same season as the proposed action. It is also important to note that NMSDD sea turtle density modeling does not extend as far offshore as it does for whales in NMSDD.

These exposure estimates were calculated by using the density per 1,000 km^2 multiplied by the total survey track area (6,073 km^2 in shallow, 2,548 km^2 in intermediate, and 23,552 km^2 in deep water depths, respectively, ensonified to at least the 166 dB re 1 μPa_{rms} level including overlap) to obtain the total number of exposures (rounded to the next whole number).

Although we considered this analysis, we ultimately determined that the density data upon which the analysis was either not available or should not be used. In seaward potions of the action area, data are not available. Here, habitat fundamentally different (associated with the Gulf Stream and its features) than the nearshore habitat where data were available. For areas where data are available, sighting data are not considered robust enough to warrant their use.

Instead, we considered the area over which the action would take place and, particularly, the area expected to be ensonified to at least the 166 dB re 1 μPa_{rms} level (32,173 km^2). We believe that an unknown number of sea turtles will occur here, likely ranging from a few hundred to a few thousand individuals (based upon sighting, stranding, and bycatch data) of green, Kemp's ridley, leatherback, and loggerhead sea turtles, as well as lesser numbers of hawksbill sea turtles. Based upon similar rationale as articulated in the Re-exposure section above, a few individuals may be re-exposed up to three times.

We do not expect sound generated by the proposed action to expose eggs on land or hatchlings in water because we do not expect these life stages to be present in the action area. However, the *Status of Listed Resources* section identifies the oceanic environment of the North Atlantic as an important developmental habitat for juveniles and subadults of all sea turtle species and we expect these to occur in the action area. In addition, adult life stages of all species are expected to be exposed to sound. For sea turtle species that have been studied, a skewed sex distribution biased towards females versus males exists. As such, we expect more female sea turtles of all species to be exposed than males.

Exposure of listed turtles to multibeam echosounder, sub-bottom profiler, and ADCP. As with baleen whales, sea turtles hear in the low frequency range. The multibeam echosounder operates at 10.5-13 kHz, the sub-bottom profiler at 3.5 kHz, and the ADCP at 75 kHz, all of which are frequencies outside the hearing range of sea turtles. Thus, while sea turtles may be exposed to multibeam echosounder, sub-bottom profiler, or ADCP emissions, we do not expect them to respond.

8.3 Response Analysis

As discussed in the *Approach to the Assessment* section of this Opinion, response analyses determine how ESA-listed resources are likely to respond after exposure to an action's effects on the environment or directly on ESA-listed species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might result in reducing the fitness of listed individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

Marine Mammals

Response of marine mammals to airguns. A pulse of seismic airgun sound displaces water around the airgun and creates a wave of pressure, resulting in physical effects on the marine environment that can then affect marine organisms, such as ESA-listed whales and sea turtles considered in this Opinion. Possible responses considered in this analysis consist of:

- threshold shifts,
- auditory interference (masking),
- behavioral responses, and
- non-auditory physical or physiological effects

The *Response Analysis* also considers information on the potential for stranding and the potential effects on the prey of ESA-listed whales and sea turtles in the action area.

Marine mammals and threshold shifts. Exposure of marine mammals to very strong sound pulses can result in physical effects, such as changes to sensory hairs in the auditory system, which may temporarily or permanently impair hearing. A TTS results in a temporary hearing change and depends upon the duration, frequency, sound pressure, and rise time of the sound (Finneran and Schlundt 2013). TTSs can last minutes to days. Full recovery is expected and this condition is not considered a physical injury. However, a recent mouse study has shown that although full hearing can be regained from TTS (i.e., the sensory cells actually receiving sound are normal), damage can still occur to nerves of the cochlear nerve leading to delayed but permanent hearing damage (Kujawa and Liberman 2009). At higher received levels, or in frequency ranges where animals are more sensitive, permanent threshold shifts (PTSs) can occur in which auditory sensitivity is unrecoverable. Either of these conditions can result from a single pulse or from the accumulated effects of multiple pulses, in which case each pulse need not be as loud as a single pulse to have the same accumulated effect. TTS and PTS are specific only to the frequencies over which exposure occurs.

Few data are available to precisely define each ESA-listed species' hearing range, let alone its sensitivity and levels necessary to induce TTS or PTS. Based upon captive studies of odontocetes, our understanding of terrestrial mammal hearing, and extensive modeling, the best available information supports sound levels at a given frequency would need to be ~186 dB SEL or ~196-201 dB re 1 μPa_{rms} in order to produce a low-level TTS from a single pulse (Southall et al. 2007b). PTS is expected at levels ~6 dB greater than TTS levels on a peak-pressure basis, or 15 dB greater on an SEL basis than TTS (Southall et al. 2007b). In terms of exposure to the *Langseth's* airgun array, an individual would need to be within a few meters of the largest airgun to experience a single pulse >230 dB re 1 µPa peak (Caldwell and Dragoset 2000). If an individual experienced exposure to several airgun pulses of ~190 dB re 1 μPa_{rms}, PTS could occur. A marine mammal would have to be within 100 m of the *Langseth's* airgun array to be within the 190 dB re 1 μPa_{rms} isopleth and risk a TTS. Estimates that are conservative for species protection are 230 dB re 1 µPa (peak) for a single pulse, or multiple exposures to ~198 dB re 1 $\mu Pa^2 s$.

Overall, we do not expect TTS or PTS to occur to any ESA-listed whale as a result of airgun exposure for several reasons. We expect that individuals will move away from the airgun array as it approaches. We further believe that as sound intensity increases, individuals will experience conditions (stress, loss of prey, discomfort, etc.) that prompt them to move away from the sound source and thus avoid exposures that would induce TTS. Ramp-ups will also reduce the probability of TTS exposure at the start of seismic surveys. Furthermore, mitigation measures would be in place to initiate a ramp-down if individuals enter or are about to enter the 180 dB isopleth or within 585 m during full airgun operations, which is below the levels believed to be necessary for potential TTS.

Marine mammals and auditory interference (masking). Interference, or masking, generally occurs when the interfering noise is of a similar frequency and similar to or louder than the auditory signal received by an animal processing echolocation signals or listening for acoustic information from other individuals (Francis and Barber 2013). Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues. Generally, noise will only mask a signal if it is sufficiently close to the signal in frequency. This can result in loss of environmental cues of predatory risk, mating opportunity, or foraging options (Francis and Barber 2013). Low frequency sounds are broad and tend to have relatively constant bandwidth, whereas higher frequency bandwidths are narrower (NMFS 2006h).

There is frequency overlap between airgun noise and vocalizations of ESA-listed whales, particularly baleen whales. Any masking that might occur would likely be temporary because seismic sources are not continuous and the seismic vessel would continue to transit. The proposed seismic surveys could mask whale calls at some of the lower frequencies, in particular for baleen whales but also for sperm whales. This could affect communication between individuals, affect their ability to receive information from their environment, or affect sperm whale echolocation (Evans 1998; NMFS 2006h). Most of the energy of sperm whales clicks is concentrated at 2 to 4 kHz and 10 to 16 kHz, and though the findings by Madsen et al. (2006) suggest frequencies of seismic pulses can overlap this range, the strongest spectrum levels of airguns are below 200 Hz (0-188 Hz for the *Langseth* airguns). Given the disparity between sperm whale echolocation and communication-related sounds with the dominant frequencies for seismic surveys, masking is not likely to be significant for sperm whales (NMFS 2006h). Overlap of the dominant low frequencies of airgun pulses with low-frequency baleen whale calls would be expected to pose a greater risk of effects due to masking. The *Langseth's* airguns will emit a 0.1 sec pulse when fired every 5 sec. Therefore, pulses will not "cover up" the vocalizations of listed whales to a significant extent (Madsen et al. 2002). Individuals can continue calling and be heard between airgun pulses (Nieukirk et al. 2012). We address the response of listed whales stopping vocalizations as a result of airgun sound in the *Marine mammals and behavioral responses* section below.

Although seismic sound pulses begin as short, discrete sounds, they interact with the marine environment and lengthen through processes such as reverberation. This means that in some cases, such as shallow water environments, seismic sound can become part of the acoustic background (Gedamke and McCauley 2011; Guerra et al. 2013). Few studies of how impulsive sound in the marine environment deforms from short bursts to lengthened waveforms exist, but can apparently add significantly to acoustic background (Gedamke and McCauley 2011; Guerra et al. 2013; Guerra et al. 2011), potentially interfering with the ability of animals to hear otherwise detectible sounds in their environment. Wittekind et al. (2013) estimated that blue and fin whales may have their communication range reduced by 2,000 km.

Marine mammals and behavioral responses. We expect the greatest response to airgun sounds by number of responses and overall impact to be in the form of changes in behavior. Listed individuals may briefly respond to underwater sound by slightly changing their behavior or relocating a short distance, in which case the effects are unlikely to be significant at the population level, but can equate to take. Displacement from important feeding or breeding areas over a prolonged period would likely be more significant. This has been suggested for humpback whales along the Brazilian coast as a result of increased seismic activity (Parente et al. 2007). Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012); this is reflected in a variety of aquatic, aerial, and terrestrial animal responses to anthropogenic noise that may ultimately have fitness consequences (Francis and Barber 2013). Although some studies are available which address responses of ESA-listed whales considered in this Opinion directly, additional studies to other related whales (such as bowhead and gray whales) are relevant in determining the responses expected by species under consideration. Therefore, studies from non-listed or species outside the action area are also considered here. Individual differences in responding to stressful stimuli also appear to exist and appear to have at least a partial genetic basis in trout (Laursen et al. 2011). Animals generally respond to anthropogenic perturbations as they would predators, increasing vigilance and altering habitat selection (Reep et al. 2011). Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013).

Several studies have aided in assessing the various levels at which whales may modify or stop their calls in response to airgun sound. Whales continue calling while seismic surveys are operating locally (Greene Jr et al. 1999; Jochens et al. 2006; Madsen et al. 2002; McDonald et al. 1993; McDonald et al. 1995a; Nieukirk et al. 2004; Richardson et al. 1986; Smultea et al. 2004; Tyack et al. 2003). However, humpback whale males increasingly stopped vocal displays on Angolan breeding grounds as received seismic airgun levels increased (Cerchio et al. 2014). Some blue, fin, and sperm whales stopped calling for short and long periods apparently in response to airguns (Bowles et al. 1994; Clark and Gagnon 2006; McDonald et al. 1995a). Fin whales (presumably adult males) engaged in singing in the Mediterranean Sea moved out of the area of a seismic survey while airguns were operational as well as for at least a week thereafter (Castellote et al. 2012). A blue whale discontinued calls in response to received airgun sound of 143 dB re 1 μPa for one hour before resuming (McDonald et al. 1995a). Blue whales may also attempt to compensate for elevated ambient sound by calling more frequently during seismic surveys (Iorio and Clark 2009). Sperm whales, at least under some conditions, may be particularly sensitive to airgun sounds, as they have been documented to cease calling in association with airguns being fired hundreds of kilometers away (Bowles et al. 1994). Other studies have found no response by sperm whales to received airgun sound levels up to 146 dB re 1 μPa_{p-p} (Madsen et al. 2002; McCall Howard 1999). Some exposed individuals may cease calling in response to the *Langseth's* airguns. If individuals ceased calling in response to the *Langseth's* airguns during the course of the proposed survey, the effect would likely be temporary.

There are numerous studies of the responses of some baleen whale to airguns. Although responses to lower-amplitude sounds are known, most studies seem to support a threshold of ~160 dB re 1 μPa_{rms} as the received sound level to cause behavioral responses other than vocalization changes (Richardson et al. 1995c). Activity of individuals seems to influence response (Robertson et al. 2013), as feeding individuals respond less than mother/calf pairs and migrating individuals (Harris et al. 2007; Malme and Miles 1985; Malme et al. 1984; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995c; Richardson et al. 1999b). Surface duration decreased markedly during seismic sound exposure, especially while individuals were engaged in traveling or non-calf social interactions (Robertson et al. 2013). Migrating bowhead whales show strong avoidance reactions to received 120–130 dB re 1 μPa_{rms} exposures at distances of 20-30 km, but only changed dive and respiratory patterns while feeding and showed avoidance at higher received sound levels (152–178 dB re 1 μPa_{rms}) (Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995c; Richardson et al. 1999b; Richardson et al. 1986). Responses such as stress may occur and the threshold for displacement may simply be higher while feeding. Bowhead calling rate was found to decrease during migration in the Beaufort Sea as well as temporary displacement from seismic sources (Nations et al. 2009). Bowheads were found to be less sightable during airgun exposure than at other times due to altered dive patterns (Robertson 2014). Calling rates decreased when exposed to seismic airguns at received levels of 116-129 dB re 1 μPa (possibly but not knowingly due to whale movement away from the airguns), but did not change at received levels of 99-108 dB re 1 μPa (Blackwell et al. 2013). Despite the above information and exposure to repeated seismic surveys, bowheads continue to return to summer feeding areas and when displaced, bowheads appear to reoccupy areas within a day (Richardson et al. 1986). We do not know whether the individuals exposed in these ensonified areas are the same returning or whether individuals that tolerate repeat exposures may still experience a stress response.

Gray whales respond similarly. Gray whales discontinued feeding and/or moved away at received sound levels of 163 dB re 1 μPa_{rms} (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007b; Malme and Miles 1985; Malme et al. 1984; Malme et al. 1986; Malme et al. 1988; Würsig et al. 1999; Yazvenko et al. 2007a; Yazvenko et al. 2007b). Migrating gray whales began to show changes in swimming patterns at ~160 dB re 1 μPa and slight behavioral changes at 140-160 dB re 1 μPa_{rms} (Malme and Miles 1985; Malme et al. 1984). As with bowheads, habitat continues to be used despite frequent seismic survey activity, but long-term effects have not been identified, if they are present at all (Malme et al. 1984). Johnson et al. (2007a) reported that gray whales exposed to seismic airguns off Sakhalin Island, Russia, did not experience any biologically significant or population level effects, based on subsequent research in the area from 2002–2005.

Humpback whales continue a pattern of lower threshold responses when not occupied with feeding. Migrating humpbacks altered their travel path (at least locally) along Western Australia at received levels as low as 140 dB re 1 μPa_{rms} when females with calves were present, or 8-12 km from the seismic source (McCauley et al. 2000a; McCauley et al. 1998). A startle response occurred as low as 112 dB re 1 μPa_{rms}. Closest approaches were generally limited to 3-4 km, although some individuals (mainly males) approached to within 100 m on occasion where sound levels were 179 dB re 1 μPa_{rms}. Changes in course and speed generally occurred at estimated received level of 157–164 dB re 1 μPa_{rms}. Feeding humpbacks appear to be somewhat more tolerant. Humpback whales along Alaska startled at 150–169 dB re 1 μPa and no clear evidence of avoidance was apparent at received levels up to 172 re 1 μPa_{rms} (Malme et al. 1984; Malme et al. 1985). Potter et al. (2007) found that humpbacks on feeding grounds in the Atlantic did exhibit localized avoidance to airguns. Among humpback whales on Angolan breeding grounds, no clear difference was observed in encounter rate or point of closest approach during seismic versus non-seismic periods (Weir 2008).

Observational data are sparse for specific baleen whale life histories (breeding and feeding grounds) in response to airguns. Available data support a general avoidance response. Some fin and sei whale sighting data indicate similar sighting rates during seismic versus non-seismic periods, but sightings tended to be further away and individuals remained underwater longer (Stone 2003; Stone and Tasker 2006). This has been a general observation of large whales (excluding sperm whales) for several seismic surveys off eastern Canada (Moulton and Hols 2010). Other studies have found at least small differences in sighting rates (lower during seismic activities) as well as whales being more distant during seismic operations (Moulton et al. 2006a; Moulton et al. 2006b; Moulton and Miller 2005). When spotted at the average sighting distance, individuals would have likely been exposed to ~169 dB re 1 μPa_{rms} (Moulton and Miller 2005).

Sperm whale response to airguns has thus far included mild behavioral disturbance (temporarily disrupted foraging, avoidance, cessation of vocal behavior) or no reaction. Several studies have found Atlantic sperm whales to show little or no response (Davis et al. 2000d; Madsen et al. 2006; Miller et al. 2009; Moulton et al. 2006a; Moulton and Miller 2005; Stone 2003; Stone and Tasker 2006; Weir 2008). Detailed study of Gulf of Mexico sperm whales suggests some alteration in foraging from <130-162 dB re 1 μPa_{p-p}, although other behavioral reactions were not noted by several authors (Gordon et al. 2006; Gordon et al. 2004; Jochens et al. 2006; Madsen et al. 2006; Winsor and Mate 2006). This has been contradicted by other studies, which found avoidance reactions by sperm whales in the Gulf of Mexico in response to seismic ensonification (Jochens and Biggs 2003; Jochens and Biggs 2004; Mate et al. 1994). Johnson and Miller (2002) noted possible avoidance at received sound levels of 137 dB re 1 μPa. Other anthropogenic sounds, such as pingers and sonars, disrupt behavior and vocal patterns (Goold 1999; Watkins et al. 1985; Watkins and Schevill 1975). Miller et al. (2009) found sperm whales to be generally unresponsive to airgun exposure in the Gulf of Mexico, with possible but inconsistent responses that included delayed foraging and altered vocal behavior. Displacement from the area was not observed. Winsor and Mate (2013) did not find a nonrandom distribution of satellite-tagged sperm whales at and beyond five kilometers from seismic airgun arrays, suggesting individuals were not displaced or move away from the array at and beyond these distances in the Gulf of Mexico (Winsor and Mate 2013). However, no tagged whales within five kilometers were available to assess potential displacement within five kilometers (Winsor and Mate 2013). The lack of response by this species may in part be due to its higher range of hearing sensitivity and the low-frequency (generally <188 Hz) pulses produced by seismic airguns (Richardson et al. 1995c). Sperm whales are exposed to considerable energy above 500 Hz (Goold and Fish 1998). Breitzke et al. (2008) found that source levels were ~30 dB re 1 μPa lower at 1 kHz and 60 dB re 1 μPa lower at 80 kHz compared to dominant frequencies during a seismic source calibration. Another odontocete, bottlenose dolphins, progressively reduced their vocalizations as an airgun array came closer and got louder (Woude 2013). Reactions to impulse noise likely vary depending on the activity at time of exposure – e. g., in the presence of abundant food or during sexual encounters toothed whales sometimes are extremely tolerant of noise pulses (NMFS 2006b).

For whales exposed to seismic airguns during the proposed activities, behavioral changes stemming from airgun exposure may result in loss of feeding opportunities. We expect ESA-listed whales exposed to seismic airgun sound will exhibit an avoidance reaction, displacing individuals from the area at least temporarily. We also expect secondary foraging areas to be available that would allow whales to continue feeding. Although breeding may be occurring, we are unaware of any habitat features that sperm whales would be displaced from that is essential for breeding if sperm whales depart an area as a consequence of the *Langseth*'s presence. We expect breeding may be temporarily disrupted if avoidance or displacement occurs, but we do not expect the loss of any breeding opportunities. Individuals engaged in travel or migration would continue with these activities, although potentially with a deflection of a few kilometers from the route they would otherwise pursue.

Marine mammals and physical or physiological effects. Individual whales exposed to airguns (as well as other sound sources) could experience effects not readily observable, such as stress, that can significantly affect life history.

Stress is an adaptive response and does not normally place an animal at risk. Distress involves a stress response resulting in a biological consequence to the individual. The mammalian stress response involves the hypothalamic-pituitary-adrenal axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Busch and Hayward 2009; Gregory and Schmid 2001; Gulland et al. 1999; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Thomson and Geraci 1986). These hormones subsequently can cause short-term weight loss, the liberation of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Busch and Hayward 2009; Cattet et al. 2003; Dickens et al. 2010; Dierauf and Gulland 2001b; Elftman et al. 2007; Fonfara et al. 2007; Kaufman and Kaufman 1994; Mancia et al. 2008; Noda et al. 2007; Thomson and Geraci 1986). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer et al. 2005). In highly-stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Cowan and Curry 2008; Herraez et al. 2007). The most widely-recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the hypothalamic-pituitary-adrenal axis may persist for weeks (Dierauf and Gulland 2001a). Mammalian stress levels can vary by age, sex, season, and health status (Gardiner and Hall 1997; Hunt et al. 2006; Keay et al. 2006; Romero et al. 2008; St. Aubin et al. 1996). Stress is lower in immature right whales than adults and mammals with poor diets or undergoing dietary change tend to have higher fecal cortisol levels (Hunt et al. 2006; Keay et al. 2006).

Loud noises generally increase stress indicators in mammals (Kight and Swaddle 2011b). Romano et al. (2004) found beluga whales and bottlenose dolphins exposed to a seismic water gun (up to 228 dB re 1 μPa · m_{p-p}) and single pure tones (up to 201 dB re 1 μPa) had increases in stress chemicals, including catecholamines, which could affect an individual's ability to fight off disease. During the time following September 11, 2001, shipping traffic and associated ocean noise decreased along the northeastern U.S. This decrease in ocean noise was associated with a significant decline in fecal stress hormones in North Atlantic right whales, providing evidence that chronic exposure to increased noise levels, although not acutely injurious, can produce stress (Rolland et al. 2012a). These levels returned to baseline after 24 hours of traffic resuming. As whales use hearing as a primary way to gather information about their environment and for communication, we assume that limiting these abilities would be stressful. Stress responses may also occur at levels lower than those required for TTS (NMFS 2006g). Therefore, exposure to levels sufficient to trigger onset of PTS or TTS are expected to be accompanied by physiological stress responses (NMFS 2006g; NRC 2003). As we do not expect individuals to experience TTS or PTS, (see *Marine mammals and threshold shifts*), we also do not expect any ESA-listed individual to experience a stress response at high levels. We assume that a stress response could be associated with displacement or, if individuals remain in a stressful environment, the stressor (sounds associated with the airgun, multibeam echosounder, or sub-bottom profiler) will dissipate in a short period as the vessel (and stressors) transects away without significant or long-term harm to the individual via the stress response.

Exposure to loud noise can also adversely affect reproductive and metabolic physiology (Kight and Swaddle 2011b). Premature birth and indicators of developmental instability (possibly due to disruptions in calcium regulation) have been found in embryonic and neonatal rats exposed to loud sound. In fish eggs and embryos exposed to sound levels only 15 dB greater than background, increased mortality was found and surviving fry had slower growth rates (a similar effect was observed in shrimp), although the opposite trends have also been found in sea bream. Dogs exposed to loud music took longer to digest food. The small intestine of rats leaks additional cellular fluid during loud sound exposure, potentially exposing individuals to a higher risk of infection (reflected by increases in regional immune response in experimental animals). Exposure to 12 hours of loud noise can alter elements of cardiac tissue. In a variety of factors, including behavioral and physiological responses, females appear to be more sensitive or respond more strongly than males (Kight and Swaddle 2011b). It is noteworthy that although various exposures to loud noise appear to have adverse results, exposure to music largely appears to result in beneficial effects in diverse taxa; the impacts of even loud sound are complex and not universally negative (Kight and Swaddle 2011b).

Overall, sound can produce stress responses in mammals. The degree of this response (stress or distress) drives downstream physiological effects that can cause impacts ranging from normal physiological responses to lethal outcomes. We expect that exposure to loud sounds associated with the proposed airgun array will cause a stress response, but that this response will generally motivate individuals sufficiently to move away from the sound source and avoid more severe physiological responses.

Marine mammals and strandings. There is some concern regarding the coincidence of marine mammal strandings and proximal seismic surveys. No conclusive evidence exists to causally link stranding events to seismic surveys. For more discussion regarding marine mammal strandings related to anthropogenic acoustic sources, please see (NMFS 2013).

Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al., 2004) were not well founded (IAGC, 2004; IWC, 2007). In September 2002, two Cuvier's beaked whales stranded in the Gulf of California, Mexico. The *R/V Ewing* had been operating a 20-airgun, 8,490-in^3 airgun array 22 km offshore the general area at the time that strandings occurred. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth 2002; Yoder 2002) as some vacationing marine mammal researchers who happened upon the stranding were ill-equipped to perform an adequate necropsy. Furthermore, the small numbers of animals involved and the lack of knowledge regarding the spatial and temporal correlation between the beaked whales and the sound source underlies the uncertainty regarding the linkage between seismic sound sources and beaked whale strandings (Cox et al. 2006). We do not expect ESA-listed whales to strand as a result of the proposed seismic survey.

Responses of marine mammal prey. Seismic surveys may also have indirect, adverse effects on prey availability through lethal or sub-lethal damage, stress responses, or alterations in their behavior or distribution. Studies described herein provide extensive support for this, which is the basis for later discussion on implications for ESA-listed whales. Unfortunately, species-specific information on the prey of listed whales is not generally available. Until more specific information is available, we expect that teleost, cephalopod, and krill prey of listed whales to react in manners similar to those fish and invertebrates described herein.

Some support has been found for fish or invertebrate mortality resulting from airgun exposure, and this is limited to close-range exposure to high-amplitudes (Bjarti 2002; Falk and Lawrence 1973; Hassel et al. 2003; Holliday et al. 1987; Kostyuchenko 1973; La Bella et al. 1996b; McCauley et al. 2000a; McCauley et al. 2000b; McCauley et al. 2003; Popper et al. 2005;

Santulli et al. 1999). Nedelec et al. (2014) found boat noise playbacks to cause significantly higher levels of mortality in early life stage sea hares. Lethal effects, if any, are expected within a few meters of the airgun array (Buchanan et al. 2004; Dalen and Knutsen 1986). We expect fish to be capable of moving away from the airgun array if it causes them discomfort.

More evidence exists for sub-lethal effects on fishes and invertebrates. Several species at various life stages have been exposed to high-intensity sound sources (220-242 dB re 1 μPa) at close distances, with some cases of injury (Booman et al. 1996; McCauley et al. 2003). TTS was not found in whitefish at received levels of ~175 dB re 1 $\mu Pa^2 \cdot s$, but pike did show 10-15 dB of hearing loss with recovery within 1 day (Popper et al. 2005). Caged pink snapper have experienced PTS when exposed over 600 times to received seismic sound levels of 165-209 dB re 1 μPa_{p-p}. Exposure to airguns at close range were found to produce balance issues in exposed fry (Dalen and Knutsen 1986). Exposure of monkfish and capelin eggs at close range to airguns did not produce differences in mortality compared to control groups (Payne et al. 2009). Salmonid swim bladders (similar to the swim bladders of some marine mammal prey species) were reportedly damaged by received sound levels of ~230 dB re 1 μPa (Falk and Lawrence 1973).

By far the most common response by fishes is a startle or distributional response, where fish react momentarily by changing orientation or swimming speed, or change their vertical distribution in the water column. Although received sound levels were not reported, caged *Pelates* spp., pink snapper, and trevally generally exhibited startle, displacement, and/or grouping responses upon exposure to airguns (McCauley and Fewtrell 2013a). This effect generally persisted for several minutes, although subsequent exposures to the same individuals did not necessarily elicit a response (McCauley and Fewtrell 2013a). Startle responses were observed in rockfish at received airgun levels of 200 dB re 1 μPa_{0-p} and alarm responses at >177 dB re 1 μPa_{0-p} (Pearson et al. 1992). Fish also tightened schools and shifted their distribution downward. Normal position and behavior resumed 20-60 minutes after seismic firing ceased. A downward shift was also noted by Skalski et al. (1992) at received seismic sounds of 186–191 re 1 μPa_{0-p}. Caged European sea bass showed elevated stress levels when exposed to airguns, but levels returned to normal after 3 days (Skalski et al. 1992). These fish also showed a startle response when the survey vessel was as much as 2.5 km away; this response increased in severity as the vessel approached and sound levels increased, but returned to normal after about two hours following cessation of airgun activity. Whiting exhibited a downward distributional shift upon exposure to 178 dB re 1 μPa_{0-p} airgun sound, but habituated to the sound after one hour and returned to normal depth (sound environments of 185-192 dB re 1 μPa) despite airgun activity (Chapman and Hawkins 1969). Whiting may also flee from airgun sound (Dalen and Knutsen 1986). Hake may redistribute downward (La Bella et al. 1996b). Lesser sandeels exhibited initial startle responses and upward vertical movements before fleeing from the survey area upon approach of an active seismic vessel (Hassel et al. 2003; Hassel et al. 2004). McCauley et al. (2000; 2000a) found smaller fish show startle responses at lower levels than larger fish in a variety of fish species and generally observed responses at received sound levels of 156–161 dB re 1 μPa_{rms}, but responses tended to decrease over time suggesting habituation. As with previous studies, caged fish showed increases in swimming speeds and downward vertical shifts. Pollock did not respond to airgun sounds received at 195–218 dB re 1 μPa_{0-p}, but did exhibit continual startle responses and fled from the seismic source when visible (Wardle et al. 2001). Blue whiting and mesopelagic fishes were found to redistribute 20–50 m deeper in response to airgun ensonification and a shift away from the survey area was also found (Slotte et al. 2004). Startle responses were infrequently observed from salmonids receiving 142–186 dB re 1 $\mu Pa_{p\text{-}p}$ sound levels from an airgun (Thomsen 2002). Cod and haddock likely vacate seismic survey areas in response to airgun activity and estimated catchability decreased starting at received sound levels of 160–180 dB re 1 $\mu Pa_{0\text{-}p}$ (Dalen and Knutsen 1986; Engås et al. 1996; Engås et al. 1993; Løkkeborg 1991; Løkkeborg and Soldal 1993; Turnpenny et al. 1994). Increased swimming activity in response to airgun exposure, as well as reduced foraging activity, is supported by data collected by Lokkeborg et al. (2012). Bass did not appear to vacate during a shallow-water seismic survey with received sound levels of 163–191 dB re 1 $\mu Pa_{0\text{-}p}$ (Turnpenny and Nedwell 1994). Similarly, European sea bass apparently did not leave their inshore habitat during a 4-5 month seismic survey (Pickett et al. 1994). La Bella et al. (1996a) found no differences in trawl catch data before and after seismic operations and echosurveys of fish occurrence did not reveal differences in pelagic biomass. However, fish kept in cages did show behavioral responses to approaching airguns. Schooling herring in a sea pen did not respond behaviorally to sounds in the 10 Hz-2 kHz range, although increases in cortisol and glucose indicated a stress response when killer whales sounds were played back (Handegard et al. 2013). No response was seen in a free-swimming school upon the approach of a seismic airgun array (Pena et al. 2013). Passage of a seismic survey did not appear to alter the alter species richness of a demersal coral fish family compared to baseline conditions (Miller and Cripps 2013).

Squid responses to airguns have also been studied, although to a lesser extent than fishes. In response to airgun exposure, squid exhibited both startle and avoidance responses at received sound levels of 174 dB re 1 μPa_{rms} by first ejecting ink and then moving rapidly away from the area (McCauley and Fewtrell 2013b; McCauley et al. 2000a; McCauley et al. 2000b). The authors also noted some movement upward. During ramp-up, squid did not discharge ink but alarm responses occurred when received sound levels reached 156–161 dB re 1 μPa_{rms}. Guerra et al. (2004) suggested that giant squid mortalities were associated with seismic surveys based upon coincidence of carcasses with the surveys in time and space, as well as pathological information from the carcasses. Sole et al. (2013) found damage to the statocysts of several squid species exposed to 50-400 Hz sounds with received sound levels of 157 ±5 dB re: 1 mPa with peak levels up to 175 dB re 1 mPa). Lobsters did not exhibit delayed mortality, or apparent damage to mechanobalancing systems after up to eight months post-exposure to airguns fired at 202 or 227 dB peak-to-peak pressure (Payne et al. 2013). However, feeding did increase in exposed individuals (Payne et al. 2013). Crayfish exposed to 100 Hz-25kHz signals in a tank showed blood and immune system changes as well as reduced aggression (Celi et al. 2013).

The overall response of fishes and squids is to exhibit startle responses and undergo vertical and horizontal movements away from the sound field. We do not expect krill (the primary prey of most ESA-listed baleen whales) to experience effects from airgun sound. Although humpback whales consume fish regularly, we expect that any disruption to their prey will be temporary, if at all. Therefore, we do not expect any adverse effects from lack of prey availability to baleen whales. Sperm whales regularly feed on squid and some fishes and we expect individuals to feed while in the action area during the proposed survey. Based upon the best available information, fishes and squids ensonified by the ~160 dB isopleths could vacate the area and/or dive to greater depths, and be more alert for predators. We do not expect indirect lethal or sub-lethal effects from airgun activities through reduced feeding opportunities for ESA-listed whales to be sufficient to reach a significant level. Effects are likely to be temporary and, if displaced, both sperm whales and their prey would re-distribute back into the area once survey activities have passed.

Marine mammal response to multibeam echosounder, sub-bottom profiler, and ADCP. We expect ESA-listed whales to experience ensonification from not only airguns, but also seafloor and ocean current mapping systems. ADCP frequencies are much higher than those frequencies used by ESA-listed marine mammals in the action area, except for sperm whales. Multibeam echosounder and sub-bottom profiler frequencies are much higher than frequencies used by all ESA-listed whales except blue, humpback, and sperm whales. We expect that these systems will produce harmonic components in a frequency range similar to other commercial sonars (Deng et al. 2014). However, we do not expect these sub-harmonic frequencies in these systems to be audible to these species. Although Todd et al. (1992) found that mysticetes reacted to sonar sounds at 3.5 kHz within the 80-90 dB re 1 μPa range, it is difficult to determine the significance of this because the source was a signal designed to be alarming and the sound level was well below typical ambient noise. Goldbogen et al. (2013) found blue whales to respond to 3.5-4.0 kHz mid-frequency sonar at received levels below 90 dB re 1 μPa. Responses included cessation of foraging, increased swimming speed, and directed travel away from the source (Goldbogen et al. 2013). Hearing is poorly understood for ESA-listed baleen whales, but it is assumed that they are most sensitive to frequencies over which they vocalize, which are much lower than frequencies emitted by the multibeam echosounder and sub-bottom profiler systems (Ketten 1997; Richardson et al. 1995c). Thus, if fin, sei, or North Atlantic right whales are exposed, they are unlikely to hear these frequencies and a response is not expected.

Assumptions for blue, humpback, and sperm whale hearing are much different than for other ESA-listed whales. Humpback and sperm whales vocalize between 3.5-12.6 kHz and an audiogram of a juvenile sperm whale provides direct support for hearing over this entire range (Au 2000a; Au et al. 2006; Carder and Ridgway 1990; Erbe 2002a; Frazer and Mercado 2000; Goold and Jones 1995; Levenson 1974; Payne and Payne 1985; Payne 1970; Richardson et al. 1995c; Silber 1986; Thompson et al. 1986; Tyack 1983; Tyack and Whitehead 1983; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997; Weir et al. 2007; Winn et al. 1970). MacGillivray et al. (2014) modeled sounds from a sub-bottom profiler (of lower frequency than that proposed for use in the proposed seismic survey) to be audible to humpback whales. The response of a blue whale to 3.5 kHz sonar supports this species ability to hear this signal as well (Goldbogen et al. 2013). Maybaum (1990; 1993) observed that Hawaiian humpbacks moved away and/or increased swimming speed upon exposure to 3.1-3.6 kHz sonar. Kremser et al. (2005) concluded the probability of a cetacean swimming through the area of exposure when such sources emit a pulse is small, as the animal would have to pass at close range and be swimming at speeds similar to the vessel. Sperm whales have stopped vocalizing in response to 6-13 kHz pingers, but did not respond to 12 kHz echo-sounders (Backus and Schevill 1966; Watkins 1977; Watkins and Schevill 1975). Sperm whales exhibited a startle response to 10 kHz pulses upon exposure while resting and feeding, but now while traveling (Andre and Jurado 1997; André et al. 1997).

Investigations stemming from a recent stranding event in Madagascar suggest a 12 kHz multibeam echosounder, similar in operating characteristics as that proposed for use aboard the *Langseth*, suggest that this sonar played a significant role in the mass stranding of a large group of melon-headed whales (Southall et al. 2013). Although pathological data to suggest a direct physical affect are lacking and the authors acknowledge that although the use of this type of sonar is widespread and common place globally without noted incidents like the Madagascar stranding, all other possibilities were either ruled out or believed to be of much lower likelihood as a cause or contributor to stranding compared to the use of the multibeam echosounder (Southall et al. 2013). This incident highlights the caution needed when interpreting effects that may or may not stem from anthropogenic sound sources, such as the *Langseth*'s multibeam echosounder and that of the chase vessel. Although effects such as this have not been documented for ESA-listed species, the combination of exposure to this stressor with other factors, such as behavioral and reproductive state, oceanographic and bathymetric conditions, movement of the source, previous experience of individuals with the stressor, and other factors may combine to produce a response that is greater than would otherwise be anticipated or has been documented to date (Ellison et al. 2012; Francis and Barber 2013).

Recent stranding events associated with the operation of naval sonar suggest that mid-frequency sonar sounds may have the capacity to cause serious impacts to marine mammals. The sonars proposed for use by L-DEO differ from sonars used during naval operations, which generally have a longer pulse duration and more horizontal orientation than the more downward-directed multibeam echosounder and sub-bottom profiler. The sound energy received by any individuals exposed to the multibeam echosounder and sub-bottom profiler sources during the proposed activities is lower relative to naval sonars, as is the duration of exposure. The area of possible influence for the multibeam echosounder and sub-bottom profiler is also much smaller, consisting of a narrow zone close to and below the source vessel. Because of these differences, we do not expect these systems to contribute to a stranding event.

We do not expect masking of blue, sperm, or humpback whale communications to occur due to multibeam echosounder, sub-bottom profiler, or ADCP signal directionality, low duty cycle, and the brief period when an individual could be within its beam. These factors were considered when Burkhardt et al. (2013) estimated the risk of injury from multibeam echosounder was less than 3% that of ship strike.

Sea Turtles

Sea turtle response to airguns. As with marine mammals, sea turtles may experience

- threshold shifts
- behavioral responses
- non-auditory physical or physiological effects

Sea turtles and threshold shifts. Although leatherback sea turtles detect low frequency sound, the potential effects on sea turtle biology remain largely unknown (Samuel et al. 2005). Few data are available to assess sea turtle hearing, let alone the effects seismic equipment may have on their hearing potential. The only study which addressed sea turtle TTS was conducted by Moein et al. (1994), in which a loggerhead experienced TTS upon multiple airgun exposures in a shallow water enclosure, but recovered within one day.

As with marine mammals, we assume that sea turtles will not move towards a source of stress or discomfort. Some experimental data suggest sea turtles may avoid seismic sources (McCauley et al. 2000a; McCauley et al. 2000b; Moein et al. 1994), but monitoring reports from seismic surveys in other regions suggest that some sea turtles do not avoid airguns and were likely exposed to higher levels of seismic airgun pulses (Smultea and Holst 2003). For this reason, mitigation measures are also in place to limit sea turtle exposure. Although data on the precise levels that can result in TTS or PTS are lacking, we do not expect either of these to occur to any sea turtle as a result of the proposed action.

Sea turtles and behavioral responses. As with ESA-listed whales, it is likely that sea turtles will experience behavioral responses in the form of avoidance. O'Hara and Wilcox (1990) found loggerhead sea turtles exhibited an avoidance reaction at an estimated sound level of 175–176 dB re 1 μPa $_{rms}$ (or slightly less) in a shallow canal. Green and loggerhead sea turtles avoided airgun sounds at received sound levels of 166 dB re 1 μPa and 175 dB re 1 μPa, respectively (McCauley et al. 2000a; McCauley et al. 2000b). Sea turtle swimming speed increased and becomes more erratic at 175 dB re 1 μPa, with individuals becoming agitated. Loggerheads also appeared to move towards the surface upon airgun exposure (Lenhardt 1994b; Lenhardt et al. 1983). However, loggerheads resting at the ocean surface were observed to startle and dive as active seismic source approached them (DeRuiter and Larbi Doukara 2012). Responses decreased with increasing distance of closest approach by the seismic array (DeRuiter and Larbi Doukara 2012). The authors developed a response curve based upon observed responses and predicted received exposure level. Recent monitoring studies show that some sea turtles move away from approaching airguns, although sea turtles may approach active seismic arrays within 10 m (Holst et al. 2006; LGL Ltd 2005a; LGL Ltd 2005b; LGL Ltd 2008; NMFS 2006e; NMFS 2006h).

Observational evidence suggests that sea turtles are not as sensitive to sound as are marine mammals and behavioral changes are only expected when sound levels rise above received sound levels of 166 dB re 1 μPa. This corresponds with previous reports of sea turtle hearing thresholds being generally higher than for marine mammals (DFO 2004). At 166 dB re 1 μPa, we anticipate some change in swimming patterns and a stress response of exposed individuals. Some turtles may approach the active seismic array to closer proximity, but we expect them to eventually turn away. We expect temporary displacement of exposed individuals from some portions of the action area while the *Langseth* transects through.

Sea turtles and stress. Direct evidence of seismic sound causing stress is lacking in sea turtles. However, we expect sea turtles to generally avoid high-intensity exposure to airguns in a fashion similar to predator avoidance. As predators generally induce a stress response in their prey (Dwyer 2004; Lopez and Martin 2001; Mateo 2007), we assume that sea turtles experience a stress response to airguns when they exhibit behavioral avoidance or when they are exposed to sound levels apparently sufficient to initiate an avoidance response (~166 dB re 1 μPa). We expect breeding adult females may experience a lower stress response, as female loggerhead, hawksbill, and green sea turtles appear to have a physiological mechanism to reduce or eliminate hormonal response to stress (predator attack, high temperature, and capture) in order to maintain reproductive capacity at least during their breeding season; a mechanism apparently not shared with males (Jessop 2001; Jessop et al. 2000; Jessop et al. 2004). Individuals may experience a stress response at levels lower than ~166 dB re 1 μPa, but data are lacking to evaluate this possibility. Therefore, we follow the best available evidence identifying a behavioral response as the point at which we also expect a significant stress response.

Sea turtle response to multibeam echosounder and sub bottom profiler. Sea turtles do not possess a hearing range that includes frequencies emitted by these systems. Therefore, ESA-listed sea turtles will not hear these sounds even if they are exposed and are not expected to respond to them.

9 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

We expect that those aspects described in the *Environmental Baseline* will continue to impact ESA-listed resources into the foreseeable future. We expect climate change, habitat degradation, dredging, seismic surveys, vessel traffic, military activities, entrapment and entanglement, oil and gas activities, wind energy projects, entrainment in power plants, ship-strikes, commercial whaling, and scientific research to continue into the future. Movement towards bycatch reduction and greater foreign protections of sea turtles are generally occurring throughout the Atlantic Ocean, which may aid in abating the downward trajectory of sea turtle populations.

10 Integration and Synthesis of Effects

As explained in the *Approach to the Assessment* section, risks to ESA-listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, as well as lifetime reproductive success. When ESA-listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992). As a result, if the assessment indicates that ESA-listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment. If possible, reductions in individuals' fitness are likely to occur, the assessment considers the risk posed to population(s) to which those individuals belong, and then to the species those population(s) represent. Figure 4 provides a conceptual organization as to how we considered fitness consequences.

ESA-listed whales. The NSF proposes to allow the use of its vessel, the *Langseth*, to conduct a seismic survey that could incidentally harass several ESA-listed marine mammal species. These species include: blue whales, fin whales, humpback whales, North Atlantic right whales, sei whales, and sperm whales, all of whom are endangered throughout their ranges.

The *Status of Listed Resources* section identified commercial whaling as the primary reason for reduced populations, many of whom are a small fraction of their former abundance (Tables 3-7). Although large-scale commercial harvests no longer occur for these species, some harvests from subsistence and scientific research in regional and worldwide populations still occur. Other worldwide threats to the survival and recovery of ESA-listed whale species include: altered prey base and habitat quality as a result of global warming, ship strike, entanglement in fishing gear, toxic chemical burden and biotoxins, ship noise, competition with commercial fisheries, and killer whale predation. Populations of whales inhabiting the North Atlantic face area-specific threats identified in the *Environmental Baseline*.

Despite these pressures, available trend information indicates most local populations of ESA-listed whales are stable or increasing. As previously mentioned, the *Cumulative Effects* section identifies actions in the *Environmental Baseline* we expect to generally continue for the foreseeable future.

The *Effects Analysis* supports the conclusion of harassment to ESA-listed whales by proposed seismic activities. We evaluated three approaches to estimate the number of ESA-listed animals that would be exposed to the seismic survey; each approach has advantages and disadvantages. Under the NSF approach, we expect up to 1 blue, 1 fin, 0 sei, 60 humpback, 0 North Atlantic right, and 144 sperm whales could be exposed to airgun sounds during the course of the proposed seismic survey which will elicit a behavioral response of temporarily moving out of the area. Under the Permits and Conservation Division approach, up to 3 blue, 19 fin, 98 sei, 368 humpback, 5 North Atlantic right, and 104 individual sperm whales (with some additional re-exposure) could be exposed to airgun sounds that would result in a similar response over the entirety of the seismic survey. Under the ESA Interagency Cooperation Division approach approach, up to 2 blue, 47 fin, 189 sei, 405 humpback, 102 North Atlantic right, and 1,204 sperm whales (with which includes re-exposure of the same individuals) could be exposed to airgun sounds that would result in a similar response over the entirety of the seismic survey. In any case, we expect a low-level, transitory stress response to accompany this behavior. The number of individuals exposed based on the OBIS-SEAMAP, NMSDD, and group size approaches are expected to generally represent a small fraction of the populations, except for NMSDD results for sei, sperm, and North Atlantic right whales. We also consider that the population estimate (Nova Scotia stock) for sei whales is likely low, as the stock assessment includes only a small portion of the range that sei whales in the western Atlantic are expected to occur in, producing percent of population exposed estimates that are likely considerable overestimates. We also expect that exposed individuals may experience a degree of masking, where they cannot hear environmental cues as well as they otherwise would. This would specifically occur at the time each airgun pulse is emitted, as well as a very brief period thereafter due to reverberation of the signal. We expect the vast majority of the intervening period (22-65 sec) would be available for normal communication and sensory that will allow individuals to interact normally with their environment.

The other actions we considered in the Opinion, the operation of multibeam echosounder, sub-bottom profiler, and ADCP systems, are not expected to be audible to fin, North Atlantic right, or sei whales and consequently are not expected to have any direct effects on these species. However, blue, humpback, and sperm whales could hear sounds produced by these systems. Responses could include cessation of vocalization by sperm whales and/or movement out of the survey area by these species.

Behavioral harassment caused by exposure to sound sources associated with the proposed seismic survey are expected to cause some individuals to cease these activities temporarily and possibly move out of the immediate area. However, we expect that individuals will either resume foraging in a secondary location (which may be of somewhat lesser quality, but we cannot establish a defensible rationale for estimating it would be significantly so) or reoccupy the habitat from which they were displaced within a period of days. A metabolic cost associated with movement away from the sound sources may also occur, perhaps in most or all individuals exposed to 160 dB re 1 μPa levels or higher. However, as all ESA-listed marine mammal species in the action area routinely undertake long-distance movements in association with normal breeding and foraging patterns, we do not expect this to be meaningful to any individual's survival, growth, or reproductive potential.

These responses are expected from all individuals exposed and we do not expect a fitness consequence for any individual. Therefore, even though one exposure approach results in a much larger number estimates of exposure for some ESA-listed species, the proportion of population that experiences the response is not meaningful in determining jeopardy at the population or species level. Overall, we do not expect a fitness reduction to any individual whale. As such, we do not expect fitness consequences to populations or ESA-listed whale species as a whole.

ESA-listed turtles. Listed turtles that occur within the action area include green sea turtles, hawksbill sea turtles, leatherback sea turtles, loggerhead sea turtles, and Kemp's ridley sea turtles, which are either threatened or endangered. The *Status of Listed Resources* section found that most sea turtle populations have undergone significant to severe reduction by human harvesting of both eggs and turtles, as well as severe bycatch pressure in worldwide fishing industries. As previously mentioned, the *Cumulative Effects* section identified actions in the *Environmental Baseline* to generally continue for the foreseeable future.

From the *Effects Analysis*, we expect that 10,734 green, 1,952 hawksbill, 4,383 Kemp's ridley, 6,817 leatherback, and 7,772 loggerhead sea turtles could experience exposure to airgun sounds and be harassed by these sounds. These sounds may induce a temporary effect in low-level stress levels, swimming patterns, and movement out of the action area. Population size is not available to calculate the subset of all population affected. However, those that are available suggest a small proportion of each population would be affected. We expect that any response would be transient and of short duration and would not affect the fitness of any one individual. Therefore, the proportions of the populations exposed are not relevant to determining jeopardy at the species level. We do not expect impairment of local nesting by the proposed survey. As we do not expect any sea turtle to be capable of hearing signals produced by the multibeam echosounder, sub-bottom profiler, and ADCP systems, we expect no effects from these systems on sea turtles. We do not anticipate any indirect effects from the proposed actions to impact sea turtles. Overall, we do not expect any individual sea turtle to undergo a fitness consequence.

11 Conclusion

After reviewing the current status of blue, fin, sei, humpback, North Atlantic right, and sperm whales as well as green, hawksbill, leatherback, loggerhead, and Kemp's ridley sea turtles; the *Environmental Baseline* for the action area; the anticipated effects of the proposed activities; and the *Cumulative Effects*, it is the NMFS's biological opinion that proposed seismic survey using the NSF's vessel off North Carolina and NMFS's Permits and Conservation Division's issuance of an incidental harassment authorization pursuant to the MMPA for the seismic survey are not likely to jeopardize the continued existence of these species. The proposed actions would have no effect on critical habitat.

12 Incidental Take Statement

Section 9 of the ESA and federal regulation pursuant to Section 4(d) of the ESA prohibit the "take" of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the NMFS as an act which actually kills or injures wildlife, which may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by the NSF and NMFS's Permits and Conservation Division so that they become binding conditions of any funding or authorization for L-DEO for the exemption in Section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with Section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures and terms and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of Section 9(a), pursuant to Section 7(o) of the ESA.

Section 7(b)(4)(C) of the ESA specifies that in order to provide an incidental take statement for an endangered or threatened species of marine mammal, the taking must be authorized under Section 101(a)(5) of the MMPA. One of the federal actions considered in this Opinion is NMFS's Permits and Conservation Division's proposed authorization of the incidental taking in the form of harassment of fin, blue, sei, humpback, North Atlantic right, and sperm whales pursuant to Section 101(a)(5)(D) of the MMPA. With this authorization, the incidental take of ESA-listed whales is exempt from the taking prohibition of Section 9(a), pursuant to section 7(o) of the ESA as long as such take occurs consistent with this statement.

12.1 Amount or Extent of Take

The NMFS anticipates the proposed seismic survey off North Carolina is likely to result in the incidental take of ESA-listed species by harassment. We expect up to 3 blue, 19 fin, 98 sei, 368 humpback, 5 North Atlantic right, and 104 individual sperm whales could be exposed to airgun sounds during the course of the proposed seismic survey which will elicit a behavioral response that would constitute harassment. Harassment is expected to occur at received levels above 160 dB re: 1 μPa. Additional exposures to the same individuals sufficient to elicit responses may also occur. We also expect green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles to received seismic sound levels greater than 160 dB re 1 μPa by harassment. Because density estimates are unavailable or unreliable for sea turtles in this time period and area, we estimated take based on the extent of sound levels at which sea turtles are expected to be harassed. Therefore, take is estimated as all turtles that are exposed to seismic sound levels at or above 166 dB re: 1 μPa during the proposed activities (32,173 km^2; Figure 10). For all species of whales and sea turtles, this incidental take would result primarily from exposure to acoustic energy during seismic operations and would be in the form of harassment, and is not expected to result in the death or injury of any individuals that are exposed.

Harassment of blue, fin, humpback, North Atlantic right, sei, and sperm whales exposed to seismic studies at levels less than 160 dB re: 1 μPa, or of leatherback, loggerhead, green, hawksbill, and Kemp's ridley sea turtles at levels less than 166 dB re: 1 μPa, is not expected. If overt adverse reactions (for example, startle responses, dive reactions, or rapid departures from the area) by ESA-listed whales or sea turtles are observed at less intense levels than 160 dB or 166 dB re: 1 μPa, respectively, while airguns are operating, incidental take may be exceeded. If such reactions by ESA-listed species are observed while airguns are in operation, this may constitute take that is not covered in this Incidental Take Statement. The NSF, and NMFS's Permits and Conservation Division must contact the ESA Interagency Cooperation Division to determine whether reinitiation of consultation is required because of such operations.

Any incidental take of blue, fin, humpback, North Atlantic right, sei, and sperm whales or leatherback, loggerhead, green, hawksbill, and Kemp's ridley sea turtles is restricted to the permitted action as proposed. If the actual incidental take exceeds the predicted level, the NSF and NMFS's Permits and Conservation Division must reinitiate consultation. All anticipated takes would be "takes by harassment," as described previously, involving temporary changes in behavior.

12.2 Effect of the Take

In the accompanying Opinion, NMFS has determined that the level of incidental take is not likely to jeopardize the continued existence of any ESA-listed species or result in the destruction or adverse modification of critical habitat**.**

12.3 Reasonable and Prudent Measures

NMFS believes the reasonable and prudent measure described below is necessary and appropriate to minimize the amount of incidental take of ESA-listed whales and sea turtles resulting from the proposed actions. This measure is non-discretionary and must be a binding condition of NSF's funding and NMFS Permits and Conservation Division authorization for the exemption in Section 7(o)(2) to apply. If the NSF or NMFS fail to ensure compliance with this term and conditions and its implementing terms and conditions, the protective coverage of Section 7(o)(2) may lapse.

The NSF and NMFS Permits Division must ensure that L-DEO implements and monitors the effectiveness of mitigation measures incorporated as part of the proposed authorization of the incidental taking of blue, fin, sei, humpback, North Atlantic right, and sperm whales pursuant to Section 101(a)(5)(D) of the MMPA and as specified below for green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles.

12.4 Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, NMFS's Permits and Conservation Division and NSF must insure that L-DEO comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above. These terms and conditions are non-discretionary.

If NSF, L-DEO, and/or the Permits and Conservation Division fail to ensure compliance with these terms and conditions and their implementing reasonable and prudent measures, the protective coverage of Section 7(o)(2) may lapse.

To implement the Reasonable and Prudent Measure, the NSF and the NMFS's Permits and Conservation Division thru its IHA shall ensure that L-DEO implements the following:

Mitigation and Monitoring Requirements

A. Establish an exclusion zone.[7] corresponding to the anticipated 177 dB (in waters <100 m deep) or 180 (in waters >100 m deep) dB re 1 μPa_{rms} isopleth for the airgun subarray (6,600 in^3 or smaller), and single (40 in^3) airgun operations as well as a 160 dB re 1 μPa_{rms} buffer zone.

B. Lamont-Doherty will not operate the multi-beam echosounder, the sub-bottom profiler, or the acoustic Doppler current profiler during transit.

B. Use two, NMFS-approved, vessel-based observers to watch for and monitor marine mammal or sea turtle species near the seismic source vessel during daytime airgun operations (dawn to dusk), start-ups of airguns at night, and while the seismic array and streamers are being deployed and retrieved. Vessel crew will also assist in detecting marine mammals or sea turtles, when practical. Observers will have access to reticle binoculars (7 X 50 Fujinon), big-eye binoculars (25 X 150), optical range finders, and night vision devices. Observers shifts will last no longer than four hours at a time. Observers will also observe during daytime periods when the seismic system is not operating for comparisons of animal abundance and behavior, when feasible.

C. Record the following information when a marine mammal or sea turtle is sighted:

i. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace.

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

iii. The data listed under ii. would also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

D. Visually observe the entire extent of the exclusion zone using observers, for at least 30 min prior to starting the airgun (day or night). If observers find a marine mammal or sea turtle within the exclusion zone, L-DEO must delay the seismic survey until the marine mammal or sea turtle has left the area. If the observer sees a marine mammal or sea turtle that surfaces, then dives below the surface, the observer shall wait 60 minutes. If the observer sees no marine mammals or sea turtle during that time, they should assume that the animal has moved beyond the exclusion zone. If for any reason the entire radius cannot be seen for the entire 30 min (e. g., rough seas, fog, darkness), or if marine mammals or sea turtle are near, approaching or in the exclusion zone, the airguns may not be started up. If one airgun is already running at a source level of at least 180 dB re 1 μPa_{rms}, L-DEO may start subsequent guns without observing the

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7 The "exclusion zone" refers to a region around the seismic airgun source where mitigation would be undertaken to avoid or minimize the impacts of the airguns if marine mammals or sea turtles are observed within it.

entire exclusion zone for 30 min prior, provided no marine mammals or sea turtle are known to be near the safety radius. While it is considered unlikely, in the event a North Atlantic right whale (*Eubalaena glacialis*) is visually sighted, the airgun array will be shut-down regardless of the distance of the animal(s) to the sound source. The array will not resume firing until 30 min after the last documented whale visual sighting. Concentrations (greater than or equal to six individuals that do not appear to be traveling) of humpback, sei, fin, blue, and/or sperm whales will be avoided if possible (*i.e.*, exposing concentrations of animals to 160 dB), and the array will be powered-down if necessary.

E. Use the PAM to detect marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. One observer and/or bioacoustician will monitor the PAM at all times in shifts of 1-6 h. A bioacoustician shall design and set up the PAM system and be present to operate or oversee PAM, and be available if technical issues occur during the survey.

F. Do or record the following when an animal is detected by the PAM:

i. Contact the observer immediately (and initiate power or shut-down, if required);

ii. Enter the information regarding the vocalization into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position and water depth when first detected, bearing if determinable, species or species group, types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

G. Apply a “ramp-up” procedure when starting up at the beginning of seismic operations or any time after the entire array has been shut-down for 8 min, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-min period. During ramp-up, the observers will monitor the 177 (in waters <100 m deep) or 180 (in waters >100 m deep) dB re 1 μPa_{rms} exclusion zone, and if marine mammals or sea turtles are sighted, a course/speed alteration, power-down, or shut-down will occur as though the full array were operational.

H. Alter speed or course during seismic operations if a marine mammal or sea turtle, based on its position and relative motion, appears likely to enter the exclusion zone. If speed or course alteration is not safe or practical, or if after alteration the marine mammal or sea turtle still appears likely to enter the exclusion zone, further mitigation measures, such as power-down or shut-down, will be taken.

I. Shut-down or power-down the airguns upon marine mammal or sea turtle detection within, approaching, or entering the exclusion zone. A power-down means shutting down one or more airguns and reducing the buffer and exclusion zones to the degree that the animal is outside of one or both. Following a power-down, if the marine mammal or sea turtle approaches the smaller designated exclusion zone, the airguns must be completely shut down. Airgun activity will not resume until the marine mammal or sea turtle has cleared the exclusion zone, which means it was visually observed to have left the exclusion zone, or has not been seen within the exclusion zone for 15 min (small odontocetes) or 60 min (sea turtles, mysticetes and large odontocetes). The *Langseth* may operate a small-volume airgun (*i.e.*, mitigation airgun) during turns and short maintenance periods (less than three hours) at approximately one shot per minute. During turns or brief transits between seismic tracklines, one mitigation airgun would continue to operate.

J. Marine seismic operations may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire exclusion zone is visible and can be effectively monitored. No initiation of airgun array operations is permitted from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the entire exclusion zone cannot be effectively monitored by the observer(s) on duty. To the maximum extent practicable, seismic airgun operations should be scheduled during daylight hours and surveys (especially when near land) should transect from inshore to offshore in order to avoid trapping marine mammals or sea turtles in shallow water.

L. In the unanticipated event that the specified activity clearly causes any cases of marine mammal or sea turtle injury or mortality are judged to result from these activities (*e.g.*, ship-strike, gear interaction, and/or entanglement), L-DEO will cease operating seismic airguns and report the incident to NMFS's Office of Protected Resources at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov, the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) (Blair.Mase@noaa.gov) immediately. Airgun operation will then be postponed until NMFS is able to review the circumstances and work with L-DEO to determine whether modifications in the activities are appropriate and necessary.

M. In the event that L-DEO discovers an injured or dead marine mammal or sea turtle, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.,* in less than a moderate state of decomposition as described in the next paragraph), L-DEO will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov, the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) (Blair.Mase@noaa.gov). Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with L-DEO to determine whether modifications in the activities are appropriate.

N. In the event that L-DEO discovers an injured or dead marine mammal or sea turtle, and the lead visual observer determines that the injury or death is not associated with or related to the activities (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), L-DEO shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov, the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) (Blair.Mase@noaa.gov), within 24 hours of the discovery. L-DEO shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

O. L-DEO is required to comply with the Terms and Conditions of this Opinion's Incidental Take Statement issued to both the NSF and the NMFS's Permits and Conservation Division.

In addition, the proposed incidental harassment authorization requires L-DEO to adhere to the following reporting requirements:

A. Submit a report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days after the completion of the *Langseth*'s cruise.

i. Dates, times, locations, heading, speed, weather, and associated activities during all seismic operations.

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

iii. An estimate of the number (by species) of marine mammals and sea turtles that:

c. Are known to have been exposed to the seismic activity (visual observation) at received levels greater than or equal to 160 dB re 1 microPa (rms) and/or 177 or 180 dB re 1 microPa (rms) for cetaceans with a discussion of any specific behaviors those individuals exhibited.

d. May have been exposed (modeling results) to the seismic activity at received levels greater than or equal to 160 dB re 1 microPa (rms) and/or 177 or 180 dB re 1 microPa (rms) with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

iv. A description of the implementation and effectiveness of the:

a. Terms and conditions of the Opinion's Incidental Take Statement.

b. Mitigation measures of the IHA. For the Opinion, the report will confirm the implementation of each term and condition and describe the effectiveness, as well as any conservation measures, for minimizing the adverse effects of the action on listed whales and sea turtles.

13 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend the following conservation recommendations, which would provide information for future consultations involving seismic surveys and the issuance of incidental harassment authorizations that may affect endangered large whales as well as endangered or threatened sea turtles:

1. *Effects of seismic noise on sea turtles.* The NSF should promote and fund research examining the potential effects of seismic surveys on ESA-listed sea turtle species.

In order for the ESA Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting ESA-listed species or their habitats, NMFS's Permits and Conservation Division should notify the ESA Interagency Cooperation

Division of any conservation recommendations they implement in their final action.

14 Reinitiation Notice

This concludes formal consultation on the proposed seismic source survey to be carried out with the NSF's vessel and conducted by the L-DEO on board the *R/V Langseth* in the Atlantic Ocean off North Carolina, and the issuance of an incidental harassment authorization for the proposed studies pursuant to Section 101(a)(5)(D) of the MMPA. As provided in 50 CFR §402.16, reinitiation of consultation will be required where discretionary Federal involvement or control over the action has been retained or is authorized by law, and: (1) if the amount or extent of incidental take is exceeded; (2) if new information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) if the agency action is subsequently modified in a manner that causes an effect to the ESA-listed species or critical habitat not considered in this opinion; or (4) if a new species is listed or critical habitat designated that may be affected by the action.

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APPENDIX C: NMFS Environmental Assessment

NOAA FISHERIES

PROPOSED ACTION: Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Atlantic Ocean Offshore North Carolina, September through October, 2014.

TYPE OF STATEMENT: Environmental Assessment

LEAD AGENCY: U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

RESPONSIBLE OFFICIAL: Donna S. Wieting, Director
Office of Protected Resources,
National Marine Fisheries Service

FOR FURTHER INFORMATION: Jeannine Cody
National Marine Fisheries Service
Office of Protected Resources
Permits and Conservation Division
1315 East West Highway
Silver Spring, MD 20910
301-427-8401

LOCATION: The Atlantic Ocean, approximately 17 to 422 kilometers (10 to 262 miles off the coast of Cape Hatteras, North Carolina.

ABSTRACT: This Environmental Assessment analyzes the environmental impacts of the National Marine Fisheries Service, Office of Protected Resources proposal to issue an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory, for the taking, by Level B harassment, of small numbers of marine mammals, incidental to a marine geophysical survey in the Atlantic Ocean, September - October, 2014.

DATE: September 2014

CONTENTS

LIST OF ABBREVIATIONS OR ACRONYMS

2-D	two dimensional
ACRC	U.S. Navy's Atlantic City Range Complex
ADCP	acoustic Doppler current profiler
Authorization	Incidental Harassment Authorization
BOEM	Bureau of Ocean Energy and Management
CFR	Code of Federal Regulations
CHSRA	Cape Hatteras Special Research Area
Commission	Marine Mammal Commission
CZMA	Coastal Zone Management Act (16 U.S.C. §§ 1451 *et seq*.)
dB	decibel
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENAM	East North America Margin
ESA	Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.)
EEZ	Exclusive Economic Zone
EZ	exclusion zone
FONSI	Finding of No Significant Impact
FR	*Federal Register*
ft	feet
Hz	hertz
IHA	Incidental Harassment Authorization
ITA	Incidental Take Authorization
ITS	Incidental Take Statement
kHz	kilohertz
km	kilometer
km^2	square kilometer
m	meter
mi	mile
mi^2	square mile
MMPA	Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq*.)
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
µPa	micropascal
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq*.)
NNCE	Northern North Carolina Estuarine stock of bottlenose dolphins
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NSF	National Science Foundation
OMB	Office of Management and Budget
Opinion	Biological Opinion
PSO	Protected species Observer
SNCE	Southern North Carolina Estuarine stock of bottlenose dolphins
SMC	Southern Migratory Coastal stock of bottlenose dolphins
UME	Unusual Mortality Event
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey

CHAPTER 1 – INTRODUCTION AND PURPOSE AND NEED

1.1 DESCRIPTION OF PROPOSED ACTION

The Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq*.) prohibits the incidental taking of marine mammals. The incidental take of a marine mammal falls under four categories: mortality, serious injury, injury, or harassment. The MMPA defines harassment as any act of pursuit, torment, or annoyance which: (1) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (2) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

There are exceptions to the MMPA's prohibition on take. The National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division (NMFS, hereinafter, we) may authorize the incidental taking of small numbers of marine mammals by harassment upon the request of a U.S. citizen provided we follow certain statutory and regulatory procedures and make determinations. We discuss this exception in more detail in section 1.2.

Lamont-Doherty Earth Observatory of Columbia University (Lamont-Doherty) has requested an Incidental Harassment Authorization (Authorization) to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the Atlantic Ocean off the coast of Cape Hatteras, North Carolina. In response to their request, we propose to issue an Authorization to Lamont-Doherty under Section 101(a)(5)(D) of the MMPA, which would allow them to take small numbers of marine mammals, incidental to the conduct of their activities, September through October, 2014. We do not have the authority to permit, authorize, or prohibit Lamont-Doherty's research seismic activities under Section 101(a)(5)(D) of the MMPA, as that authority lies with the National Science Foundation (Foundation).

Our proposed issuance of an Authorization to Lamont-Doherty is a major federal action under the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq*.), the Council on Environmental Quality (CEQ) regulations in 40 CFR §§ 1500-1508, and NOAA Administrative Order (NAO) 216-6. Thus, we are required to analyze the effects of our proposed action on the human environment.

This Environmental Assessment (EA) addresses the potential environmental impacts of the following choices available to us under section 101(a)(5)(D) of the MMPA, namely:

- Issue the proposed Authorization to Lamont-Doherty for take, by Level B harassment, of marine mammals during the seismic survey, taking into account the prescribed means of take, mitigation measures, and monitoring requirements;
- Do not issue the proposed Authorization to Lamont-Doherty, in which case, for the purposes of NEPA analysis only, we assume that the proposed activities would proceed and cause incidental take without the mitigation and monitoring measures prescribed in the proposed Authorization[1]; or

[1] The National Science Foundation's EA, *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*, states that Lamont-Doherty would not conduct the proposed survey without an Incidental Harassment Authorization.

- Issue the proposed Authorization to Lamont-Doherty for take, by Level B harassment, of marine mammals during the seismic survey by incorporating additional required mitigation measures in addition to Lamont-Doherty's or our proposed mitigation and monitoring measures.

1.1.1 Background on the Lamont-Doherty's MMPA Application

Lamont-Doherty proposes to use the R/V *Marcus G. Langseth* (*Langseth*) to collect and analyze data on the mid-Atlantic coast of the East North America Margin (ENAM). The two-dimensional (2-D) seismic survey would cover a portion of the rifted margin of the eastern U.S. and the results would allow scientists to investigate how the continental crust stretched and separated during the opening of the Atlantic Ocean and understand magnetism's role during the continental breakup. The proposed seismic survey is purely scientific in nature and not related to oil and natural gas exploration on the outer continental shelf of the Atlantic Ocean.

The Foundation, which owns and operates the *Langseth* under a cooperative agreement with Lamont-Doherty, supports basic scientific research in the mathematical, physical, medical, biological, social, and other sciences pursuant to the National Science Foundation Act of 1950, (Public Law 810507, as amended). The Foundation considers proposals submitted by organizations and makes contracts and/or other arrangements (*i.e.*, grants, loans, and other forms of assistance) to support research activities. In 2013, a Foundation-expert panel recommended a research proposal titled, *Collaborative Research: A community seismic experiment targeting the pre-, syn-, and post-rift evolution of the Mid Atlantic US margin*, (Award #1348454) for funding and ship time on the *Langseth*. As the federal action agency for this award, the Foundation has funded the proposed seismic survey in the Atlantic Ocean, September through October, 2014 as a part of the NSF Act of 1950.

Acoustic stimuli generated by the seismic airgun array have the potential to cause behavioral disturbances to marine mammals in the proposed project area. We describe the Foundation-supported seismic survey in more detail in section 2.2.

1.1.2 Marine Mammals in the Action Area

There are 33 marine mammal species with confirmed or potential occurrence in the proposed action area (Tables 1a, b, and c). Of the species listed in Tables 1a, b, and c, 30 species would most likely be harassed incidental to conducting the seismic survey. (See Table 6 in section 3.2.1 Affected Environment, Marine Mammals).

Table 1(a) – Mysticetes with possible/confirmed occurrence in the proposed activity area.

Mysticetes		
1	**North Atlantic right whale***	*Eubalaena glacialis*
2	**Humpback whale***	*Megaptera novaeangliae*
3	Minke whale	*Balaenoptera acutorostrata*
4	**Sei whale***	*Balaenoptera borealis*
5	**Fin whale***	*Balaenoptera physalus*
6	**Blue whale***	*Balaenoptera musculus*
7	Bryde's whale	*Balaenoptera edeni*

* Listed as threatened or endangered under the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq*.).

Table 1(b) – Odontocetes with possible/confirmed occurrence in the proposed activity area.

Odontocetes		
1	**Sperm whale***	*Physeter macrocephalus*
2	Dwarf sperm whale	*Kogia sima*
3	Pygmy sperm whale	*K. breviceps*
4	Blainville's beaked whale	*Mesoplodon densirostris*
5	Cuvier's beaked whale	*Ziphius cavirostris*
6	Gervais' beaked whale	*M. europaeus*
7	True's beaked whale	*M. mirus*
8	Rough-toothed dolphin	*Steno bredanensis*
9	Bottlenose dolphin	*Tursiops truncatus*
10	Pantropical spotted dolphin	*Stenella attenuate*
11	Atlantic spotted dolphin	*S. frontalis*
12	Spinner dolphin	*S. longirostris*
13	Striped dolphin	*S. coeruleoalba*
14	Clymene dolphin	*S. clymene*
15	Short-beaked common dolphin	*Delphinus delphis*
16	Atlantic white-sided-dolphin	*Lagenorhynchus acutus*
17	Fraser's dolphin	*Lagenodelphis hosei*
18	Risso's dolphin	*Grampus griseus*
19	Melon-headed whale	*Peponocephala electra*
20	False killer whale	*Pseudorca crassidens*
21	Pygmy killer whale	*Feresa attenuate*
22	Killer whale	*Orcinus orca*
23	Long-finned pilot whale	*Globicephala melas*
24	Short-finned pilot whale	*G. macrorhynchus*
25	Harbor porpoise	*Phocoena phocoena*

* Listed as threatened or endangered under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.).

Table 1(c) – Pinnipeds with possible/confirmed occurrence in the proposed activity area.

Pinnipeds		
1	Harbor seal	*Phoca vitulina*

1.1.3 Species Not Considered Due to Rarity in the Action Area

We do not consider the following species in this EA because their range does not overlap with the survey area or they are rarely present in the proposed survey area (NSF, 2014; Waring et al., 2014). Therefore, take is unlikely for these species.

Table 2 – Species with rare or uncommon occurrence in the proposed activity area.

Species Not Considered Further in this EA		
1	Beluga whale	*Delphinapterus leucas*
2	Gray seal	*Halichoerus grypus*
3	Hooded seal	*Cystophora cristata*
4	Harp seal	*Pagophilus groenlandicus*
5	West Indian manatee[1]	*Trichechus manatus*

[1] This species is under the jurisdiction of the U.S. Fish and Wildlife Service.

1.2 PURPOSE AND NEED

The MMPA prohibits "takes" of marine mammals with only a few specific exceptions. The applicable exception in this case is an exemption for incidental take of marine mammals in section 101(a)(5)(D) of the MMPA.

Section 101(a)(5)(D) of the MMPA directs the Secretary of Commerce (Secretary) to authorize, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if we make certain findings and provide a notice of a proposed authorization to the public for review.

We have issued regulations to implement the Incidental Take Authorization provisions of the MMPA (50 CFR § 216) and have produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures necessary to apply for authorizations. All applicants must comply with the regulations at 50 CFR § 216.104 and submit applications requesting incidental take according to the provisions of the MMPA.

Purpose: The primary purpose of our proposed action is to authorize the take of marine mammals incidental to Lamont-Doherty's proposed seismic survey. The Authorization would exempt Lamont-Doherty from the take prohibitions contained in the MMPA.

To authorize the take of small numbers of marine mammals, we must evaluate the best available information to determine whether the take would have a negligible impact on the affected marine mammal species or stock (*i.e.*, the population level) and have an unmitigable impact on the availability of the affected species or stock for certain subsistence uses.

In addition, we must prescribe, where applicable, the permissible methods of taking and other means of effecting the least practicable adverse impact on the marine mammal species or stocks and their habitat (*i.e.*, mitigation), paying particular attention to rookeries, mating grounds, and other areas of similar significance. Our duty under this *least practicable adverse impact* standard is to prescribe mitigation reasonably designed to minimize, to the extent practicable, any adverse population level impacts, as well as habitat impacts. While one can minimize population-level impacts only by reducing impacts on individual marine mammals, not all take translates to population-level impacts. Thus, our objective under the *least practicable adverse impact* standard is to design mitigation targeting those impacts on individual marine mammals that would most likely to lead to adverse population-level effects (78 FR at 78113 and 78135, 2013c).

If appropriate, we must also prescribe the means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. Authorizations must also include requirements or conditions pertaining to the monitoring and reporting of such taking—in large part to better understand the effects of such taking on the species or stock.

Need: On February 26, 2014, Lamont-Doherty submitted an adequate and complete application demonstrating both the need and potential eligibility for issuance of an Authorization in connection with the activities described in section 1.1.1. We now have a corresponding duty to determine whether and how we can authorize take by Level B harassment incidental to the activities described in Lamont-Doherty's application. Our responsibilities under section

101(a)(5)(D) of the MMPA and its implementing regulations establish and frame the need for this proposed action.

Any alternatives considered under NEPA must meet the agency's statutory and regulatory requirements. Our described purpose and need guide us in developing reasonable alternatives for consideration, including alternative means of mitigating potential adverse effects.

1.3 THE ENVIRONMENTAL REVIEW PROCESS

NEPA compliance is necessary for all "major" federal actions with the potential to significantly affect the quality of the human environment. Major federal actions include activities fully or partially funded, regulated, conducted, authorized, or approved by a federal agency. Because our proposed issuance of an Authorization would allow for the taking of marine mammals consistent with provisions under the MMPA, we consider this as a major federal action subject to NEPA.

Under the requirements of NAO 216-6 section 6.03(f)(2)(b) for incidental harassment authorizations, we prepared this EA to determine whether the direct, indirect, and cumulative impacts related to the proposed issuance of an Authorization for incidental take of marine mammals during the conduct of Lamont-Doherty's proposed seismic survey activities could be significant. If we deem the potential impacts to be not significant, this analysis, in combination with other analyses incorporated by reference—may support the issuance of a Finding of No Significant Impact (FONSI) for the proposed Authorization.

1.3.1 LAWS, REGULATIONS, OR OTHER NEPA ANALYSES INFLUENCING THE EA'S SCOPE

We have based the scope of the proposed action and nature of the alternatives considered in this EA on the relevant requirements in section 101(a)(5)(D) of the MMPA. Thus, our authority under the MMPA bounds the scope of our alternatives. We conclude that this analysis–combined with the analyses in the following documents–fully describes the potential impacts associated with the proposed seismic survey program, including any required mitigation and monitoring measures.

After conducting an independent review of the information and analyses for sufficiency and adequacy, we incorporate by reference the relevant analyses on Lamont-Doherty's proposed action, as well as a discussion of the affected environment and environmental consequences within the following documents per 40 CFR 1502.21 and NAO 216-6 § 5.09(d):

- our notice of the proposed Authorization in the *Federal Register* (79 FR 44549, July 31, 2014);
- *Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off Cape Hatteras, September–October 2014* (LGL, 2014);
- *Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off Cape Hatteras, September-October 2014* (NSF, 2014);
- *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* (NSF, 2011); and

- *Record of Decision for Marine Seismic Research Funded by the National Science Foundation. June, 2012* (NSF, 2012).

MMPA APPLICATION AND NOTICE OF THE PROPOSED IHA

The CEQ regulations (40 CFR § 1502.25) encourage federal agencies to integrate NEPA's environmental review process with other environmental review laws. We rely substantially on the public process for developing proposed Authorizations and evaluating relevant environmental information and provide a meaningful opportunity for public participation as we develop corresponding EAs. We fully consider public comments received in response to our publication of the notice of proposed Authorization during the corresponding NEPA review process.

On July 31, 2014, we published a notice of a proposed Authorization in the *Federal Register* (79 FR 44549) which included the following:

- A detailed description of the proposed action and an assessment of the potential impacts on marine mammals and their habitat;
- Plans for Lamont-Doherty's mitigation and monitoring measures to avoid and minimize potential adverse impacts to marine mammals and their habitat and proposed reporting requirements; and
- Our preliminary findings under the MMPA.

We considered Lamont-Doherty's proposed seismic survey and associated mitigation and monitoring measures and preliminarily determined that the proposed seismic survey in the Atlantic Ocean, September through October, 2014, would result, at worst, in a modification in behavior and/or low-level physiological effects (Level B harassment) of certain species of marine mammals. In addition, we determined that the proposed activity would not have an unmitigable adverse impact on the availability of marine mammals for subsistence uses. The notice afforded the public a 30-day comment period on our proposed MMPA Authorization.

1.3.2 SCOPE OF ENVIRONMENTAL ANALYSIS

Given the limited scope of the decision for which we are responsible, this EA intends to provide more focused information on the primary issues and impacts of environmental concern related specifically to our proposed issuance of the Authorization. This EA does not further evaluate effects to the elements of the human environment listed in Table 3 because environmental reviews for Lamont-Doherty's seismic survey, incorporated by reference (NSF, 2011, 2012, 2014), have evaluated the effects of their activities on other elements of the human environment.

The Foundation's EA for this activity (NSF, 2014); their *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* (hereafter refered as the PEIS, NSF, 2011); and Record of Decision (NSF, 2012) concluded that the impact of the action:

- would have minor and transitory effects on the marine environment or marine resources;
- would not significantly impact marine invertebrate populations, recreational and commercial fisheries, seabirds, and associated Essential Fish Habitat;
- would not significantly impact archaeological and traditional cultural resources; and
- would not significantly impact recreational dive sites and shipwrecks.

Table 3 – Components of the human environment not affected by our issuance of an Authorization.

Biological	Physical	Socioeconomic / Cultural
Amphibians	Air Quality	Commercial Fishing
Humans	Essential Fish Habitat	Military Activities
Non-Indigenous Species	Geography	Oil and Gas Activities
Seabirds	Land Use	Recreational Fishing
Sea Turtles	Oceanography	Shipping and Boating
	State Marine Protected Areas	Recreational Diving
	Federal Marine Protected Areas	National Historic Preservation Sites
	National Estuarine Research Reserves	National Trails and Nationwide Inventory of Rivers
	National Marine Sanctuaries	Low Income Populations
	Park Land	Minority Populations
	Prime Farmlands	Indigenous Cultural Resources
	Wetlands	Public Health and Safety
	Wild and Scenic Rivers	Historic and Cultural Resources
	Ecologically Critical Areas	

In addition, previous environmental reviews for similar Authorizations for seismic survey activities in the Atlantic Ocean, incorporated by reference, have shown that our limited action would not affect those components of the human environment listed in Table 3. They include:

- *Environmental Assessment for the Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Atlantic Ocean, April - June, 2013* (NMFS, 2013a);
- *Environmental Assessment: Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northeast Atlantic Ocean, June to July 2013* (NMFS, 2013b); and
- *Environmental Assessment on the Issuance of an Incidental Harassment Authorization to Lamont Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northwest Atlantic Ocean, June – August, 2014* (NMFS, 2014b).

In each case, we concluded that the proposed issuance of an Authorization for each seismic survey would not significantly affect the quality of the human environment and issued findings of no significant impact (FONSI).

1.3.3 Integrating NEPA Review with Other Environmental Reviews

NAO 216-6 established agency procedures for complying with NEPA and the implementing NEPA regulations issued by the CEQ. Consistent with the intent of NEPA and the clear direction in NAO 216-6 to involve the public in NEPA decision-making, we requested comments on the potential environmental impacts described in Lamont-Doherty's MMPA application and in the *Federal Register* notice of the proposed Authorization (79 FR 44549, July 31, 2014). The CEQ regulations further encourage agencies to integrate the NEPA review process with review under the environmental statutes. Consistent with agency practice, we integrated our NEPA review and preparation of this EA with the public process required by the MMPA for the proposed issuance of an Authorization.

The *Federal Register* notice of the proposed Authorization, combined with our preliminary determinations, supporting analyses, and corresponding public comment period are instrumental in providing the public with information on relevant environmental issues and offering the public a meaningful opportunity to provide comments to us for consideration in both the MMPA and NEPA decision-making processes.

The *Federal Register* notice of the proposed Authorization summarized our proposed action and any potential impacts to marine mammals and their habitat, and included a statement that we would evaluate the Foundation's draft EA (NSF, 2014) and determine whether or not to adopt it or prepare a separate NEPA analysis and incorporate relevant portions of the Foundation's draft EA by reference. We invited interested parties to submit written comments concerning the application and our preliminary analyses and findings including those relevant for consideration in the EA. The public comment period for the notice of the proposed Authorization began on July 31, 2014 and ended on September 2, 2014. The Foundation will finalize their EA at the conclusion of environmental reviews conducted under various statutes, including the MMPA and ESA.

We posted Lamont-Doherty's application on our website concurrently with the release of the *Federal Register* notice of the proposed Authorization. We base this EA on the information included in our *Federal Register* notice, the documents it references, and the public comments provided in response. At the conclusion of this process, we will post the final EA, and, if appropriate, FONSI, on the same website.

1.3.4 RELEVANT COMMENTS ON OUR *FEDERAL REGISTER* NOTICE

During the 30-day public comment period on the notice of the proposed Authorization, we received comment letters from the following individuals or groups (Tables 4a and 4b).

Table 4a – Federal, state, or municipal agencies who submitted comments on our proposed action.

Federal / State / Municipal Agencies	
U.S. Marine Mammal Commission	Town of Nags Head, NC
NMFS, Northeast Fisheries Science Center	Town of Kill Devil Hills, NC

Table 4b – Organizations and individuals who submitted comments on our proposed action.

Organizations and Private Citizens	
William McLellan	Meira Warshauer
Dr. D. Ann Pabst	Linda Ward
Jeff Oden	Marcus Langseth Science Oversight Committee
Bonnie Monteleone	Natural Resources Defense Council
Ginger Taylor	Center for Biological Diversity
Allen and Kathy Fitz	Anonymous commenter

The substantive public comments related to the potential environmental impacts associated with our action of issuing an Authorization for Lamont-Doherty's action include:

- Establishing larger exclusion zones for species of concern;
- Evaluating impacts to North Atlantic Right whales, beaked whales, and other species of concern;

- Ensuring that take remains below estimates by limiting Lamont-Doherty to both the specified tracklines and the specified number of line-kilometers, and requiring Lamont-Doherty to cease operations when they complete the authorized number of tracklines;
- Requiring Lamont-Doherty to use lowest practicable source level for the survey;
- Evaluating the potential impacts on marine species from sound-producing sources other than airguns and requiring Lamont-Doherty to use another type of multi-beam echosounder;
- Considering the use of alternate technologies for seismic airgun testing;
- Extending the post-shutdown and post-power-down monitoring for sperm and beaked whales from 30 minutes to 60 minutes or greater to minimize impacts;
- Considering time-area restrictions or closure for areas such as the Cape Hatteras Special Research Area (CHSRA);
- Suspending activities at night;
- Enhancing the visual monitoring program with additional technologies (*e.g.*, hydrophone buoys, aerial surveys, shore-based and small-vessel monitoring;
- Coordinating and notifying the regional stranding networks;
- Reconsidering acoustic thresholds;
- Ensuring adequate consideration of cumulative effects; and
- Re-evaluating our preliminary determinations for negligible impact and small numbers.

The Marine Mammal Commission (Commission) provides comments on all proposed incidental take authorizations as part of their established role under the MMPA (§ 202 (a)(2)). The Commission submitted the following recommendations:

- Require Lamont-Doherty to use site-specific sound modeling to verify, refine, and if needed, recalculate exclusion zone distances and take estimates;
- Require Lamont-Doherty to power down the airgun array when concentrations of six or more humpback, sei, fin, blue, and/or sperm whales are within the 160-dB buffer zone.
- Prohibit Lamont-Doherty from operating the multi-beam echosounder, sub-bottom profiler, and acoustic Doppler current profiler during transit;
- Prohibit Lamont-Doherty from engaging in any contingency activities (*e.g.*, repeating tracklines over what we proposed in the notice of proposed Authorization);
- Revise take estimates for harbor seals, spinner dolphins, Fraser's dolphins, melon-headed whales, pygmy killer whales, false killer whales, killer whales, Northern North Carolina Estuarine (NNCE) stock and Southern North Carolina Estuarine (SNCE) stock of bottlenose dolphins, based on presence in the area or average group size; and
- Consult with the Foundation and Lamont-Doherty to develop, validate, and implement a monitoring program that provides a scientifically sound, reasonably accurate assessment of the types of marine mammal takes and the actual numbers of marine mammals taken.

We fully considered all of the public comments, including any pertinent and substantive information, as part of our MMPA and NEPA decision-making process and crafted our proposed final Authorization and this EA accordingly. We have also provided responses to the public comments in the *Federal Register* notice announcing our final decision on the proposed issuance of the Authorization.

Where appropriate, we have modified the proposed Authorization based on public comments. Modifications to the proposed mitigation and/or monitoring measures include:

- Revising the take estimates for harbor seals, spinner dolphins, Fraser's dolphins, melon-headed whales, pygmy killer whales, false killer whales, killer whales, NNCE and SNCE stocks of bottlenose dolphins to account for presence or increases in group size;
- Restricting the operation of the multi-beam echosounder, sub-bottom profiler, and acoustic Doppler current profiler during transit;
- Prohibiting Lamont-Doherty from engaging in any contingency activities;
- Requiring a power down of the airgun array for concentrations of six or more animals are within the 160-dB buffer zone; and
- Extending the post-shutdown and post-power down monitoring for sperm and beaked whales from 30 minutes to 60 minutes or greater to minimize impacts.

1.4 Other Permits, Licenses, or Consultation Requirements

This section summarizes federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action. We incorporate those descriptions by reference in this EA and briefly summarize them in this section.

1.4.1 Endangered Species Act

Section 7 of the ESA and implementing regulations at 50 CFR § 402 require consultation with the appropriate federal agency (either NMFS or the U.S. Fish and Wildlife Service) for federal actions that "may affect" a listed species or critical habitat. Our proposed issuance of an Authorization is a federal action subject to the section 7 consultation requirements. Accordingly, we are required to ensure that our action is not likely to jeopardize the continued existence of any threatened or endangered species or result in destruction or adverse modification of critical habitat for such species.

There are six marine mammal species under our jurisdiction listed as endangered under the ESA with confirmed or possible occurrence in the proposed project area: blue, fin, humpback, North Atlantic right, sei, and sperm whales. There is no designated critical habitat for any of the ESA-listed species within the action area; thus, our proposed Authorization would not affect any of these species' critical habitats.

The Foundation requested authorization for the incidental take of three marine mammals listed as endangered under the ESA under our jurisdiction: humpback, fin, and sperm whales. Under section 7 of the ESA, the Foundation, the lead Federal agency which owns and operates the *Langseth*, initiated formal consultation on their action with the National Marine Fisheries Service, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division.

We also initiated formal consultation on our proposed action with the National Marine Fisheries Service, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division. For the proposed Authorization, NMFS reviewed Lamont-Doherty's take estimates for listed species under the ESA presented in Table 3 of their application (LGL, 2014). Based on the best available information, we requested consultation on the issuance of incidental take for additional listed species (i.e., blue, sei, and North Atlantic right whales) in addition to the Foundation's original incidental take request.

The formal consultation under section 7 of the ESA will conclude with a single Biological Opinion for the National Science Foundation's Division of Ocean Sciences and to the National

Marine Fisheries Service's Office of Protected Resources, Permits and Conservation Division for the seismic survey and proposed Authorization under the MMPA.

1.4.2 Marine Mammal Protection Act

We discuss the MMPA and its provisions that pertain to the proposed action described within section 1.2.

1.4.3 Magnuson-Stevens Fishery Conservation and Management Act

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA; 16 U.S.C. 1801 *et seq*.), Federal agencies are required to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency which may adversely affect essential fish habitat (EFH) identified under the MSFCMA.

Table 4 (pages 38-39) of the Foundation's draft EA (NSF, 2014) identifies marine species with EFH overlapping the proposed survey area. As the federal action agency funding Lamont-Doherty's activities, the Foundation would consult with NMFS' Southeast Regional Office on EFH.

We determined that mitigation and monitoring measures required by the Authorization for the action would not result in adverse effects to EFH. Thus, the proposed issuance of an Authorization for the taking of marine mammals, incidental to Lamont-Doherty's seismic survey would not impact EFH and would not require an EFH consultation.

1.4.4 Coastal Zone Management Act

Congress enacted the Coastal Zone Management Act (CZMA) (16 U.S.C. §§ 1451 *et seq*.) to encourage states to manage land and water uses that may affect coastal uses and resources. Once state coastal management programs and the policies within them receive federal approval from NOAA, federal agency activities that may have reasonably foreseeable effects on coastal uses or resources are required to be consistent with those enforceable policies.

North Carolina has not requested approval from NOAA's Office of Ocean and Coastal Resource Management (OCRM) to review the proposed Authorization as an unlisted activity. As the federal action agency funding Lamont-Doherty's activities, the Foundation would consult with North Carolina. The state of North Carolina evaluated the proposed project for consistency with their coastal management program and submitted their consistency concurrence to the Foundation on September 8, 2014. The determination requests the Foundation to abide by mitigation measures for marine mammals, including; conducting 60 minutes of visible monitoring for marine mammals prior to starting the airguns; using a passive acoustic monitoring system; and having at least two protected species visual observers on watch during daylight hours. The Foundation has agreed to follow, to the maximum extent practicable, that state's mitigation measures.

Chapter 2 – Alternatives

2.1 Introduction

The NEPA and the implementing CEQ regulations (40 CFR §§ 1500-1508) require consideration of alternatives to proposed major federal actions and NAO 216-6 provides agency policy and guidance on the consideration of alternatives to our proposed action. An EA must consider all reasonable alternatives, including the No Action Alternative. This provides a baseline analysis against which we can compare the other alternatives.

To warrant detailed evaluation as a reasonable alternative, an alternative must meet our purpose and need. In this case, and as we previously explained, an alternative meets the purpose and need if it satisfies the requirements under section 101(a)(5)(D) the MMPA. We evaluated each potential alternative against these criteria; identified two action alternatives along with the No Action Alternative; and carried these forward for evaluation in this EA.

Alternatives 1 and 3 include a suite of mitigation measures intended to minimize any potential adverse effects to marine mammals. This chapter describes both alternatives and compares them in terms of their environmental impacts and their achievement of objectives.

2.2 Description of Lamont-Doherty's Proposed Activities

We presented a general overview of Lamont-Doherty's proposed 2-D seismic survey operations in our *Federal Register* notice of the proposed Authorization (79 FR 44549, July 31, 2014). Also, the Lamont-Doherty's application and addendum (LGL, 2014) and the Foundation's draft EA (NSF, 2014), describe the survey protocols. We incorporate those descriptions by reference in this EA and briefly summarize them here.

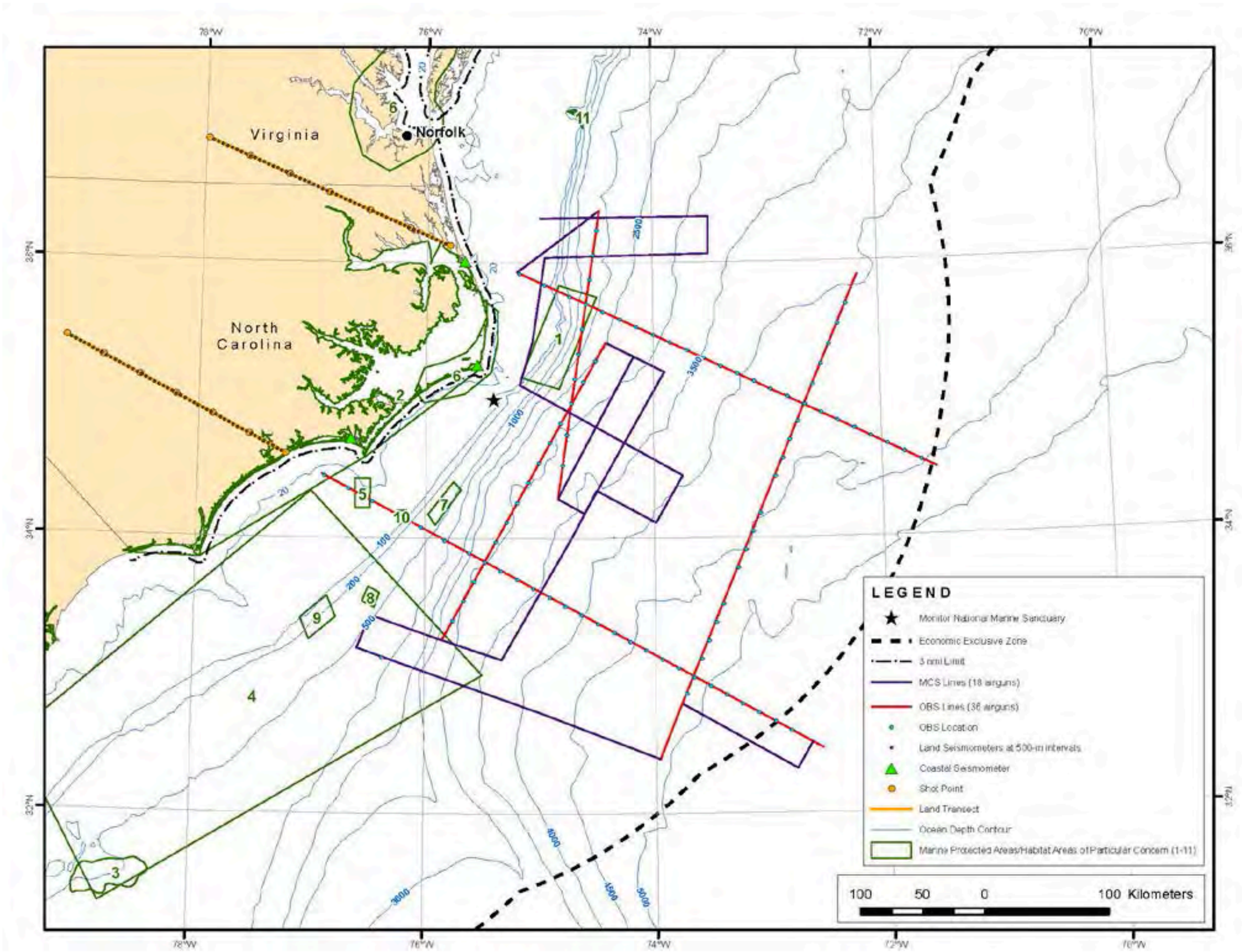
2.2.1 Specified Time and Specified Area

Lamont-Doherty proposes to conduct the seismic survey from the period of September 15 through October 31, 2014. The proposed study would include approximately 792 hours of airgun operations (i.e., a 24-hour operation over 33 days). Lamont-Doherty would not conduct the proposed survey after October 31, 2014 to avoid exposing North Atlantic right whales to sound at the beginning of their migration season.

Lamont-Doherty proposes to conduct the seismic survey in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, NC between approximately 32-37° N and approximately 71.5-77° W (Figure 1).

Water depths in the survey area are approximately 20 to 5,300 m (66 feet (ft) to 3.3 mi). They would conduct the proposed survey outside of North Carolina state waters, within the U.S. Exclusive Economic Zone, and partly in international waters.

Figure 1 – Proposed location of the seismic survey in the Atlantic Ocean off the coast of North Carolina during September through October, 2014.



2.2.2 2-D Seismic Survey Operations

Source Vessel: The *Langseth* is 71.5 m (235 ft) long vessel with a gross tonnage of 3,834 pounds. The vessel's speed during operations would be approximately 4.5 knots (kt) (8.3 km/hour (hr); 5.1 miles per hour (mph)). It has an observation tower that is 21.5 m (71 ft) above sea level providing protected species observers an unobstructed view around the entire vessel.

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

Transects: The proposed survey would cover approximately 5,185 km (3,221 mi) of transect lines (approximately 3,425 km for the multi-channel seismic and approximately 1,760 km for the seismometer acquisition operations) within the survey area. This represents a 1,165 km (723 mi) (reduction in transect lines from Lamont-Doherty's original proposal that totaled 6,350 km (3,946 mi) of transect lines within the survey area.

Seismic Airguns: During the survey, the *Langseth* crew would deploy a four-string array consisting of 36 airguns with a total discharge volume of approximately 6,600 cubic inches (in^3), or a two-string array consisting of 18 airguns with a total discharge volume of 3,300 in^3 as an energy source. The *Langseth* would tow the four-string array at a depth of approximately 9 m (30 ft) and would tow the two-string array at a depth of 6 m (20 ft). The shot interval during seismometer acquisition would be approximately 65 seconds every 150 m (492 ft) and 22 seconds every 50 m (164 ft) during multi-channel acquisition operations. During acquisition, the airguns will emit a brief (approximately 0.1 second) pulse of sound and during the intervening periods of operations, the airguns are silent.

Hydrophones and Ocean Bottom Seismometers: The receiving system would consist of one 8-km (5-mi) hydrophone streamer which would receive the returning acoustic signals and transfer the data to the on-board processing system. In addition to the hydrophone, the study would also use approximately 94 seismometers placed on the seafloor to record the returning acoustic signals from the airgun array internally for later analysis.

Multibeam Echosounder: The *Langseth* will operate a Kongsberg EM 122 multibeam echosounder only during airgun operations to map characteristics of the ocean floor. The hull-mounted echosounder emits brief pulses of sound (also called a ping) (10.5 to 13.0 kilohertz (kHz) in a fan-shaped beam that extends downward and to the sides of the ship. The nominal source level for the multibeam echosounder is 242 dB re: 1 μPa.

Sub-bottom Profiler: The *Langseth* will also operate a Knudsen Chirp 3260 sub-bottom profiler only during airgun operations to provide information about the sedimentary features and bottom topography. The hull-mounted profiler emits a ping with a dominant frequency component at 3.5 kHz. The nominal source level for the profiler is 204 dB re: 1 μPa.

Acoustic Doppler Current Profiler: Lamont-Doherty would measure currents only during airgun operations using a Teledyne OS75 75-kilohertz (kHz) acoustic Doppler current profiler (ADCP). The ADCP's configuration consists of a 4-beam phased array with a beam angle of 30°. The source level is proprietary information but has a maximum acoustic source level of 224 dB re: 1 μPa.

Support Vessels: Lamont-Doherty would use two support vessels for the proposed survey. The first support vessel, the R/V *Endeavor* (*Endeavor*) has a length of 56.4 m (184 ft), a beam of 10.1 m (33 ft), and a maximum draft of 5.6 m (18.3 ft). The *Endeavor* crew would deploy and retrieve the seismometers one-by-one from the stern of the vessel while onboard protected species observers monitor for marine mammals and recommend ceasing deploying or recovering the seismometers to avoid potential entanglement with marine mammals. Lamont-Doherty would use a second vessel to prevent the *Langseth's* streamer entangling with fixed fishing gear. The vessel would be a multi-purpose offshore utility vessel similar to the *Northstar Commander*, which is 28 m (91.9 ft) long with a beam of 8 m (26.2 ft) and a draft of 2.6 m (8.5 ft).

Ballast Water Requirements: The proposed seismic research would not result in discharges of any pollutants or non-indigenous species or into ocean waters. The operation of the Langseth would only result in discharges incidental to normal operations of a surface vessel (NSF, 2011).

2.2.2 APPROACH TO DEVELOPING MITIGATION EXCLUSION ZONES

Lamont-Doherty's application (LGL, 2014) and Appendix A in the Foundation's draft EA (NSF, 2014), describe the approach to establishing mitigation exclusion zones in detail. We incorporate those descriptions by reference in this EA and briefly summarize them here.

In summary, Lamont-Doherty acquired sound propagation measurements for several array configurations at shallow- and deep-water depths during acoustic verification studies conducted in the northern Gulf of Mexico in 2003 (Tolstoy et al., 2004) and in 2007 and 2008 (Tolstoy et al., 2009). Based on the empirical data from those studies, Lamont-Doherty developed a sound propagation modeling approach[2] that conservatively predicts received sound levels as a function of distance from a particular airgun array configuration in deep water (Diebold et al., 2010).

In 2010, Lamont-Doherty assessed the accuracy of their modeling approach by comparing the sound levels of the field measurements in the Gulf of Mexico study to their model predictions (Diebold, et al., 2010). They reported that the observed sound levels from the field measurements fell almost entirely below the predicted mitigation radii curve for deep water (Diebold, et al., 2010). Based on this information, Lamont-Doherty has shown that their model can reliably estimate mitigation radii in deep water. We acknowledge that Lamont-Doherty based their modeling approach on the environmental variability present in the Gulf of Mexico, but the model has limited ability to capture the variability resulting from site-specific factors present in the marine environment offshore North Carolina.

Lamont-Doherty used a similar process to develop mitigation radii (i.e., exclusion and buffer zones) for a shallow-water seismic survey in the northeast Pacific Ocean offshore Washington in 2012. Lamont-Doherty conducted a shallow-water survey using an airgun configuration that was similar or larger to the discharge volumes proposed for this survey in shallow-water survey (i.e., 3,300 or 6,600 in^3) and recorded the received sound levels on the shelf and slope off Washington using the *Langseth's* 8-km hydrophone streamer. Crone et al. (2013) analyzed those received sound levels from the 2012 survey and reported that the actual distances for the exclusion and buffer zones were two to three times smaller than what Lamont-Doherty's modeling approach predicted. While the results confirm bathymetry's role in sound propagation, Crone et al. (2013) confirmed that the empirical measurements from the Gulf of Mexico calibration survey (the same measurements used to inform Lamont-Doherty's modeling approach for this survey in shallow water) overestimated the size of the exclusion and buffer zones for the shallow-water 2012 survey off Washington and were thus precautionary, in that particular case, for effecting the least practicable impact marine mammals.

The comparisons of Lamont-Doherty's model results and the field data collected in the Gulf of Mexico and Washington illustrate a degree of conservativeness built into Lamont-Doherty's model for deep water, which we would expect to offset some of the limited ability of the model to capture the variability resulting from site-specific factors, especially in shallow water. However, in the interest of additional protection, we have required more conservative and

[2] The modeling approach uses ray tracing (*i.e.*, a graphical representation of the effects of refracting sound waves) 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).

precautionary mitigation and monitoring measures within this Authorization. Following our consideration of those conservative factors, we have included an additional layer of conservativeness by increasing the 180-dB and 190-dB exclusion zones for the shallow-water portions of this survey to be precautionary and to account for sound levels falling well below the estimated radii. The precautionary exclusion zone with the additional buffer would increase the radius of the exclusion zones in shallow water by a factor of approximately 41 percent for the single airgun, approximately 48 percent for the 18-airgun array, and approximately 38 percent for the 36-airgun array. Thus, enlarging the exclusion zones within the shallow-water portions of the survey should be able to account for any environmental variability within the study area in addition to the other conservative factors that we have considered in estimating the exclusion zones. Table 5 in this EA shows the original and revised predicted distances that Lamont-Doherty would use to establish exclusion and buffer zones for mitigation.

Table 5 –Modeled exclusion zones (EZ) for marine mammals in the survey area.

Source and Volume (in^3)	**Tow Depth (m)**	**Water Depth (m)**	**Predicted RMS Distances[1] (m)**				
			190 dB with Buffer	190 dB	180 dB with Buffer	180 dB	160 dB
Single Bolt airgun (40 in^3)	6 or 9	< 100	37[3]	27[3]	121[3]	86[3]	938[3]
		100-1,000	-	-	100	100	582[2]
		> 1,000	-	-	100	100	388[1]
18-Airgun array (3,300 in^3)	6	< 100	436[4]	294[4]	1,628[4]	1,097[4]	15,280[4]
		100-1,000	-	-	-	675[2]	5,640[2]
		> 1,000	-	-	-	450[1]	3,760[1]
36-Airgun array (6,600 in^3)	9	< 100	877[3]	645[3]	2,838[3]	2,060[3]	22,600[3]
		100-1,000	-	-	-	1,391[2]	8,670[2]
		> 1,000	-	-	-	927[1]	5,780[1]

[1] Based on Lamont-Doherty modeling results.
[2] Predicted distances based on model results with a 1.5 correction factor between deep and intermediate water depths.
[3] Predicted distances based on empirically-derived measurements in the Gulf of Mexico with scaling factor applied to account for differences in tow depth.
[4] Predicted distances based on empirically-derived measurements in the Gulf of Mexico.

2.3 DESCRIPTION OF ALTERNATIVES

2.3.1 ALTERNATIVE 1 – ISSUANCE OF AN AUTHORIZATION WITH MITIGATION MEASURES

The Proposed Action constitutes Alternative 1 and is the Preferred Alternative. Under this alternative, we would propose to issue an Authorization (valid from September through October 2014) to Lamont-Doherty allowing the incidental take, by Level B harassment, of 30 species of marine mammals subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the proposed Authorization, along with any additions based on consideration of public comments.

MITIGATION MEASURES

As described in Section 1.2, we must prescribe the means of effecting the least practicable adverse impact on the species or stocks of marine mammals and their habitat. In order to do so, we must consider Lamont-Doherty's proposed mitigation measures, as well as other potential measures, and assess how such measures could benefit the affected species or stocks and their habitat. Our evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, we expect the successful implementation of the measure to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Any additional mitigation measure proposed by us beyond what the applicant proposes should be able to or have a reasonable likelihood of accomplishing or contributing to the accomplishment of one or more of the following goals:

- Avoidance or minimization of marine mammal injury, serious injury, or death wherever possible;
- A reduction in the numbers of marine mammals taken (total number or number at biologically important time or location);
- A reduction in the number of times the activity takes individual marine mammals (total number or number at biologically important time or location);
- A reduction in the intensity of the anticipated takes (either total number or number at biologically important time or location);
- Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base; activities that block or limit passage to or from biologically important areas; permanent destruction of habitat; or temporary destruction/disturbance of habitat during a biologically important time; and
- For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

To reduce the potential for disturbance from acoustic stimuli associated with the activities, Lamont-Doherty has agreed to implement the following monitoring and mitigation measures for marine mammals. These include:

1) Utilize NMFS-qualified, vessel-based Protected Species Observers (PSOs) to visually watch for and monitor marine mammals near the seismic source vessel during daytime operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during start-ups of sound sources day or night. Two PSOs would observe the exclusion and disturbance zones. When practicable, as an additional means of visual observation, the *Langseth's* vessel crew may also assist in detecting marine mammals.

2) Establish a 180-dB and 190-dB exclusion zone (with 3-dB buffer) exclusion zone (EZ) for marine mammals for the shallow-water portion of the survey and establish a 180-dB and 190-dB EZ in intermediate or deep water depths before the full array (either 3,300 or 6,600 in^3) or a single airgun (40 in^3) is in operation (Table 5).

3) Visually observe the entire extent of the relevant EZ (the 180-dB with buffer in shallow water and 180 dB in intermediate or deep water depths for cetaceans; or 190-dB with buffer in shallow water depths and 190-dB in intermediate or deep water for pinnipeds) using NMFS-qualified PSOs, for at least 30 minutes (min) prior to starting the airgun array (day or night).

4) Implement a ramp-up procedure when initiating the seismic operations or any time after the entire array has been shut down for more than 8 minutes, which means start the smallest sound source first and add sound sources in a sequence such that the source level of the array shall increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-

up, the PSOs would monitor the EZ, and if they sight marine mammals, they would implement a power-down or shutdown as though the full array were operational. Therefore, initiation of ramp-up procedures from shutdown requires that the PSOs visually observe the full EZ described in Measures 2 and 3.

5) Power-down or shutdown the sound source(s) if a PSO detects a marine mammal that is within, approaches, or enters the applicable EZ. A shutdown means that the crew shuts down all operating sound sources (i.e., turned off). A power-down means reducing the number of operating sound sources to a single operating 40 in^3 airgun, which reduces the EZ to the degree that the animal(s) is no longer within or about to enter it.

6) Set the shot interval for the single operating 40 in^3 airgun to one shot per minute.

7) Following a power-down, the *Langseth* crew would not resume full airgun activity until the marine mammal has cleared the relevant exclusion zone (see Table 5). The observers would consider the animal to have cleared the exclusion zone if:
    a. the observer has visually observed the animal leave the exclusion zone; or
    b. an observer has not sighted the animal within the exclusion zone for 15 minutes for species with shorter dive durations (*i.e.*, small odontocetes); or 30 minutes has passed for mysticetes and large odontocetes (including pygmy sperm, dwarf sperm, and killer whales); and 60 minutes has passed for sperm and beaked whales which can have longer dive durations.

8) Following a power-down, the *Langseth* crew would resume operating the airguns at full power after for 15 minutes for species with shorter dive durations (*i.e.*, small odontocetes); or 30 minutes has passed for mysticetes and large odontocetes (including pygmy sperm, dwarf sperm, and killer whales); and 60 minutes has passed for sperm and beaked whales which can have longer dive durations.

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

10) Following a shutdown for more than 8 minutes and subsequent animal departure, survey operations may resume following ramp-up procedures described in Measure 4.

11) The seismic survey may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire applicable EZs can be effectively monitored visually (*i.e.*, PSO(s) must be able to see the extent of the entire applicable EZ).

12) No initiation of survey operations involving the use of sound sources is permitted from a shutdown position at night or during low-light hours (such as in dense fog or heavy rain) unless at least one airgun (40-in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the vessel's crew would not ramp up the airgun array from a complete shutdown at night or in thick fog, because the outer part of the EZ would not be visible during those conditions.

13) Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant EZ. If speed or course alteration is not safe or practicable, or if after implementing an alteration the marine mammal still appears likely to enter the EZ, further mitigation measures, such as a power-down or shutdown, shall be taken.

14) Power down the airgun array for concentrations of six or more animals are within the 160-dB buffer zone and avoid concentrations of humpback , sei, fin, blue, and/or sperm whales (if possible (i.e., exposing concentrations of animals to 160 dB re: 1 μPa). For purposes of the survey, a concentration or group of whales will consist of six or more individuals visually sighted that do not appear to be traveling (*e.g.*, feeding, socializing, etc.).

15) Restrict the operation of the multi-beam echosounder, sub-bottom profiler, and acoustic Doppler current profiler during transit; and

16) Prohibit Lamont-Doherty from engaging in any contingency activities.

MONITORING MEASURES

Lamont-Doherty proposes to sponsor marine mammal monitoring during the present project, in order to implement the mitigation measures that require real-time monitoring and to satisfy the monitoring requirements of the Authorization. Lamont-Doherty understands that we would review the monitoring plan and may require refinements to the plan.

The Authorization would require Lamont-Doherty to use a passive acoustic monitoring (PAM) system, to the maximum extent practicable, to detect, and allow some localization of marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. When the PAM operator detects an animal, he/she must notify the PSO immediately of a vocalizing marine mammal so the *Langseth* crew can initiate a power-down or shut-down, if required.

REPORTING MEASURES

Lamont-Doherty would submit a report to us and the Foundation within 90 days after the end of the cruise. The report would describe the operations conducted and sightings of marine mammals near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The report must contain and summarize the following information:

1) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;
2) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of power-downs and shutdowns), observed throughout all monitoring activities;
3) An estimate of the number (by species) of: (A) pinnipeds that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 μPa and/or 190 dB re: 1 μPa with a discussion of any specific behaviors those individuals exhibited; and (B) cetaceans that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 μPa and/or 180 dB re: 1 μPa with a discussion of any specific behaviors those individuals exhibited.
4) A description of the implementation and effectiveness of the: (A) terms and conditions of the Biological Opinion's Incidental Take Statement (ITS); and (B) mitigation measures required by our Authorization. For the Biological Opinion, the report shall confirm implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on ESA-listed marine mammals.

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the Authorization, such as an injury (Level A harassment), serious injury, or mortality (*e.g.*, ship-strike, gear interaction, and/or entanglement), Lamont-Doherty would immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, her designees, and the Southeast Regional Stranding Coordinator. Lamont-Doherty may not resume activities until we are able to review the circumstances of the prohibited take. The report must include the following information:

1) Time, date, and location (latitude/longitude) of the incident;
2) The *Langseth's* speed during and leading up to the incident;
3) Description of the incident;
4) Status of all sound source use in the 24 hours preceding the incident;
5) Water depth;
6) Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
7) A description of marine mammal observations in the 24 hours preceding the incident;
8) Species identification or description of the animal(s) involved;
9) The fate of the animal(s); and
10) Photographs or video footage of the animal (if equipment is available).

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

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the injury or death is not associated with or related to the authorized activities (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Lamont-Doherty would report the incident to the Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, her designees, and the and the Southeast Regional Stranding Coordinator within 24 hours of the discovery. Lamont-Doherty would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Activities may continue while we review the circumstances of the incident.

TAKE ESTIMATES

Lamont-Doherty modeled the number of different individuals that could be exposed to airgun sounds with received levels greater than or equal to 160 dB re: 1 μPa on one or more occasions by multiplying the total marine area that would be within the 160-dB radius around the operating seismic source on at least one occasion (3,425 km^2 which does not include contingency for repeating tracklines) along with the expected density of animals in the area.

Based on public comments received on the *Federal Register* notice of proposed Authorization, we re-evaluated the mitigation and monitoring proposed for incorporation in the Authorization. We determined—based on the best available information—that the revised mitigation measures and revised take estimates are presently the most feasible and effective measures for implementation (Wright, 2014). Thus, this Preferred Alternative would satisfy the purpose and need of our proposed action under the MMPA–issuance of an Authorization, along with required mitigation measures and monitoring that meets the standards set forth in section 101(a)(5)(D) of the MMPA and the implementing regulations.

2.3.2 Alternative 2 – No Action Alternative

Under the No Action Alternative, Lamont-Doherty could choose not to proceed with their proposed activities or to proceed without an Authorization. If they choose the latter, Lamont-Doherty would not be exempt from the MMPA take prohibitions and would be in violation of the MMPA if take of marine mammals occurs.

For purposes of this EA, we characterize the No Action Alternative as Lamont-Doherty not receiving an Authorization and Lamont-Doherty conducting the 2-D seismic survey program without the protective measures and reporting requirements required by an Authorization under the MMPA. We take this approach to meaningfully evaluate the primary environmental issues—the impact on marine mammals from these activities in the absence of protective measures.

2.3.3 Alternative 3 – Issuance of Authorization with Additional Mitigation Measures

Under Alternative 3, we would issue an Authorization to Lamont-Doherty, allowing the incidental take by Level B harassment only of small numbers of marine mammal species incidental to conducting seismic survey activities in the Atlantic Ocean during the effective period of the Authorization. Alternative 3 would consist of all of the mitigation, monitoring, and reporting measures contained in Alternative 1, including the following additional measures derived from the public comment process on our notice of the proposed Authorization.

(1) **Alternate Survey Areas:** This measure would require Lamont-Doherty to not conduct the survey within the CHSRA to minimize interactions with marine life.

(2) **Operational Restrictions**: This measure would require Lamont-Doherty to suspend their activities in low-light/nighttime conditions and minimize the number of repeated tracklines for the survey.

(3) **Augmented Visual Monitoring**: This measure would require the use of alternative technologies and methods (e.g., hydrophone buoys, aerial surveys, shore-based and small-vessel monitoring) to detect marine mammals beyond the proposed visual and acoustic monitoring.

2.4 Alternatives Considered but Eliminated from Further Consideration

We considered whether other alternatives could meet the purpose and need and support the Lamont-Doherty's activities. We considered an alternative that would allow for the issuance of an Authorization with no required mitigation or monitoring but eliminated that Alternative from consideration, as it would not be in compliance with the MMPA and therefore would not meet the purpose and need. For that reason, we do not analyze this alternative further in this document.

CHAPTER 3 – AFFECTED ENVIRONMENT

This chapter describes existing conditions in proposed survey area. Descriptions of the physical and biological environment of the action area are contained in the documents incorporated by reference (see section 1.3.1) and summarized here.

3.1 PHYSICAL ENVIRONMENT

As discussed in Chapter 1, our proposed action and alternatives relate only to the proposed issuance of our Authorization of incidental take of marine mammals and not to the physical environment. Certain aspects of the physical environment are not relevant to our proposed action (see section 1.3.2 - Scope of Environmental Analysis). Because of the requirements of NAO 216.6, however, we briefly summarize the physical components of the environment here.

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 approximately 300 to 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 less than 200 m offshore, then sloping gradually to 5000-m depth (NSF, 2014).

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 (NSF, 2014).

3.1.1 MARINE MAMMAL HABITAT

We presented information on marine mammal habitat and the potential impacts to marine mammal habitat in our notice of the proposed Authorization. Also, the Foundation presented more detailed information on the physical and oceanographic aspects of the North Carolina environment in their draft EA (NSF, 2014).

The Cape Hatteras Research Area (CHSRA) is a special research area offshore of Cape Hatteras, North Carolina designated by NMFS under the Pelagic Longline Take Reduction Plan (50 CFR 229.36). The research conducted within the CHSRS results in a better understanding the nature of marine mammal interactions incidental to the commercial pelagic longline fishery. The goal is to reduce serious injuries and mortalities of pilot whales and Risso’s dolphins resulting from interactions with pelagic longline gear. The CHSRA designation relates specifically to commercial longline fishing and regulatory and non-regulatory measures to reduce marine mammal and other species bycatch from that fishery. It does not, however, include restrictions on other activities including navigation through the area (BOEM, 2014).

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 MARINE MAMMALS

We provide information on the occurrence of marine mammals with possible or confirmed occurrence in the survey area in section 1.1.2 of this EA (Tables 1a, b, and c). The marine mammals most likely to be present in the action area are in Table 6.

The *Federal Register* notice on the proposed Authorization provided information on the stock, regulatory status, abundance, occurrence, seasonality, and hearing ability of the marine mammals in the action area. Lamont-Doherty's application and the Foundation's EA also provided distribution, life history, and population size information for marine mammals within the action area. We incorporate those descriptions by reference and briefly summarize the information in Table 6.

Table 6 – Marine mammals most likely to be harassed incidental to Lamont-Doherty's survey.

Species	Stock Name	Regulatory Status[1, 2]	Stock/Species Abundance[3]	Range	Seasonal Occurrence
North Atlantic right whale	Western Atlantic	MMPA - D ESA – EN	455	Coastal/shelf	Uncommon
Humpback whale	Gulf of Maine	MMPA - D ESA – EN	823	Pelagic	Uncommon
Minke whale	Canadian East Coast	MMPA - D ESA – NL	20,741	Coastal/shelf	Uncommon
Sei whale	Nova Scotia	MMPA - D ESA – EN	357	Offshore	Rare
Fin whale	Western North Atlantic	MMPA - D ESA – EN	3,522	Pelagic	Rare
Blue whale	Western North Atlantic	MMPA - D ESA – EN	440[4]	Coastal/pelagic	Rare
Bryde's whale	NA	MMPA - D ESA – NL	11,523[5]	Shelf/pelagic	Uncommon
Sperm whale	Nova Scotia	MMPA - D ESA – EN	2,288	Pelagic	Common
Dwarf sperm whale	Western North Atlantic	MMPA - NC ESA – NL	3,785	Off Shelf	Uncommon
Pygmy sperm whale	Western North Atlantic	MMPA - NC ESA – NL	3,785	Off Shelf	Uncommon
Blainville's beaked whale	Western North Atlantic	MMPA - NC ESA – NL	7,092	Pelagic	Rare
Cuvier's beaked whale	Western North Atlantic	MMPA - NC ESA – NL	6,532	Pelagic	Uncommon
Gervais' beaked whale	Western North Atlantic	MMPA - NC ESA – NL	7,092	Pelagic	Rare
True's beaked whale	Western North Atlantic	MMPA - NC ESA – NL	7,092	Pelagic	Rare
Rough-toothed dolphin	Western North Atlantic	MMPA - NC ESA – NL	271	Pelagic	Uncommon
Bottlenose dolphin	Western North Atlantic Offshore	MMPA - NC ESA – NL	77,532	Pelagic	Common
	Western North Atlantic Southern Migratory Coastal	MMPA – D, S ESA – NL	9,173	Coastal	Common
	WNA Southern NC Estuarine System	MMPA – D, S ESA – NL	188	Coastal	Common
	WNA Northern NC Estuarine System	MMPA – D, S ESA – NL	950	Coastal	Common
Pantropical spotted dolphin	Western North Atlantic	MMPA - NC ESA – NL	3,333	Pelagic	Common
Atlantic spotted dolphin	Western North Atlantic	MMPA - NC ESA – NL	44,715	Shelf/slope pelagic	Common
Spinner dolphin	Western North Atlantic	MMPA - NC ESA – NL	11,441[6]	Coastal/pelagic	Rare
Striped dolphin	Western North Atlantic	MMPA - NC ESA – NL	54,807	Off shelf	Common
Clymene dolphin	Western North Atlantic	MMPA - NC ESA – NL	6,086[7]	Slope	Uncommon

Table 6 (cont.) – Marine mammals most likely to be harassed incidental to Lamont-Doherty's survey.

Short-beaked common dolphin	Western North Atlantic	MMPA - NC ESA – NL	173,486	Shelf/pelagic	Common
Atlantic white-sided-dolphin	Western North Atlantic	MMPA - NC ESA – NL	48,819	Shelf/slope	Rare
Fraser's dolphin	Western North Atlantic	MMPA - NC ESA – NL	726[8]	Pelagic	Rare
Risso's dolphin	Western North Atlantic	MMPA - NC ESA – NL	18,250	Shelf/slope	Common
Melon-headed whale	Western North Atlantic	MMPA - NC ESA – NL	2,283[9]	Pelagic	Rare
False killer whale	Northern Gulf of Mexico	MMPA - NC ESA – NL	177[10]	Pelagic	Rare
Pygmy killer whale	Western North Atlantic	MMPA - NC ESA – NL	1,108[11]	Pelagic	Rare
Killer whale	Western North Atlantic	MMPA - NC ESA – NL	28[12]	Coastal	Rare
Long-finned pilot whale	Western North Atlantic	MMPA - NC ESA – NL	26,535	Pelagic	Common
Short-finned pilot whale	Western North Atlantic	MMPA - NC ESA – NL	21,515	Pelagic	Common
Harbor porpoise	Gulf of Maine/ Bay of Fundy	MMPA - NC ESA – NL	79,883	Coastal	Rare
Harbor seal	Western North Atlantic	MMPA - NC ESA – NL	70,142	Coastal	Uncommon

[1] MMPA: D = Depleted, S = Strategic, NC = Not Classified.
[2] ESA: EN = Endangered, T = Threatened, DL = Delisted, NL = Not listed.
[3] 2013 NMFS Stock Assessment Report (Waring et al., 2014) unless otherwise noted. NA = Not Available.
[4] Minimum population estimate based on photo identification studies in the Gulf of St. Lawrence (Waring et al., 2010).
[5] There is no stock designation for this species in the Atlantic. Abundance estimate derived from the ETP stock = 11,163 (Wade and Gerodette, 1993); Hawaii stock = 327 (Barlow, 2006); and Northern Gulf of Mexico stock = 33 (Waring et al., 2013).
[6] There is no abundance information for this species in the Atlantic. Abundance estimate derived from the Northern Gulf of Mexico Stock = 11,441 (Waring et al., 2014).
[7] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 6,086 (CV=0.93) (Mullin and Fulling, 2003).
[8] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 726 (CV=0.70) for the Gulf of Mexico stock (Mullin and Fulling, 2004).
[9] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 2,283 (CV=0.76) for the Gulf of Mexico stock (Mullin, 2007).
[10] There is no abundance information for this species in the Atlantic. The best available estimate of abundance was 177 (CV=0.56) for the Gulf of Mexico stock (Mullin, 2007).
[11] There is no abundance information for this species in the Atlantic. Abundance estimate derived from the Northern Gulf of Mexico stock = 152 (Mullin, 2007) and the Hawaii stock = 956 (Barlow, 2006).
[12] There is no abundance information for this species in the Atlantic. Abundance estimate derived from the Northern Gulf of Mexico stock = 28 (Waring et al., 2014).

Pinnipeds: For the proposed Authorization, we considered authorizing take for one species of pinniped based upon the best available density information (Navy, 2007) and information from the 2013 NMFS Stock Assessment Report (Waring, et al., 2014). This section includes a brief summary on life history information for harbor seals.

Harbor Seals: Harbor seals are part of the "true seal" family, *Phocidae*. True seals lack external ear flaps and have short forelimbs that result in limited locomotion on land. Harbor seals typically inhabit temperate coastal habitats and use rocks, reefs, beaches, and drifting glacial ice as haul outs and pupping sites (Waring, et al., 2014). On the east coast, they range from the Canadian Arctic to southern New England, New York, and occasionally the Carolinas (Waring et al., 2010; Waring, et al., 2014). In recent years, small numbers of seals (<50) have established winter haul-out sites in the Chesapeake Bay and near Oregon Inlet North Carolina.

The best estimate of abundance for harbor seals is 70,142 (CV=0.29) with a minimum population estimate of 55,409 based on corrected available counts along the Maine coast in 2012 (Waring, et al., 2014). Harbor seals eat a variety of prey consisting mainly of fish, shellfish, and crustaceans. Researchers have found that seals complete both shallow and deep dives during hunting depending on the availability of prey (Tollit et al., 1997).

CHAPTER 4 – ENVIRONMENTAL CONSEQUENCES

This chapter of the EA includes a discussion of the impacts of the three alternatives on the human environment. Lamont-Doherty's application, our notice of a proposed Authorization, and other related environmental analyses identified previously, inform our analysis of the direct, indirect, and cumulative effects of our proposed issuance of an Authorization.

Under the MMPA, we have evaluated the potential impacts of Lamont-Doherty's seismic survey activities in order to determine whether to authorize incidental take of marine mammals. Under NEPA, we have determined that an EA is appropriate to evaluate the potential significance of environmental impacts resulting from the issuance of our Authorization.

4.1 EFFECTS OF ALTERNATIVE 1 – ISSUANCE OF AN AUTHORIZATION WITH MITIGATION MEASURES

Alternative 1 is the Preferred Alternative where we would issue an Authorization to Lamont-Doherty allowing the incidental take, by Level B harassment, of 30 species of marine mammals from September through October, 2014, subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the Authorization, if issued.

4.1.1 IMPACTS TO MARINE MAMMAL HABITAT

Our proposed action would have no additive or incremental effect on the physical environment beyond those resulting from the proposed activities. Lamont-Doherty's proposed seismic survey is not located within a marine sanctuary, wildlife refuge, a National Park, or other conservation area. The proposed activity— which uses one seismic source vessel—would minimally add to vessel traffic in the region and would not result in substantial damage to ocean and coastal habitats that might constitute marine mammal habitats. Finally, the proposed Authorization would not impact physical habitat features, such as substrates and/or water quality.

Prey: The overall response of fishes and squids from the seismic survey is to exhibit startle responses and undergo vertical and horizontal movements away from the sound source. We expect that the seismic survey would have no more than a temporary and minimal adverse effect on any fish or invertebrate species. Although there is a potential for injury to fish or marine life in close proximity to the vessel, we expect that the impacts of the seismic survey on fish and other marine life specifically related to acoustic activities would be temporary in nature, negligible, and would not result in substantial impact to these species or to their role in the ecosystem.

4.1.2 IMPACTS TO MARINE MAMMALS

We expect that the Lamont-Doherty's 2-D seismic survey has the potential to take marine mammals by Level B harassment, as defined by the MMPA. Acoustic stimuli generated by the airgun arrays (and to a lesser extent the multibeam echosounder, sub-bottom profiler, and acoustic Doppler current profiler) may affect marine mammals in one or more of the following ways: behavioral disturbance, tolerance, masking of natural sounds, and temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al., 1995).

Our *Federal Register* notice of proposed Authorization, Lamont-Doherty's application (LGL, 2014), and the Foundation's EA on this action (NSF, 2014) provide detailed descriptions of these potential effects of seismic surveys on marine mammals. We incorporate those discussions by reference here and summarize our consideration of additional studies submitted during the public comment period in the following sections.

The effects of noise on marine mammals are highly variable, ranging from minor and negligible to potentially significant, depending on the intensity of the source, the distances between the animal and the source, and the overlap of the source frequency with the animals' audible frequency. Nevertheless, monitoring and mitigation measures required by us for Lamont-Doherty's proposed activities will effectively reduce any significant adverse effects of these sound sources on marine mammals.

Behavioral Disturbance: The studies discussed in the *Federal Register* notice for the proposed Authorization note that there is variability in the behavioral responses of marine mammals to noise exposure. However, it is important to consider the context in predicting and observing the level and type of behavioral response to anthropogenic signals (Ellison et al., 2012).

Marine mammals may react to sound when exposed to anthropogenic noise. These behavioral reactions are often shown as: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing or cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (e.g., pinnipeds flushing into water from haul-outs or rookeries). The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Richardson, et al., 1995; Southall et al., 2007).

Studies have shown that underwater sounds from seismic activities are often readily detectable by marine mammals in the water at distances of many kilometers (Castellote et al., 2012). Many studies have also shown that marine mammals at distances more than a few kilometers away often show no apparent response when exposed to seismic activities (e.g., Akamatsu et al., 1993; Harris et al., 2001; Madsen & Møhl, 2000; Malme et al., 1983, 1984; Richardson et al., 1986; Weir, 2008). Other studies have shown that marine mammals continue important behaviors in the presence of seismic pulses (e.g., Dunn & Hernandez, 2009; Greene Jr. et al., 1999; Holst & Beland, 2010; Holst & Smultea, 2008; Holst et al., 2005; Nieukirk et al., 2004; Richardson, et al., 1986; Smultea et al., 2004).

In a passive acoustic research program that mapped the soundscape in the North Atlantic Ocean, Clark and Gagnon (2006) reported that some fin whales in the northeast Pacific Ocean stopped singing for an extended period starting soon after the onset of a seismic survey in the area. The authors could not determine whether or not the whales left the area ensonified by the survey, but the evidence suggests that most, if not all, of the singers remained in the area. When the survey stopped temporarily, the whales resumed singing within a few hours and the number of singers increased with time. Also, one whale continued to sing while the seismic survey was actively operating (Figure 4, Clark & Gagnon, 2006). The authors conclude that there is not enough scientific knowledge to adequately evaluate whether or not these effects on singing or mating behaviors are significant or would alter survivorship or reproductive success.

It is important to note that Lamont-Doherty's study area is well away from any known breeding grounds for low frequency cetaceans thereby reducing further the likelihood of causing an effect on marine mammal mating behaviors or calving.

MacLeod et al. (2006) discussed the possible displacement of fin and sei whales related to distribution patterns of the species during a large-scale seismic survey offshore the west coast of Scotland in 1998. The authors hypothesized about the relationship between the whale's absence and the concurrent seismic activity, but could not rule out other contributing factors (Macleod, et al., 2006; Parsons et al., 2009). We would expect that marine mammals may briefly respond to underwater sound produced by Lamont-Doherty's seismic survey by slightly changing their behavior or relocating a short distance. Based on the best available information, we expect short-term disturbance reactions that are confined to relatively small distances and durations (Thompson et al., 1998; Thompson et al., 2013), with no long-term effects on recruitment or survival.

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

McCauley et al. (2000; 1998) studied the responses of migrating humpback whales off western Australia to a full-scale seismic survey with a 16-airgun array (2,678 cubic inches (in3)) and to a single, 20-in^3airgun. Both studies point to a contextual variability in the behavioral responses of marine mammals to sound exposure. The mean received level for initial avoidance of an approaching airgun was 140 dB re: 1 μPa for humpback whale pods containing females. In contrast, some individual humpback whales, mainly males, approached within distances of 100 to 400 m (328 to 1,312 ft), where sound levels were 179 dB re: 1 μPa (McCauley, et al., 2000). The authors hypothesized that the males gravitated towards the single operating air gun possibly due to its similarity to the sound produced by humpback whales breaching. Despite the evidence that some humpback whales exhibited localized avoidance reactions at received levels below 160 dB re: 1 μPa, the authors found no evidence of any gross changes in migration routes, such as inshore/offshore displacement during seismic operations (McCauley, et al., 2000; McCauley, et al., 1998).

DeRuiter et al.(2013) recently observed that beaked whales (considered a particularly sensitive species) exposed to playbacks (*i.e.*, simulated) of U.S. tactical mid-frequency sonar from 89 to 127 dB re: 1 μPa at close distances responded notably by altering their dive patterns . In contrast, individuals showed no behavioral responses when exposed to similar received levels from *actual* U.S. tactical mid-frequency sonar operated at much further distances (DeRuiter, et al., 2013). As noted earlier, one must consider the importance of context (*e.g.*, the distance of a sound source from the animal) in predicting behavioral responses.

Tolerance: With repeated exposure to sound, many marine mammals may habituate to the sound at least partially (Richardson & Wursig, 1997). Bain and Williams (2006) examined the effects of a large airgun array (maximum total discharge volume of 1,100 in^3) on six species in shallow waters off British Columbia and Washington: harbor seal, California sea lion (*Zalophus* *californianus*), Steller sea lion (*Eumetopias jubatus*), gray whale (*Eschrichtius robustus*), Dall's porpoise (*Phocoenoides dalli*), and the harbor porpoise. Harbor porpoises showed reactions at received levels less than 145 dB re: 1 µPa at a distance of greater than 70 km (43 miles) from the seismic source (Bain & Williams, 2006). However, the tendency for greater responsiveness by harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson, et al., 1995; Southall, et al., 2007). In contrast, the authors reported that gray whales seemed to tolerate exposures to sound up to approximately 170 dB re: 1 µPa (Bain & Williams, 2006) and Dall's porpoises occupied and tolerated areas receiving exposures of 170–180 dB re: 1 µPa (Bain & Williams, 2006; Parsons, et al., 2009). The authors observed several gray whales that moved away from the airguns toward deeper water where sound levels were higher due to propagation effects resulting in higher noise exposures (Bain & Williams, 2006). However, it is unclear whether their movements reflected a response to the sounds (Bain & Williams, 2006). Thus, the authors surmised that the lack of gray whale responses to higher received sound levels were ambiguous at best because one expects the species to be the most sensitive to the low-frequency sound emanating from the airguns (Bain & Williams, 2006).

Pirotta et al. (2014) observed short-term responses of harbor porpoises to a 2-D seismic survey in an enclosed bay in northeast Scotland which did not result in broad-scale displacement. The harbor porpoises that remained in the enclosed bay area reduced their buzzing activity by 15% during the seismic survey (Pirotta, et al., 2014). Thus, animals exposed to anthropogenic disturbance may make trade-offs between perceived risks and the cost of leaving disturbed areas (Pirotta, et al., 2014). However, unlike the semi-enclosed environment described in the Scottish study area, Lamont-Doherty's seismic study occurs in the open ocean. Because Lamont-Doherty would conduct the survey in an open ocean area, we do not anticipate that the seismic survey would entrap marine mammals between the sound source and the shore as marine mammals can temporarily leave the survey area during the operation of the airgun(s) to avoid acoustic harassment.

Masking: Studies have shown that marine mammals are able to compensate for masking by adjusting their acoustic behavior such as shifting call frequencies and increasing call volume and vocalization rates. For example, blue whales increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio & Clark, 2010). North Atlantic right whales exposed to high shipping noise increased call frequency (Parks et al., 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller et al., 2000).

Risch et al. (2012) documented reductions in humpback whale vocalizations in the Stellwagen Bank National Marine Sanctuary concurrent with transmissions of the Ocean Acoustic Waveguide Remote Sensing (OAWRS) low-frequency fish sensor system at distances of 200 km from the source. The recorded OAWRS produced series of frequency modulated pulses and the signal received levels ranged from 88 to 110 dB re: 1 µPa (Risch, et al., 2012). The authors hypothesized that individuals did not leave the area but instead ceased singing and noted that the duration and frequency range of the OAWRS signals (a novel sound to the whales) were similar to those of natural humpback whale song components used during mating (Risch, et al., 2012). Thus, the novelty of the sound to humpback whales in the study area provided a compelling contextual probability for the observed effects (Risch, et al., 2012). However, the authors did not state or imply that these changes had long-term effects on individual animals or populations (Risch, et al., 2012). The change in vocal behaviors related to mating activities do not apply to the marine mammal species present in the area of Lamont-Doherty's seismic survey. Again, Lamont-Doherty's study area is well away from any known breeding grounds for low frequency cetaceans, thereby reducing further the likelihood of causing an effect on marine mammal mating behaviors.

We expect that masking effects of seismic pulses would be limited in the case of smaller odontocetes given the intermittent nature of seismic pulses (22 or 65 seconds) plus the fact that sounds important to them are predominantly at much higher frequencies than are the dominant components of airgun sounds. Pinnipeds have best hearing sensitivity and/or produce most of their sounds at frequencies higher than the dominant components of airgun sounds, but there is some overlap in the frequencies of the airgun pulses and the calls. However, the intermittent nature of airgun pulses presumably reduces the potential for masking.

Hearing Impairment: Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Finneran et al., 2005; Finneran & Schlundt, 2013; Finneran et al., 2000; Kastak & Schusterman, 1998; Kastak et al., 1999; Schlundt et al., 2013; Schlundt et al., 2000). However, there has been no specific documentation of temporary threshold shift (TTS) or permanent hearing damage, *i.e.*, permanent threshold shift (PTS) in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions (NSF, 2014).

Lucke et al. (2009) found a threshold shift (TS) of a harbor porpoise after exposing it to airgun noise with a received sound pressure level (SPL) at 200.2 dB (peak –to-peak) re: 1 μPa, which corresponds to a sound exposure level of 164.5 dB re: 1 μPa^2 s after integrating exposure. NMFS currently uses the root-mean-square (rms) of received SPL at 180 dB and 190 dB re: 1 μPa as the threshold above which permanent threshold shift (PTS) could occur for cetaceans and pinnipeds, respectively. Because the airgun noise is a broadband impulse, one cannot directly determine the equivalent of rms SPL from the reported peak-to-peak SPLs. However, applying a conservative conversion factor of 16 dB for broadband signals from seismic surveys (McCauley, et al., 2000) to correct for the difference between peak-to-peak levels reported in Lucke et al. (2009) and rms SPLs, the rms SPL for TTS would be approximately 184 dB re: 1 μPa, and the received levels associated with PTS (Level A harassment) would be higher. This is still above our current 180 dB rms re: 1 μPa threshold for injury. However, we recognize that TTS of harbor porpoises is lower than other cetacean species empirically tested (Finneran & Schlundt, 2010; Finneran et al., 2002; Kastelein & Jennings, 2012).

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

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

The predicted distances at which sound levels could result in Level A harassment are relatively small (585 m; 1,919 ft for cetaceans, and 157 m; 515 ft for pinnipeds). The avoidance behaviors observed in Thompson et al.'s (1998) study supports our expectation that individual marine mammals would avoid exposure at higher levels. Also, it is unlikely that animals would encounter repeated exposures at very close distances to the sound source because Lamont-Doherty would implement the required shutdown and power down mitigation measures to ensure that marine mammals do not approach the applicable exclusion zones for Level A harassment. We also expect that Level A harassment will be prevented through the required vessel-based visual monitoring of the exclusion zones and implementation of mitigation measures.

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

We have considered the potential for behavioral responses and indirect injury or mortality from Lamont-Doherty's use of the multibeam echosounder. Given that Lamont-Doherty proposes to conduct the survey offshore and transit in a manner that would not entrap marine mammals in shallow water, we do not anticipate that the use of the source during the seismic survey would entrap marine mammals between the vessel's sound sources and the North Carolina coastline. In addition the proposed Authorization outlines reporting measures and response protocols intended to minimize the impacts of, and enhance the analysis of, any potential stranding in the survey area.

NOAA has declared an Unusual Mortality Event (UME) for bottlenose dolphins along the Atlantic coast from early July 2013 through the present. Elevated strandings of bottlenose dolphins have occurred in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia and Florida (through Brevard County). All age classes of bottlenose dolphins are involved and strandings range from a few live animals to mostly dead animals with many very decomposed. Many dolphins have presented with lesions on their skin, mouth, joints, or lungs (NMFS, 2014a). At this time, all age classes of bottlenose dolphins are involved. Based upon preliminary diagnostic testing and discussion with disease experts the tentative cause of this UME could be cetacean morbillivirus (NMFS, 2014c). However the investigation is still ongoing and additional contributory factors to the UME are under investigation including other pathogens, biotoxins, range expansion, etc. (NMFS, 2014c).

No studies are available that would inform our analysis of whether seismic surveys have any additional impacts on marine mammal species subject to a UME. As discussed above, we have evaluated the potential effects of seismic surveys on a number of marine mammal species, including bottlenose dolphins and beaked whales, and have concluded that Lamont-Doherty's proposed seismic survey would, at most, result in a temporary modification in behavior, temporary changes in animal distribution, and/or low-level physiological effects. We base this conclusion on the following factors: (1) the available literature supports our conclusion that the low-frequency content of air gun impulses may have fewer predicted impacts on bottlenose dolphins (Schlundt, et al., 2013); (2) the mitigation and monitoring measures are expected to limit the occurrence and intensity of any exposure; and (3) any effect on the human environment due to the project's impacts on dolphins is not expected to be significant.

In sum, we interpret these effects on all marine mammals as falling within the MMPA definition of Level B (behavioral) harassment. We expect these impacts to be minor because we do not anticipate measurable changes to the population or impacts to rookeries, mating grounds, and other areas of similar significance.

Under the Preferred Alternative, we would authorize incidental take, by Level B harassment only, of 30 species of marine mammals. Based on our best professional judgment and our evaluation of all of the available data, we expect no long-term or substantial adverse effects on marine mammals, their habitats, or their role in the environment.

Lamont-Doherty proposed a number of monitoring and mitigation measures for marine mammals as part of our evaluation for the Preferred Alternative. In consideration of the potential effects of the proposed seismic survey, we determined that the mitigation and monitoring measures described in section 2.3.1 of this EA would be appropriate for the preferred alternative to meet the Purpose and Need.

Injury: Lamont-Doherty did not request authorization to take marine mammals by injury (Level A harassment), serious injury, or mortality. Based on the results of our analyses, Lamont-Doherty's environmental analyses, and previous monitoring reports for the same activities, we do not expect Lamont-Doherty's planned activities to result in injury, serious injury, or mortality within the action area. The required mitigation and monitoring measures would minimize any potential risk for marine mammals.

Vessel Strikes: The potential for striking marine mammals is a concern with vessel traffic. Studies have associated ship speed with the probability of a ship strike resulting in an injury or mortality of an animal. However, it is highly unlikely that Lamont-Doherty would strike a marine mammal given the *Langseth's* slow survey speed (8 to 12 km/hr; 4 to 6 kt). Moreover, mitigation measures would be required of Lamont-Doherty to reduce speed or alter course if a collision with a marine mammal appears likely.

Estimated Take of Marine Mammals by Level B Incidental Harassment: Lamont-Doherty has requested take by Level B harassment as a result of the acoustic stimuli generated by their proposed seismic survey. We expect that the survey would cause a short-term behavioral disturbance for marine mammals in the proposed area.

As mentioned previously, we estimate that the activities could potentially affect, by Level B harassment only, 30 species of marine mammals under our jurisdiction. For each species, these estimates are small numbers relative to the population sizes. Table 7 outlines, the regional density estimates for marine mammals in the action area, the number of Level B harassment takes that we propose to authorize in this Authorization, the percentage of each population or stock proposed for take as a result of Lamont-Doherty's activities, and the population trend for each species.

Table 7 – Proposed Level B harassment take levels, species or stock abundance, and percentage of population proposed for take during the proposed seismic survey in the Atlantic Ocean, September through October, 2014.

Species	**Density Estimate**[1] (#/1000 km^2)	**Modeled Number of Individuals Exposed to Sound Levels ≥ 160 dB**[2]	**Proposed Take Authorization**[3]	**Percent of Species or Stock**[4]	**Population Trend**[5]
North Atlantic right whale	0.13, 0.01, 0.001[6]	5	5	1.25	Increasing
Humpback whale	0.73, 0.56, 1.06	38	44	5.24	Increasing
Minke whale	0.03, 0.02, 0.04	2	2	0.01	No data
Sei whale	1.69, 2.24, 2.19[6,7]	86	98	27.34	No data
Fin whale	0.98, 0.48,0.14[6,7]	16	19	0.52	No data
Blue whale	0.003, 0.02, 0.03[6,7]	2	3	0.52	No data
Bryde's whale	0.429, 0.429, 0.429[6]	18	20	No data	No data
Sperm whale	0.03, 0.68, 3.23	91	104	6.48	No data
Dwarf sperm whale	0.64, 0.49, 0.93	34	39	1.01	No data
Pygmy sperm whale	0.64, 0.49, 0.93	34	39	1.01	No data
Cuvier's beaked whale	0.01, 0.14, 0.58	17	19	0.29	No data
Blainville's beaked whale	0.01, 0.14, 0.58	17	19	0.26	No data
Gervais' beaked whale	0.01, 0.14, 0.58	17	19	0.26	No data
True's beaked whale	0.01, 0.14, 0.58	17	19	0.26	No data
Rough-toothed dolphin	0.30, 0.23, 0.44	16	18	6.62	No data
Bottlenose dolphin (Offshore)	70.4, 331, 49.4	3,374	3,829	4.94	No data
Bottlenose dolphin (SMC)	70.4, 0, 0	686	778	8.01	No data
Bottlenose dolphin (SNCES)	70.4, 0, 0	1[7]	23[8]	12.07	No data
Bottlenose dolphin (NNCES)	70.4, 0, 0	1[7]	7[8]	0.72	No data
Pantropical spotted dolphin	14, 10.7, 20.4	732	830	24.9	No data
Atlantic spotted dolphin	216.5, 99.7, 77.4	4,616	5,239	11.72	No data
Spinner dolphin	0, 0, 0	65[8]	74	No data	No data
Striped dolphin	0, 0.4, 3.53	98	112	0.20	No data
Clymene dolphin	6.7, 5.12, 9.73	351	398	No data	No data
Short-beaked comm. dolphin	5.8, 138.7, 26.4	1,338	1,519	0.88	No data
Atlantic white-sided dolphin	0, 0, 0	0	0	0	No data
Fraser's dolphin	0, 0, 0	100[8]	114	No data	No data
Risso's dolphin	1.18, 4.28, 2.15	88	100	0.54	No data
Melon-headed whale	0, 0, 0	100[8]	100	No data	No data
False killer whale	0, 0, 0	15[8]	18	No data	No data
Pygmy killer whale	0, 0, 0	25[8]	29	No data	No data
Killer whale	0, 0, 0	6[8]	7	No data	No data
Long-finned pilot whale	3.74, 58.9, 19.1	795	903	3.4	No data
Short-finned pilot whale	3.74, 58.9, 19.1	795	903	4.19	No data
Harbor porpoise	0, 0, 0	0	0	0	No data
Harbor seal	0, 0, 0	4[8]	5	0.01	No data

[1] Except where noted, densities are the mean values for the shallow (<100 m), intermediate (100-1,000m), and deep (>1,000m) water stratum in the survey area calculated from the SERDP SDSS NODES fall model (Read et al., 2009) as presented in Table 3 of Lamont-Doherty's application.
[2] Modeled take in this table corresponds to the total modeled take over all depth ranges within a total ensonified area of 40,968 km^2. See Table 3 of Lamont-Doherty's application for their original take estimates by shallow, intermediate, and deep strata. See Table 9 in Lamont-Doherty's EA for revised take estimates based on modifications to the tracklines to reduce the total ensonified area (40,968 km^2).
[3] The Authorization includes additional coverage for those potential takes of individuals where Lamont-Doherty would repeat tracklines. This estimate accounts for overlap and turnover within the area to account for take of additional individuals that could experience Level B harassment within those areas where the tracklines overlap.
[4] Stock/species abundance estimates from Table 1 in (79 FR 44549, July 31, 2014) used in calculating the percentage of species/stock.
[5] Population trend information is from Waring et al., 2014. No data = Insufficient data to determine population trend.
[6] Density data derived from the Navy's NMSDD.
[7] Density estimates revised from proposed density estimate (79 FR 44549, July 31, 2014).
[6] Density estimates revised from proposed density based on information from ESA section 7 consultation.
[7] Modeled estimate includes the area that is less than 3 km from shore ensonified to greater than or equal to 160 dB (10 km^2 total).
[8] Species presence offshore NC based on pers. com. with Dr. Caroline Good (2014) and Mr. McLellan (2014); group size estimates based on CETAP and AMAPPS surveys (NEFSC and SEFSC, 2011, 2012, 2013, 2014) for odontocetes and pinnipeds; and Read et al., (2003) for bottlenose dolphins.

Our *Federal Register* notice for the proposed Authorization and Lamont-Doherty's application contain descriptions of how we derived the take estimates. We do not expect the proposed activities to impact rates of recruitment or survival for any affected species or stock. Further, the activities would not adversely affect marine mammal habitat.

Under Alternative 1, the proposed action has no unmitigable adverse impact to subsistence uses, because there are no permitted subsistence uses of marine mammals in the region.

4.2 Effects of Alternative 2– No Action Alternative

Under the No Action Alternative, we would not issue an Authorization to Lamont-Doherty. As a result, Lamont-Doherty would not receive an exemption from the MMPA prohibitions against the take of marine mammals and would, if they proceeded with their activities, be in violation of the MMPA if take of marine mammals occurs.

The impacts to elements of the human environment resulting from the No Action alternative—conducting the 2-D seismic survey program in the absence of required protective measures for marine mammals under the MMPA—would be greater than those impacts resulting from Alternative 1, the Preferred Alternative.

4.2.1 Impacts to Marine Mammal Habitat

Under the No Action Alternative, the survey would have no additive effects on the physical environment beyond those resulting from Lamont-Doherty's activities, which we evaluated in the referenced documents. This Alternative would result in similar effects on the physical environment as Alternative 1.

4.2.2 Impacts to Marine Mammals

Under the No Action Alternative, Lamont-Doherty's activities would likely result in increased amounts of Level B harassment to marine mammals and possibly takes by injury (Level A harassment), serious injury, or mortality—specifically related to acoustic stimuli—due to the absence of mitigation and monitoring measures required under the proposed Authorization.

While it is difficult to provide an exact number of takes that might occur under the No Action Alternative, we would expect the numbers to be larger than those presented in Table 8 because of the lack of restrictions imposed on Lamont-Doherty's survey operations. Lamont-Doherty could take significantly more marine mammals by harassment due to the lack of required mitigation measures including shutdowns and power downs for marine mammals.

If the activities proceeded without the protective measures and reporting requirements required by a final Authorization under the MMPA, the direct, indirect, or cumulative effects on the human or natural environment of not issuing the Authorization would include the following:

- Marine mammals within the survey area could experience injury (Level A harassment) and potentially serious injury or mortality. The lack of mitigation measures that would otherwise be required in an Authorization could lead to vessels not altering their course or speed around marine mammals, not ramping up or powering or shutting down airguns when marine mammals are within applicable injury harassment zones; and not shutting down for North Atlantic right whales or for groups of six or more large whales;
- Increases in the number of behavioral responses and frequency of changes in animal distribution because of the lack of mitigation measures required in the proposed Authorization. Thus, the incidental take of marine mammals would likely occur at higher levels than we have already identified and evaluated in our *Federal Register* notice on the proposed Authorization; and
- We would not be able to obtain the monitoring and reporting data needed to assess the anticipated impact of the activity upon the species or stock; and increased knowledge of the species as required under the MMPA.

Under Alternative 2, the action has no unmitigable adverse impact to subsistence uses, as there are no permitted subsistence uses of marine mammals in the region.

4.3 Effects of Alternative 3 – Issuance of with Additional Mitigation Measures

4.3.1 Impacts to Marine Mammal Habitat

Effects to the physical environment would be the same under Alternative 3 as those described above for Alternative 1. We would expect no additional effects beyond those already described.

4.3.2 Impacts to Marine Mammals

Under this Alternative, marine mammals would still experience harassment by Lamont-Doherty's proposed seismic survey in the Atlantic Ocean. As described in Alternative 1, anticipated impacts to marine mammals associated with Lamont-Doherty's proposed activities primarily result from noise propagation. Potential impacts to marine mammals might include one or more of the following: tolerance, masking of important natural signals, behavioral disturbance, and temporary or permanent hearing impairment or non-auditory effects. These are the same types of reactions that we would anticipate under the Preferred Alternative (Alternative 1)

The primary difference under Alternative 3 is that we would require additional mitigation and monitoring measures for detecting marine mammals. These additional measures include requiring an alternate time for the survey; implementing operational restrictions for nighttime operations; and the use of alternate technologies to augment monitoring.

Alternate Survey Timing: This measure would require Lamont-Doherty to postpone their research to minimize interactions with marine life. The Foundation considered this mitigation measure in their EA (NSF, 2014) and concluded that the proposed dates for the cruise (September - October) would minimize impacts to species of concern such as the North Atlantic right whale because of the low likelihood of their presence in the area at that time. This measure, however, may have the added effect of increasing the number of takes for North Atlantic right whales (Dr. Good, pers. comm.). The Foundation also concluded that this option was not practicable because the personnel and equipment essential to meet the overall project objectives were not available.

Operational Restrictions: This measure would require Lamont-Doherty to suspend their activities in low-light/nighttime conditions and minimize the number of repeated tracklines for the survey. This measure fails to meet the meet one of Lamont-Doherty's research requirements which is to conduct the survey in the shortest time span possible, day and night. The MMPA requires us to take into account the practicability of mitigation measures. Restricting activities to daytime operations only would unnecessarily lengthen the time to complete the survey which would not be practicable from an operational standpoint. Suspending the survey at night would inevitably increase the number of days to complete the survey and would likely result in increased amounts of Level B harassment to marine mammals over a longer duration of time. While the additional measure may provide some added protection for marine mammals present in the research area during nighttime operations, we do not expect that this measure would reduce the overall level of effects. Level B harassment of marine mammals would still occur.

Augmented Monitoring: This measure would require the use of alternative methods to detect marine mammals beyond the proposed visual observation and acoustic monitoring. The Foundation considered this mitigation measure in their EA (NSF, 2014) and concluded that at the present time, these technologies are still not feasible, commercially viable, or appropriate to meet their Purpose and Need.

While the technologies for these monitoring methods are still being developed and refined, we expect that they would allow for additional detection of marine mammals beyond visual observations from shipboard observers. These additional monitoring measures could allow for necessary mitigation measures (*i.e*., power-downs and shutdowns) to be implemented more quickly and more frequently, thereby potentially reducing further the number of marine mammal takes. However, until these technologies are developed and fully tested, we are unable to provide a reasonable estimate of this reduction in take levels.

Under Alternative 3, the action has no unmitigable adverse impact to subsistence uses, as there are no permitted subsistence uses of marine mammals in the region.

4.4 Compliance with Necessary Laws – Necessary Federal Permits

We have determined that the issuance of an Authorization would be consistent with the applicable requirements of the MMPA, ESA, MSFMCA, and CZMA, and our regulations. Please refer to section 1.4 of this EA for more information.

4.5 Unavoidable Adverse Impacts

Lamont-Doherty's application, our *Federal Register* notice of a proposed Authorization, and other environmental analyses identified previously summarize unavoidable adverse impacts to marine mammals or the populations to which they belong or on their habitats, as well as subsistence uses of marine mammals, occurring in the seismic survey area. We incorporate those documents by reference.

We acknowledge that the incidental take authorized would potentially result in unavoidable adverse impacts. However, we do not expect Lamont-Doherty's activities to have adverse consequences on the viability of marine mammals in the Atlantic Ocean. We do not expect the marine mammal populations in that area to experience reductions in reproduction, numbers, or distribution that might appreciably reduce their likelihood of surviving and recovering in the wild. We expect that the numbers of individuals of all species taken by harassment would be small (relative to species or stock abundance), that the seismic survey and the take resulting from the seismic survey activities would have a negligible impact on the affected species or stocks of marine mammals, and that there would not be an unmitigable adverse impact to subsistence uses of marine mammals in the Atlantic Ocean.

4.6 Cumulative Effects

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR §1508.7). Cumulative impacts can result from individually minor but collectively significant actions that take place over a period of time.

The proposed seismic survey would add another, albeit temporary activity to the marine environment in the Atlantic Ocean and the proposed survey would be limited to a relatively small area for a comparatively short period of time. The Foundation's EA (NSF, 2014) summarizes the potential cumulative effects to marine mammals or the populations to which they belong or on their habitats occurring in the survey area. This section incorporates the Foundation's EA by reference and provides a brief summary of the human-related activities affecting the marine mammal species in the action area.

4.6.1 Previous and Future Seismic Research Surveys in the Same Area

The U.S. Geological Survey (USGS) would conduct two seismic surveys over the span of two years to support the delineation of the U.S. Extended Continental Shelf (ECS) in the Atlantic Ocean August through September, 2014, and April to August, 2015. The USGS would use the *Langseth* to conduct survey for approximately 18 to 21 days covering approximately 3,000 km of seismic tracklines that overlap in within the northern portion of Lamont-Doherty's proposed survey offshore North Carolina.

On August 21, 2014, we issued an Authorization for the USGS survey (79 FR 5212, September 2, 2014) for the take of marine mammals, by Level B harassment, incidental to conducting a marine geophysical (seismic) survey in the Atlantic Ocean off the Eastern Seaboard, August to September, 2014 and April to August, 2015. The USGS prepared a separate EA for their action and determined that the conduct of the both surveys would not likely result in significant impacts on the human environment and prepared and issued a FONSI.

Both USGS surveys are dispersed both geographically and temporally, are short-term in nature, and all of the Authorization holders would be required to use mitigation and monitoring measures to minimize impacts to marine mammals and other living marine resources in the activity area. We are unaware of any synergistic impacts to marine resources associated with reasonably foreseeable future actions that may be planned or occur within the same region of influence as the proposed survey.

4.6.2 Unusual Mortality Event (UME) for Bottlenose Dolphins

NOAA has declared an UME for bottlenose dolphins along the Atlantic coast from early July 2013 through the present. Elevated strandings of bottlenose dolphins have occurred in North Carolina. All age classes of bottlenose dolphins are involved and strandings range from a few live animals to mostly dead animals with many very decomposed (NMFS, 2014a). Based upon preliminary diagnostic testing and discussion with disease experts, the tentative cause of this UME could be cetacean morbillivirus (NMFS, 2014c). However the investigation is still ongoing and additional contributory factors to the UME are under investigation including other pathogens, biotoxins, range expansion, etc. (NMFS, 2014c).

4.6.3 Military Activities

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 known 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 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. Lamont-Doherty are coordinating with the U.S. Navy to minimize conflicts.

4.6.4 Future Oil and Gas Exploration

The proposed survey site is within the Bureau of Ocean and Energy's (BOEM) Outer Continental Shelf (OCS) Mid-Atlantic and South Atlantic Planning Areas for proposed geological and geophysical (G&G) activities (BOEM, 2014). BOEM's intention is to authorize oil and gas activities in support of all three BOEM program areas: oil and gas exploration and development, renewable energy, and marine minerals in the future. We do not anticipate that the BOEM activities would occur simultaneously to Lamont-Doherty's proposed seismic survey and we are unaware of any synergistic impacts to marine resources associated with reasonably foreseeable future actions that may be planned or occur within the same region of influence as the proposed survey.

4.6.5 Climate Change

The 2007 Intergovernmental Panel on Climate Change concluded that there is very strong evidence for global warming and associated weather changes and that humans have "very likely" contributed to the problem through burning fossil fuels and adding other "greenhouse gases" to the atmosphere (IPCC, 2007a, 2007b). This study involved numerous models to predict changes in temperature, sea level, ice pack dynamics, and other parameters under a variety of future conditions, including different scenarios for how human populations respond to the implications of the study.

Increased ocean temperatures will reduce oxygen, and atmospheric CO_2 will reduce ocean pH and threaten the health of the marine ecosystem. Ocean circulation patterns will change, with less mixing of cold and warm water in tropical and subtropical areas, affecting the ability of near-surface species to reach nutrients at lower depths (NJCAA, 2014). At more northern latitudes mixing could actually increase with melting of sea ice, but general ocean warming will alter migration and breeding patterns and push species further northward (NJCAA, 2014).

With the large degree of uncertainty on the impact of climate change to marine mammals in the Atlantic Ocean, we recognize that warming of this region could affect the prey base and habitat quality for marine mammals. Nonetheless, we expect that the conduct of the seismic survey and the issuance of an Authorization to Lamont-Doherty would not result in any noticeable contributions to climate change.

CHAPTER 5 – LIST OF PREPARERS AND AGENCIES CONSULTED

Agencies Consulted:

Marine Mammal Commission
4340 East West Highway, Room 700
Bethesda, Maryland 20814

NOAA – National Marine Fisheries Service
Office of Protected Resources
Endangered Species Act Interagency Cooperation Division
1315 East West Highway, SSMC 3
Silver Spring, MD 20910

Prepared By:

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Office of Protected Resources
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REFERENCES

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APPENDIX D: EFH Consultation Letters

NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

July 11, 2014

David Dale
National Oceanic and Atmospheric Administration
National Marine Fisheries Service Southeast Region
Habitat Conservation Division
263 13th Avenue South
St. Petersburg, FL 33701-5505

Dear Mr. Dale:

NSF has a proposed research activity which includes a marine seismic survey in the Atlantic Ocean off Cape Hatteras outside of state waters and mostly within the U.S. EEZ, and partly in International Waters during the period September - October 2014. The proposed seismic survey would be funded by the National Science Foundation (NSF) and led by Drs. H. Van Avendonk and G. Christeson (University of Texas at Austin), D. Shillington and A. Bécel, (Columbia University's Lamont-Doherty Earth Observatory (LDEO)), M. Hornbach and B. Magnani (Southern Methodist University), B. Dugan (Rice University), D. Lizarralde (Woods Hole Oceanographic Institution), and S. Harder (University of Texas at El Paso). The overall research effort would be to collect and analyze data along the mid-Atlantic coast of the East North America Margin (ENAM). The data set would 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 proposed seismic survey would be conducted on the NSF-owned research vessel (R/V) *Langseth*, which is operated by LDEO. During the survey an 18 or 36-airgun array would be deployed as an energy source, with a maximum discharge volume of 3300 in^3 or 6600 in^3. The receiving system for the returning acoustic signals would be a towed hydrophone streamer and/or ocean bottom seismometers.

We have attached a copy of our Draft Environmental Assessment (EA), prepared on our behalf by LGL, Ltd., pursuant to the National Environmental Policy Act (NEPA) and Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions". Details about the project and the proposed activities can be found in Chapters I & II of the Draft EA. Information about Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) were identified within the survey area and were described in the Draft EA (pages 36-37). Potential effects on EFH and HAPC were also considered and included in the Draft EA (pages 68-70). Although the proposed activities may affect EFH and HAPC, the Draft EA concludes that any adverse effects would be localized and transitory and therefore would not likely be significant. Monitoring and mitigation measures for the survey have been proposed in the Draft EA (pages 7-15). With the proposed monitoring and mitigation measures, 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.

Although NSF anticipates no significant impacts to EFH and HAPC, as the proposed activities may affect EFH and HAPC, in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA) NSF requests consultation.

We look forward to consulting with you on this proposed action, and we stand ready to help resolve any concerns expeditiously to ensure that the research efforts may proceed in a timely and environmentally responsible manner. Please contact me if you have any questions or concerns regarding the request or the supporting information included in the Draft EA.

Sincerely,

Holly E Smith

Holly E. Smith
Environmental Compliance Officer

Attachment: 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

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

Lamont-Doherty Earth Observatory
61 Route 9W, P.O. Box 1000
Palisades, NY 10964-8000

and

National Science Foundation
Division of Ocean Sciences
4201 Wilson Blvd., Suite 725
Arlington, VA 22230

by

LGL Ltd., environmental research associates
22 Fisher St., POB 280
King City, Ont. L7B 1A6

13 February 2014
Revised 2 May 2014

LGL Report TA8350-1

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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

~	approximately
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.

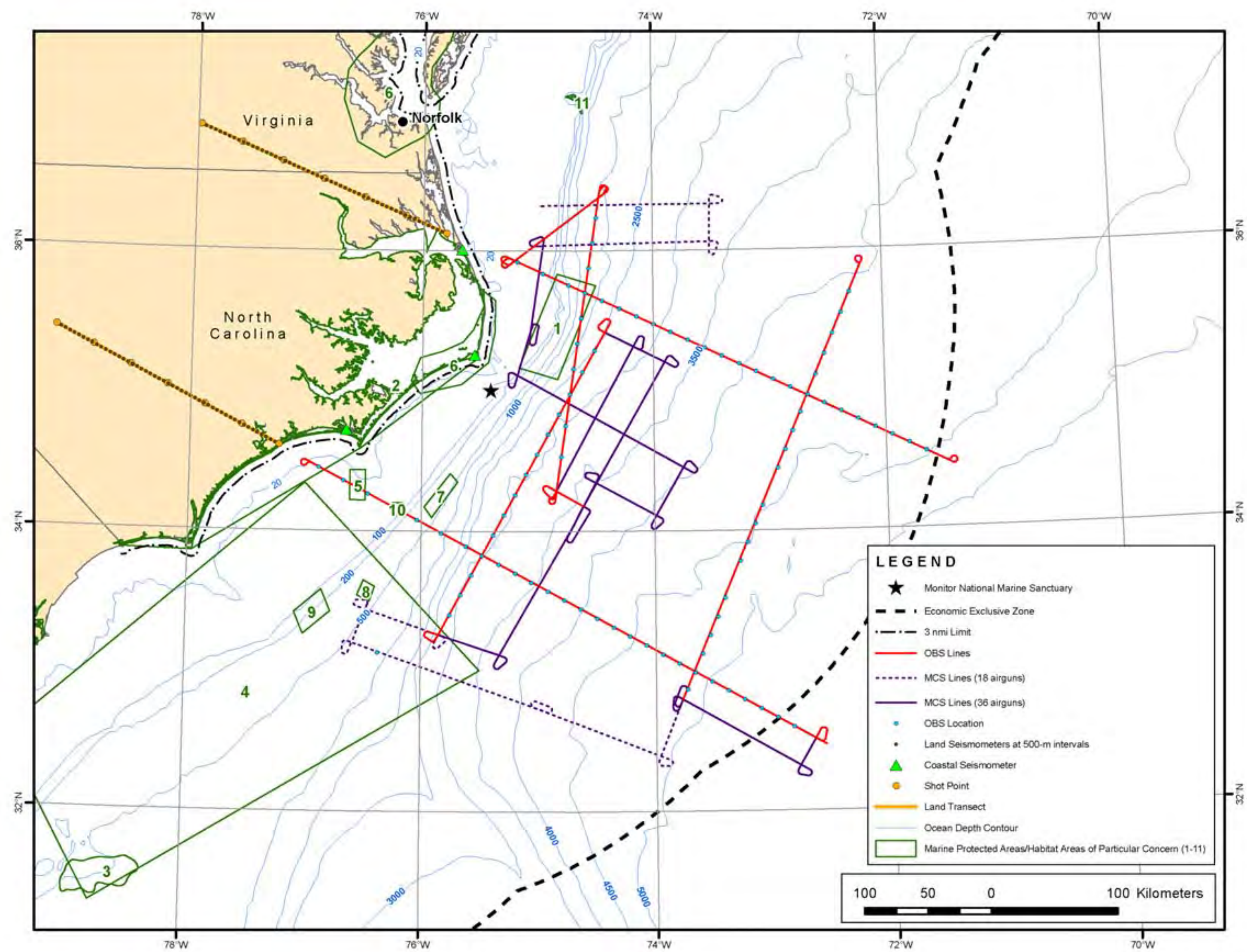


Figure 1. Location of the proposed seismic survey at the proposed survey site in the Atlantic Ocean off Cape Hatteras during September–October 2014. Also shown are a National Marine Sanctuary, one marine protected area, and 10 habitat areas of particular concern (see text).

(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.

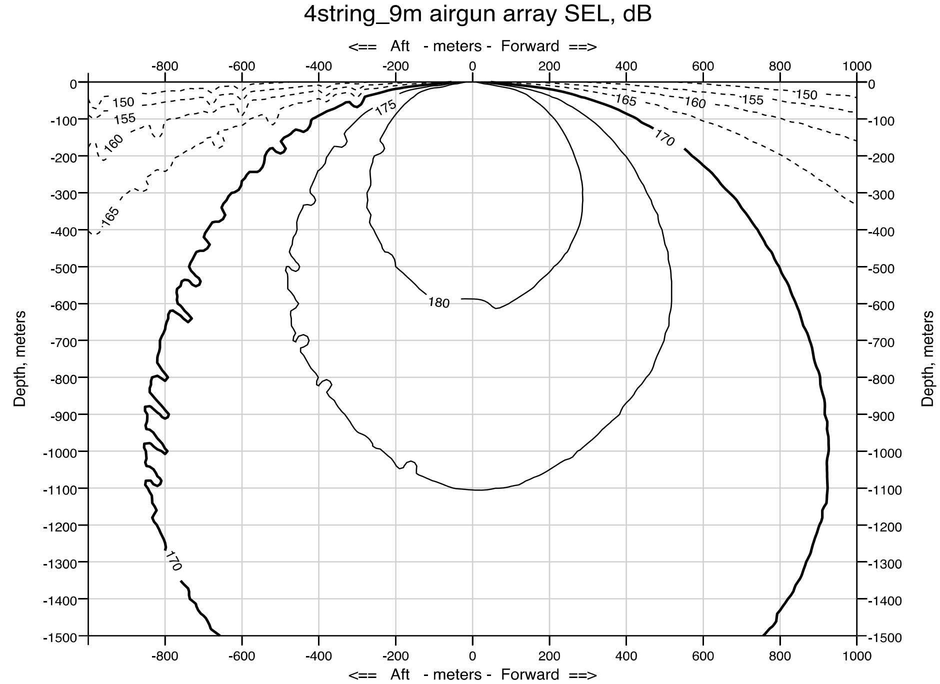
Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010, provided as Appendix H in the PEIS), as a function of distance from the airguns, for the 36-airgun array at any tow depth and for a single 1900LL 40-in^3 airgun, which would be used during power downs. This modeling approach 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



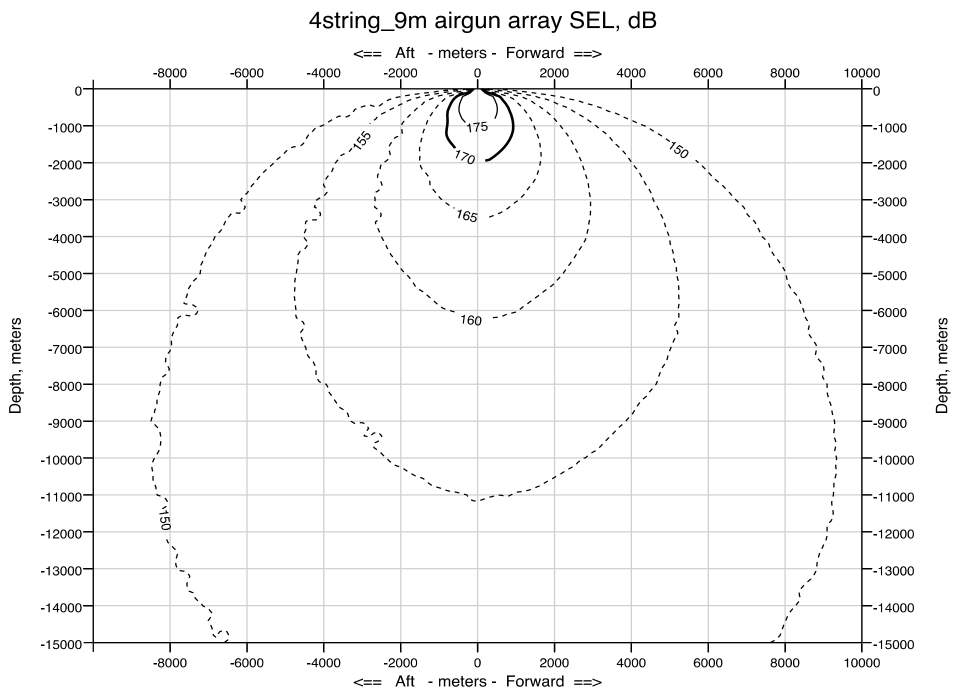
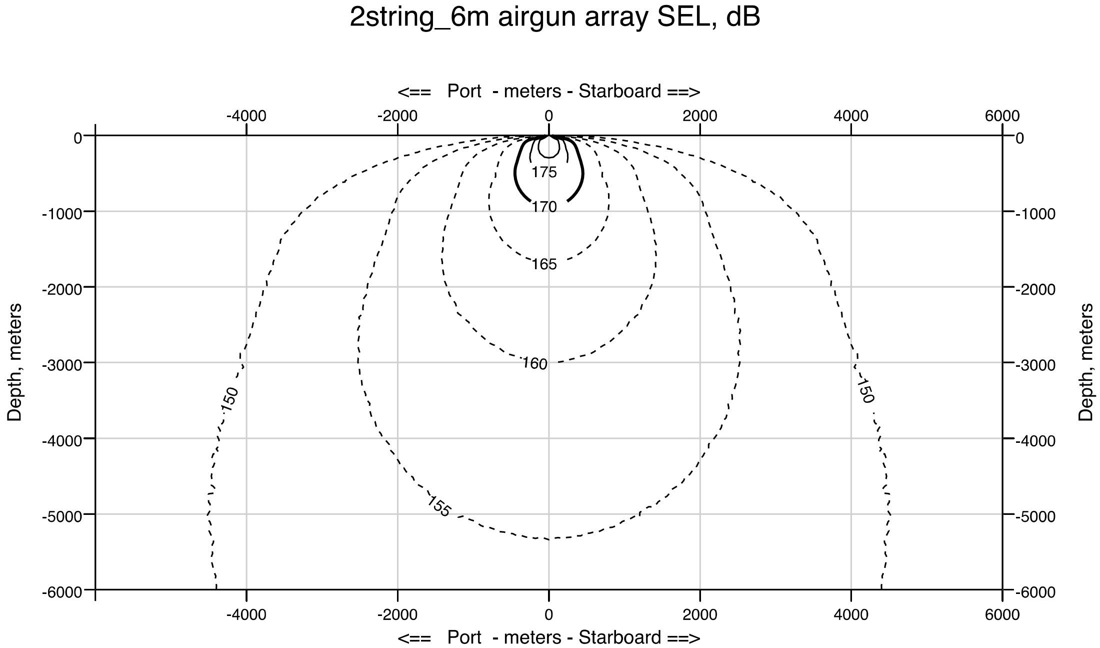


FIGURE 2. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the survey off Cape Hatteras, at a 9-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the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



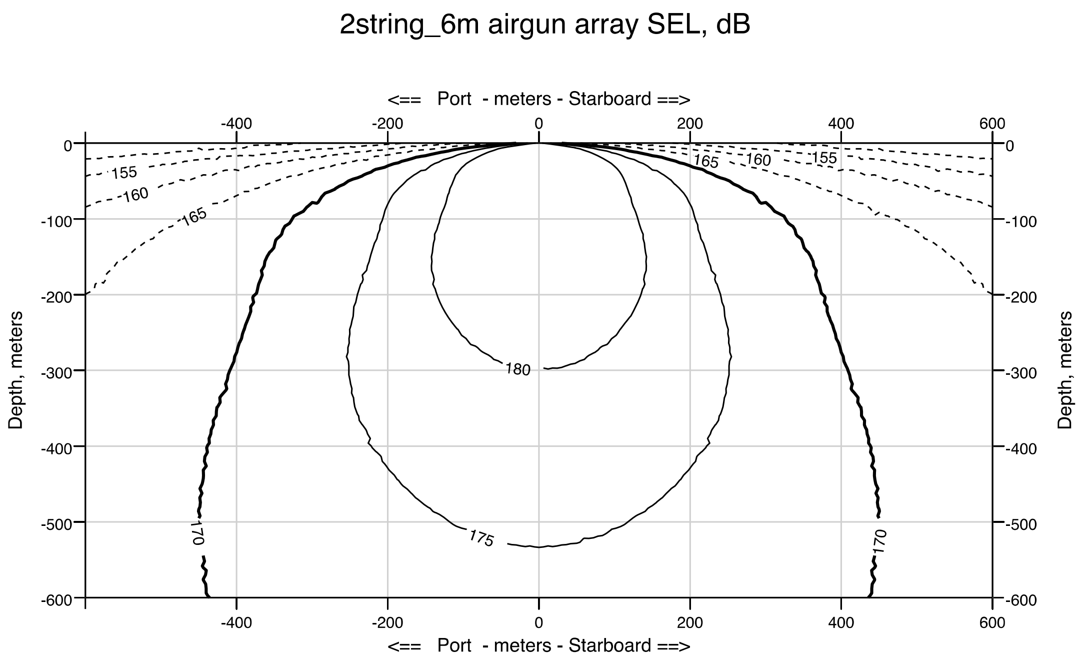


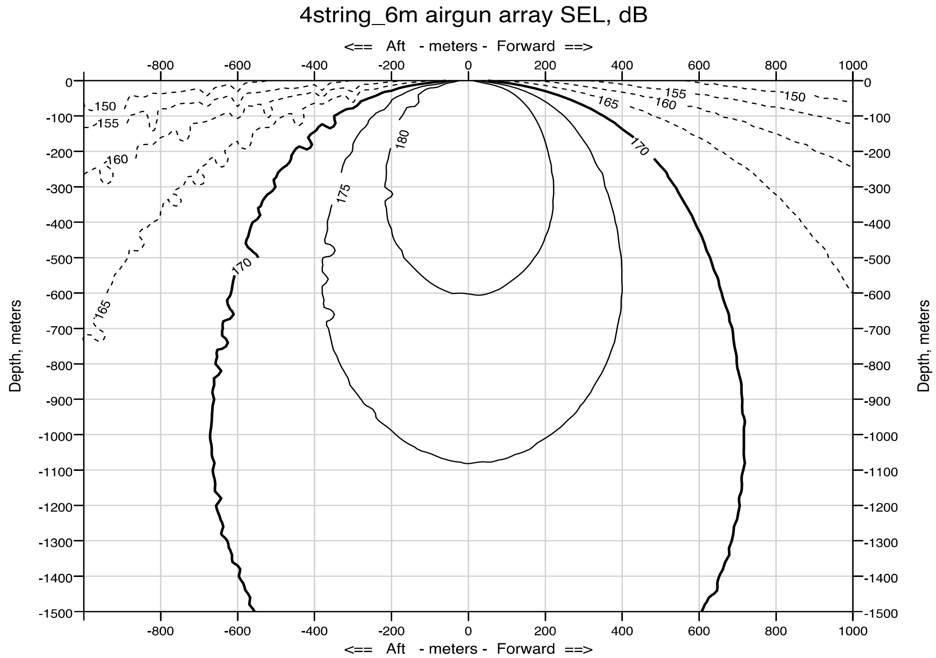
FIGURE 3. Modeled deep-water received sound levels (SELs) from the 18-airgun array planned for use during the survey off Cape Hatteras, at a 6-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the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

[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.



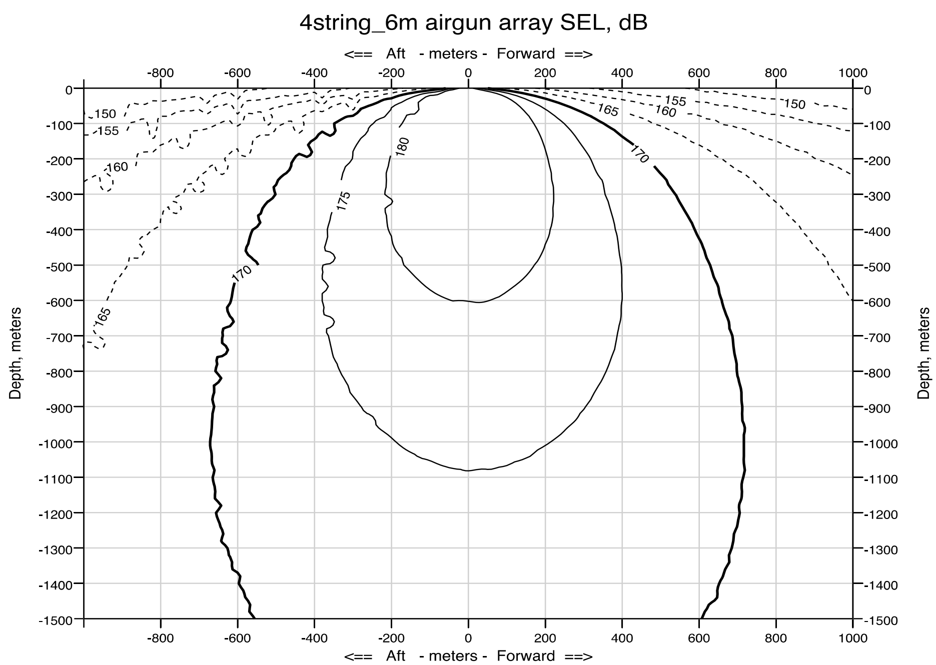
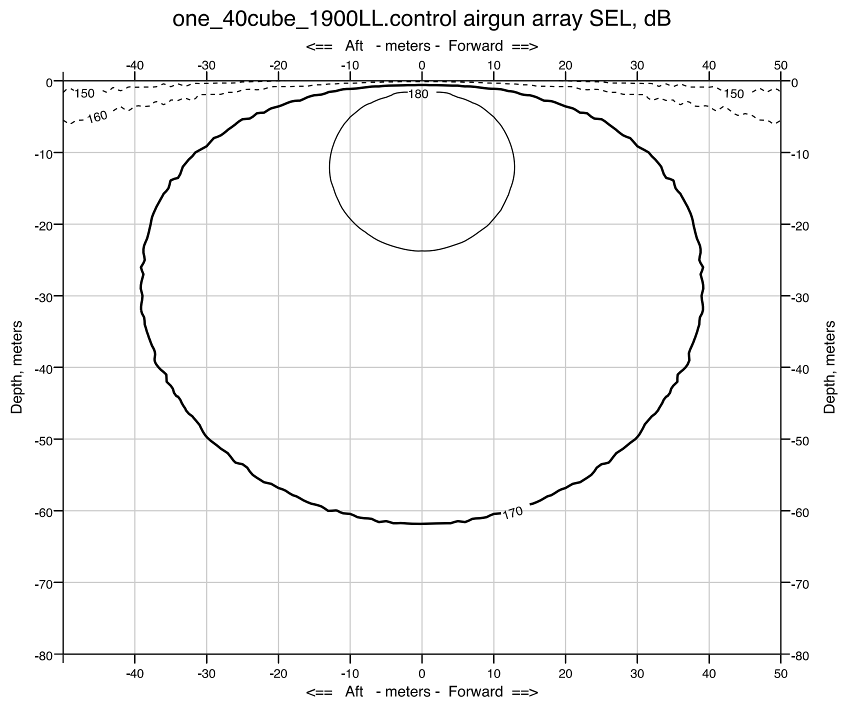


FIGURE 4. Modeled deep-water received sound levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB rms isopleth,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



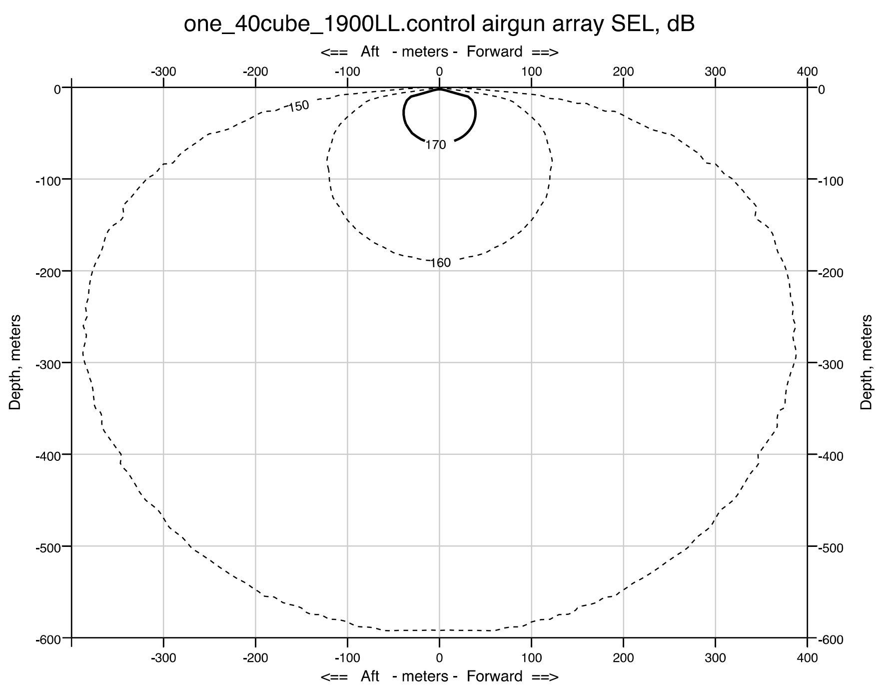


FIGURE 5. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9 m depth, which is planned for use as a mitigation gun during the proposed survey off Cape Hatteras. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to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

Species	Life stage[1] and habitat[2]				
	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	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	Gear Type: 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

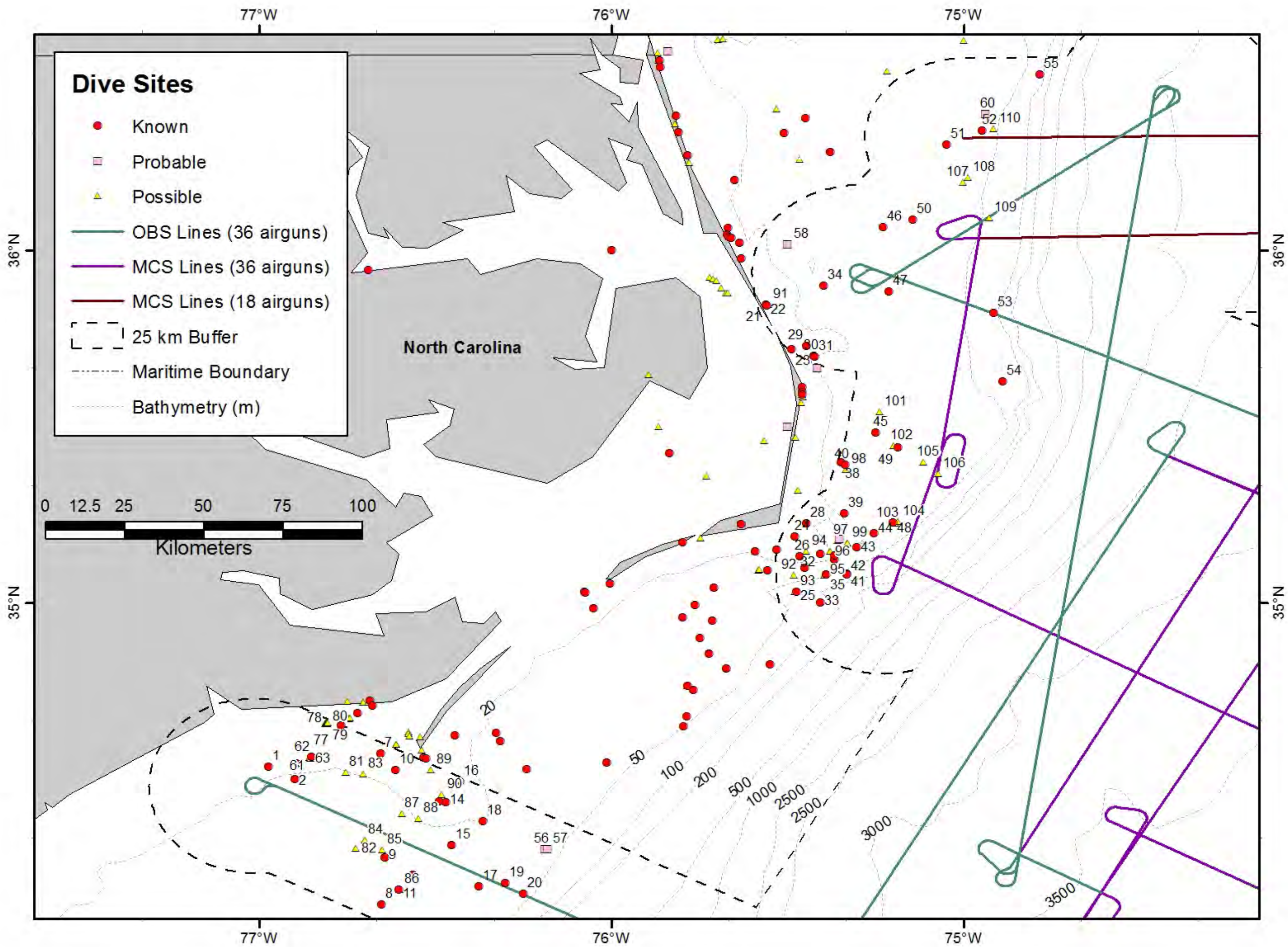

Figure 6. Recreational dive sites in water depths <100 m.

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.

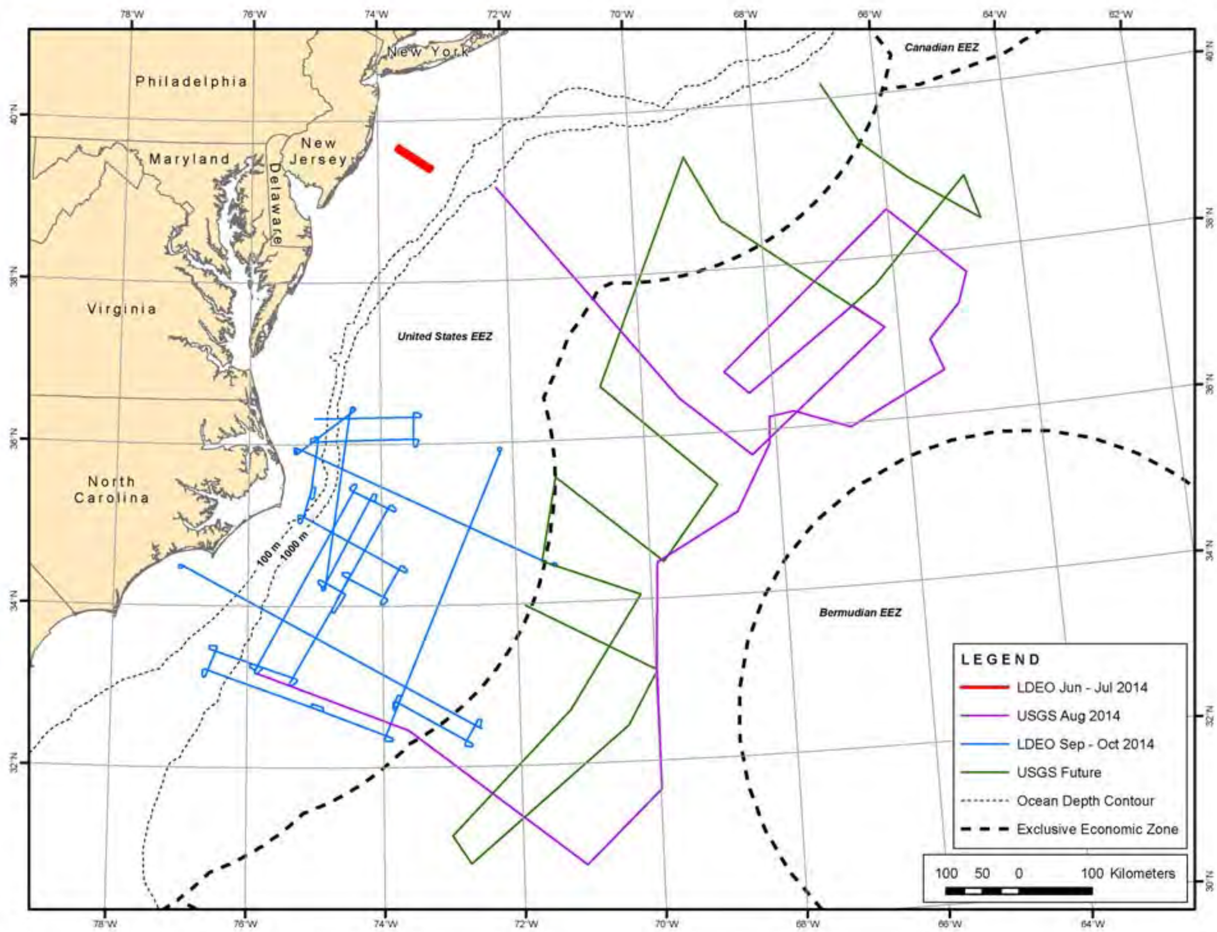

FIGURE 7. Locations of known proposed research activities off the U.S. east coast.

(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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UNITED STATES DEPARTMENT OF COMMERCE
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NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
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August 7, 2014 F/SER4:DD

Holly E. Smith
Environmental Compliance
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Dear. Ms. Smith:

This responds to your July 11, 2014, letter regarding essential fish habitat (EFH) consultation requirements for a proposed seismic scientific research survey in the U.S. exclusive economic zone off North Carolina and extending into international waters. The National Science Foundation (NSF) provided an environmental assessment (EA) dated May 2014 and tiered off a 2011 Final Programmatic Environmental Impact Statement (FPEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the NSF or Conducted by the U.S. Geological Survey.

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), EFH has been identified and described in the EEZ portions of the study area by the Mid-Atlantic and South Atlantic Fishery Management Councils and the National Marine Fisheries Service (NMFS). The Magnuson-Stevens Act specifies consultation with NMFS is required for federal actions which may adversely affect EFH. As the federal action agency for this matter, the NSF has determined the proposed survey activities may result in minor adverse impacts to EFH.

The South Atlantic Fishery Management Council designates several habitats within the study area as EFH including live/hardbottom habitats. Additionally, the SAFMC identified The Point as an area warranting special protection by designating it as an EFH Habitat Area of Particular Concern (EFH-HAPC) for snapper-grouper, dolphin-wahoo, coastal migratory pelagic species, as well as coral, coral reef, and live/hardbottom habitat. The EFH-HAPC designation provides this area with a heightened focus for protection by the SAFMC when setting restrictions on fishing and developing formal policy statements regarding habitat impacts. In light of their designation as an EFH-HAPC the NMFS applies greater scrutiny to projects affecting hardbottom habitat to ensure practicable measures to avoid and minimize adverse effects to these habitats are fully explored.

The Habitat Conservation Division (HCD) in the Southeast Regional Office has reviewed the analysis and proposed mitigation measures contained in the FPEIS/OEIS and the EA prepared for this action. Upon considering the design and nature of the seismic survey, it appears some level of adverse effect to EFH may occur, however, much of the research available to date on the adverse effects of seismic sounds on aquatic resources has been focused on marine mammals. As a result there is little information available on the effects of these activities on fish and benthic organisms and, therefore, we have no specific recommendations to offer regarding this aspect of the proposed activity at this time. However, according to the EA, 94 ocean bottom seismometers would be deployed and retrieved upon release from their individual anchors, consisting of either a 0.1 m^2 or 0.8 m^2 iron grate, which would remain on the seafloor. Consistent with other proposals for seismic activities directly affecting areas of the seafloor within a hardbottom EFH-HAPC, the NMFS recommends a 500-meter buffer from coral/hardbottom habitats be maintained for placement of any anchors or anchoring systems.

In accordance with Section 305(b)(4)(B) of the Magnuson-Stevens Act and its implementing regulations at 50 CFR 600.920(k), federal agencies are required to provide a written response to EFH conservation recommendation within 30 days of receipt. The response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the proposed activity. If the response is inconsistent with the EFH conservation recommendation, a substantive discussion justifying the reasons for not implementing the recommendations must be provided.

Be advised the NMFS Office of Protected Resources may request a similar review for their evaluation of an Incidental Harassment Authorization request for this action. However, further EFH consultation on this matter by the NSF is not necessary unless future modifications to the survey are proposed and such actions may result in adverse impacts to EFH.

If you have any questions or we can be of further assistance, please contact David Dale at 727-824-5317 or david.dale@noaa.gov.

Sincerely,

/for

Virginia M. Fay
Assistant Regional Administrator
Habitat Conservation Division

cc:
F/SER, Pace.Wilber@noaa.gov
F/PR, Howard.Goldstein@noaa.gov

NATIONAL SCIENCE FOUNDATION
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September 3, 2014

Virginia M. Fay
Assistant Regional Administrator
Habitat Conservation Division
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
263 13th Avenue South
St. Petersburg, FL 33701-5505

RE: NSF proposed marine geophysical survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September-October 2014

Dear Ms. Fay:

NSF has received NOAA Fisheries' letter of response to our Essential Fish Habitat (EFH) consultation request for a NSF proposed marine geophysical survey off of Cape Hatteras. In accordance with Section 305(b)(4)(B) of the Magnuson-Stevens Act and its implementing regulations at 50 CFR 600.920(k), NSF must provide a detailed response in writing to NOAA Fisheries regarding the EFH Conservation Recommendations within 30 days of their receipt. The response must include a description of measures proposed by NSF for avoiding, mitigating, or offsetting the impact of the activity on EFH. If the response is inconsistent with NOAA Fisheries' EFH Conservation Recommendations, NSF must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NOAA Fisheries over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

As part of the proposed research survey off of Cape Hatteras, ocean bottom seismometers (OBSs) with anchoring weights would be deployed within the survey area. Approximately 4 OBSs were proposed to be placed within designated EFH-Habitat Areas of Particular Concern (HAPC). To be consistent with other proposals for seismic activities directly affecting areas of the seafloor within coral/hardbottom EFH-HAPC, NOAA Fisheries has recommended for the proposed NSF survey a 500 meter buffer from coral/hardbottom habitats be maintained from placement of any anchors or anchoring systems. As discussed with NOAA Fisheries, since it appears that detailed data on the existence of the coral/hardbottom habitats within the relevant designated EFH-HAPC areas are not available, NSF will implement the proposed conservation recommendation to the best of its ability.

In order to comply or implement the recommended conservation measure, the following steps have been, or will be, taken with regard to the proposed placement of approximately 4 OBSs within coral/hardbottom EFH-HAPC:

- The Principal Investigators (PIs) for the proposed research project have evaluated whether all of the OBSs can be moved outside of the coral/hardbottom EFH-HAPC areas without detrimentally affecting the research goals. After evaluation, it was determined that one OBS could be moved, however, the other three would need to be retained to meet research goals.

- For the remaining 3 OBSs that could not be moved outside of the designated EFH-HAPC areas, to determine the 500m buffer and OBS placement, the PIs will:
  - review and evaluate existing information available on coral/hardbottoms within the relevant designated EFH-HAPC areas to determine OBS deployment with a 500 m buffer;
  - if necessary (due to potential lack of existing coral/hardbottom information), review existing acoustic back-scatter data for the designated EFH-HAPC areas to assess for coral/hardbottoms and determine OBS deployment with a 500 m buffer;
  - during ship operations, use the existing ship equipment to identify/verify coral/hardbottoms, and deploy OBSs with a 500m buffer within the designated EFH-HAPC areas. This measure would be implemented to verify conclusions from review of pre-existing acoustic back-scatter data for the relevant designated EFH-HAPC areas before OBS deployment, or in the event review of the existing data was unsuccessful in distinguishing coral/hardbottoms.

NSF appreciates NOAA Fisheries' prompt response to the EFH consultation request. If NOAA Fisheries has any concerns about NSF's plan for implementing the recommended EFH-HAPC conservation measures, please contact us as soon as possible.

Regards,

Holly Smith
Environmental Compliance Officer

Cc:
Pace Wilber, NMFS Southeast Regional Office: pace.wilber@noaa.gov
David Dale, NMFS Southeast Regional Office: david.dale@noaa.gov
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September 5, 2014

Holly Smith
Environmental Compliance Officer
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Dear Ms. Smith:

This responds to your September 3, 2014, letter concerning proposed marine geophysical surveys in the Atlantic Ocean off Cape Hatteras in September and October 2014. Your letter transmits the National Science Foundation (NSF) reply to National Marine Fisheries Service essential fish habitat (EFH) conservation recommendations which we provided by letter dated August 7, 2014.

According to the information provided, the NSF has agreed to implement our conservation recommendations as detailed in your response. The inclusion of these measures meets the goals of the Magnuson-Stevens Fishery Conservation and Management Act and the regulations for implementing the EFH requirements of the Act would be met.

We sincerely appreciate your efforts to protect our Nation's living marine resources. Related correspondence should be addressed to the attention of David Dale at david.dale@noaa.gov or by telephone at (727) 824-5317.

Sincerely,

for/

Virginia M. Fay
Assistant Regional Administrator
Habitat Conservation Division

APPENDIX E: USFWS Letter of Concurrence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

SEP 12 2014

In Reply Refer To:
FWS/AES/DER/BCH/058309
FWS 2014-I-0004

Ms. Holly Smith
National Science Foundation
Division of Ocean Sciences
4201 Wilson Blvd., Suite 25
Arlington, Virginia 22230

Subject: Informal Consultation on the High-Energy, 3-D Marine Geophysical Survey in the Atlantic Ocean off the Coast of Cape Hatteras and Associated Land-based Program

Dear Ms. Smith:

This letter is in response to your May 20, 2014, email requesting the U.S. Fish and Wildlife Service's (Service) concurrence that the proposed high-energy, 3-D marine geophysical survey in the Atlantic Ocean off the coast of Cape Hatteras and associated land-based program is not likely to adversely affect the endangered roseate tern (*Sterna dougallii*), Bermuda petrel (*Pterodroma cahow*), red-cockaded woodpecker (*Picoides borealis*), wood stork (*Mycteria americana*), Saint Francis' satyr butterfly (*Neonympha mitchellii francisci*), golden sedge (*Carex lutea*), pondberry *(Lindera melissifolia*), rough-leaved loosestrife (*Lysimachia asperulaefolia*), harperella (*Ptilimnium nodosum*), Michaux's sumac (*Rhus michauxii*), American chaffseed (*Schwalbea americana*), Cooley's meadowrue (*Thalictrum cooleyi*); the threatened piping plover (*Charadrius melodus*), and seabeach amaranth (*Amaranthus pumilus*); and the proposed northern long-eared bat (*Myotis septentrionalis*), pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 -1544), as amended (ESA). This consultation is based on the draft Environmental Assessment entitled a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September – October 2014.

Lamont-Doherty Earth Observatory (L-DEO), with funding from the U.S. National Science Foundation (NSF) plans to conduct high-energy, 3-D geophysical surveys along the mid-Atlantic Coast of the East North American Margin and mostly within the U.S. Exclusive Economic Zone and partly in International Waters (located between approximately 32 and 37°N and approximately 71.5 and 77°W). The seismic survey will be conducted from September through October, 2014, and will take place in water depths between 30 to 4,300 meters.

The goal of the proposed research is to collect and analyze data along the mid-Atlantic coast in order to investigate how the continental crust stretched and separated during the opening of the

Atlantic Ocean, and what the role of magmatism was during the continental breakup. The procedures to be used for the surveys would be similar to those used during previous seismic surveys by L-DEO and would use conventional seismic methodology. The surveys would involve one source vessel, the R/V *Langseth*. The *Langseth* would deploy an array of either 18 or 36 airguns as an energy source with a total discharge volume of approximately 3,300 to 6,600 cubic inches. The receiving system would consist of 8 kilometer 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 approximately 5,000 kilometers of 2-D survey lines, including turns, would be shot and the OBS lines would be shot a second time with the streamer for a total of approximately 6,350 kilometers. 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 addition to the operations of the airgun array, a multibeam echosounder, a subbottom profiler, and an acoustic Doppler current profiler will 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 or off the *Langseth* by a small vessel.

An associated land-based program would consist of passive and active components permitted by state and local agencies. Small, passive seismometers would be placed primarily alongside state roads in two, 200 kilometer 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 in pre-disturbed areas with easy access, such as along the edges of agricultural fields and along logging roads, buried approximately 25 meters deep and sealed over the upper 15 meters. This component would be carried out by the University of Texas-El Paso, 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.

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. 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. Effects of the terrestrial component of the project would be very limited because of the nature of the activities.

Although unlikely to be encountered, the listed roseate tern, Bermuda petrel, or piping plover could occur at or near the ocean-based project site.

The roseate tern 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. During the breeding season, roseate terns forage over shallow coastal waters, especially in water depths less than 5 meters, sometimes near the colony and at other times at distances of over 30 kilometers away. They usually forage over shallow bays, tidal inlets and channels, tide rips, and sandbars. Because of its distribution during the breeding season, the roseate tern likely would not be encountered at the proposed survey site.

The Bermuda petrel is a rare bird with close to 100 nesting pairs. Currently, all known breeding pairs breed on islets in Castle Harbour, Bermuda. In the non-breeding season (mid-June to mid-October), it is thought 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, thus, a small number of Bermuda petrels could be encountered over deep water at the eastern edge of the proposed survey area.

The piping plover breeds on coastal beaches from Newfoundland to North Carolina from March through August. Its marine nesting habitat consists of sandy beaches, sandflats, and barrier islands. Feeding areas include intertidal portions of ocean beaches, mudflats, sandflats, and shorelines of coastal ponds, lagoons, or salt marshes. Because its preferred habitat is strictly coastal, the piping plover likely would not be encountered at the proposed survey site.

In the rare event one of these species is in the vicinity of the survey area, there is the potential that the bird might be affected slightly by seismic sound from the proposed study. The impact would not be expected to be significant to the individual bird or their population because the majority of observed sound levels are below the water surface. Additionally, the proposed action includes precautionary measures of powering or shutting down the airguns if a listed bird is seen diving in the area.

Based upon the unlikely chance a bird of these species will be in the action area as well as the precautionary measures in place, we do not anticipate any adverse impacts to the listed roseate tern, Bermuda petrel, or piping plover.

Although unlikely to be encountered, any of the following listed or proposed animals or plants could occur at or near the land-based project sites: red-cockaded woodpecker, wood stork, Saint Francis' satyr butterfly, golden sedge, pondberry, rough-leaved loosestrife, harperella, Michaux's sumac, American chaffseed, Cooley's meadowrue, seabeach amaranth, and northern long-eared bat.

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 could potentially be found around most of the nominal drill sites. 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 hectares 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 forage more in shortleaf and loblolly pine habitats than in longleaf pine forest. The red-cockaded woodpecker likely would not be encountered because its habitat is forest, and land-based operational activities would not occur there.

The wood stork could potentially be found in 2 of the 14 nominal drill 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 northward to wetland complexes along the Atlantic coast as far as southeastern North Carolina. 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. In north and central Florida, Georgia, and South Carolina, storks lay eggs during March through 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. The wood stork likely would not be encountered because its habitat is wetlands, and land-based operational activities would not occur there.

Saint Francis' satyr butterfly could potentially be found in 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 Saint Francis' satyr butterfly, found in a range that is approximately 10 kilometers by 10 kilometers at Fort Bragg, North Carolina. The population consists of a number of small inactive (formerly occupied) and active sites (subpopulations), that range from 0.2 to 2.0 hectares in size; most active sites are found in artillery impact areas that are restricted in access. The distribution of Saint Francis' satyr 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. Saint Francis' satyr butterfly 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 Saint Francis' satyr butterfly larvae is *Carex mitchelliana*, a sedge that grows in swampy woods and wet meadows. The butterfly's adult lifespan averages 3 to 4 days. Saint Francis' satyr butterfly likely would not be encountered because its habitat is wetlands, and land-based operational activities would not occur there.

Golden sedge could potentially be found in 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, North Carolina. Eight populations are recognized made up of 17 distinct locations or element occurrences all occurring within a 26 kilometer by 8 kilometer 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. Critical habitat has been designated for the golden sedge; none of those areas are 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 could potentially be found in 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. There are two known populations in North Carolina, one in Cumberland County and one in Sampson County. 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. Pondberry likely would not be encountered because its habitat is wetlands, and land-based operational activities would not occur there.

Rough-leaved loosestrife could potentially be found in 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. As of 1995, nearly all sites were on publicly owned land, with the majority on federally owned land. 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. 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. Rough-leaved loosestrife could be encountered because several populations are known to occur near roadsides and power line rights of way where regular maintenance mimics fire and maintains vegetation so that herbaceous species are open to sunlight.

Harperella could potentially be found in 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. 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 could potentially be found in 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. 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 could potentially be found in 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. 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. 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 could potentially be found in 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 North Carolina 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. Cooley's meadowrue could be encountered because its habitat includes roadsides, where land-based operational activities would occur.

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

The northern long-eared bat is listed as proposed and could potentially be found in 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 to 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. 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.

While there is a slight potential for the aforementioned listed or proposed species to be encountered during the land-based activities of the proposed action, the chances of such an encounter are very small. Additionally, the contractors will receive specific training on how to identify the listed species and should they be encountered, alternate drill sites will be selected. Based on this avoidance measure, coupled with the mitigation measures in place for the ocean-based activities, we concur that the activities covered under the NSF's proposed high-energy, 3-D marine geophysical survey and associated land-based activities, "may affect" but "are not likely to adversely affect" the aforementioned listed and proposed species. Coordination with National Marine Fisheries Service on listed species under their jurisdiction is still required.

We are pleased that NSF, L-DEO and its contractors are committed to applying proactive protective measures in order to minimize effects on listed species. We appreciate the collaboration your staff has provided. If you have any question please contact Dr. Collette Thogerson of my office at (703) 358-2103.

Sincerely,

Larry K. Bright

Larry Bright
Acting Chief, Division of Environmental Review
Ecological Services

APPENDIX F: Public Comments on NMFS IHA Notice

MARINE MAMMAL COMMISSION

18 August 2014

Ms. Jolie Harrison, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910-3225

Dear Ms. Harrison:

The Marine Mammal Commission (the Commission), in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the application submitted by Lamont-Doherty Earth Observatory (LDEO), in collaboration with the National Science Foundation (NSF), seeking authorization under section 101(a)(5)(D) of the Marine Mammal Protection Act (the MMPA) to take small numbers of marine mammals by harassment. The taking would be incidental to a marine geophysical survey to be conducted off North Carolina. The Commission also has reviewed the National Marine Fisheries Service's (NMFS) 31 July 2014 notice announcing receipt of the application and proposing to issue the authorization, subject to certain conditions (79 Fed. Reg. 44550).

Some issues raised in previous letters regarding geophysical surveys reflect Commission concerns that apply more broadly to incidental take authorization applications beyond LDEO's proposed application. The Commission has recommended repeatedly that NMFS adjust density estimates using some measure of uncertainty when available density data originate from different geographical areas and temporal scales and that it formulate policy or guidance shaping a consistent approach for how applicants should incorporate uncertainty in density estimates. NMFS has indicated that it is currently evaluating available density information and working on guidance that would outline a consistent approach for addressing uncertainty in specific situations where certain types of data are or are not available (78 Fed. Reg. 57354). Further, the Commission has recommended that NMFS follow a consistent approach for requiring the assessment of Level B harassment takes for specific types of sound sources (e.g., sub-bottom profilers, echosounders, side-scan sonar, and fish-finding sonar) by all applicants who propose to use them. NMFS has indicated that it is evaluating the broader use of those types of sources to determine under what specific circumstances requests for incidental taking would be advisable (or not) and also is working on guidance that would outline a consistent approach for addressing potential impacts from those types of sources (78 Fed. Reg. 57354). The Commission welcomes the opportunity to meet with NMFS to review these higher-level recommendations, as well as those specific to LDEO's application.

Background

LDEO proposes to conduct a high-energy, 2D geophysical survey primarily in the U.S. exclusive economic zone (EEZ), with some portions in international waters, off North Carolina.

The survey would occur for approximately 33 days in September and October 2014. The purpose of the proposed survey is to investigate how the continental crust stretched and separated during the opening of the Atlantic Ocean and magnetism's role during the continental breakup. The survey would be conducted in waters estimated to be 20 to 5,300 m in depth with approximately 5,185 km of tracklines. LDEO would use the R/V *Marcus G. Langseth*, owned by NSF, to operate a 36-airgun array (nominal source levels 246 to 253 dB re 1μPa (peak-to-peak)) at 9 m depth and an 18-airgun array at 6 m depth. The *Langseth* also would tow one hydrophone streamer, 8,000 m in length, and would use 90 ocean-bottom seismometers (OBSs) during the survey. In addition, LDEO would operate a 10.5- to 13-kHz multibeam echosounder and a 3.5-kHz sub-bottom profiler continuously throughout the survey.

NMFS preliminarily has determined that, at most, the proposed activities would result in a temporary modification in the behavior of small numbers of up to 24 species of marine mammals and that any impact on the affected species would be negligible. NMFS does not anticipate any take of marine mammals by death or serious injury. It also believes that the potential for temporary or permanent hearing impairment will be at the least practicable level because of the proposed mitigation and monitoring measures. Those measures include monitoring exclusion and buffer zones and using power-down, shut-down, and ramp-up procedures. NMFS also would authorize the activities only until 31 October to minimize any impacts on migrating North Atlantic right whales. If, however, a right whale is sighted, LDEO would shut down the airguns immediately regardless of the distance of the whale from the *Langseth*. Ramp-up procedures would not be initiated until the right whale has not been seen at any distance for 30 minutes. In a recent USGS proposed incidental harassment authorization, NMFS proposed to require USGS to power down the array, if possible, when concentrations of humpback, sei, fin, blue, and/or sperm whales (six or more individuals that do not appear to be traveling and are feeding, socializing, etc.) are observed within the Level B harassment zone (based on 160 dB re 1 μPa; 79 Fed. Reg. 35642). The Commission is unsure why NMFS did not include the same mitigation measure in the currently proposed authorization, especially since the USGS and LDEO surveys both occur in waters up to more than 5,000 m in depth, in the same geographical region, and during September. Therefore, the Commission recommends that NMFS include a requirement that LDEO power down the array when concentrations of humpback, sei, fin, blue, and/or sperm whales (six or more individuals that do not appear to be traveling and are feeding, socializing, etc.) are observed within the Level B harassment zone (based on 160 dB re 1 μPa).

Further, NMFS would require LDEO, to the maximum extent practicable, to conduct the survey from the coast (inshore) and proceed towards the open sea (offshore) to minimize the potential for driving animals towards shore and trapping them in shallow water. The Commission agrees that this measure should be included in the incidental harassment authorization, but believes it should be an explicit requirement rather than qualified with the phrase "to the maximum extent practicable". Accordingly, the Commission recommends that NMFS require LDEO to conduct the survey from the coast (inshore) and proceed towards the sea (offshore), removing the caveat of "to the maximum extent practicable". Lastly, the Commission understands that NMFS would require that LDEO cease operation of the echosounder and sub-bottom profiler when the Langseth is in transit and only operate those types of equipment during the airgun survey itself. The Commission believes that requirement should be specified in the final incidental harassment authorization, if that is indeed NMFS's intent, and recommends that NMFS specify in the final authorization that LDEO is not authorized to operate the multi-beam echosounder and sub-bottom profiler during transit.

Staff members from NMFS, LDEO, NSF, U.S. Geological Survey (USGS), and the Commission met in March 2013 to discuss some of the Commission's ongoing concerns regarding the potential effects of geophysical surveys. Although a number of concerns were discussed and several resolved, the following sections highlight areas that, in the Commission's view, warrant further attention.

Justification for the use of the 36-airgun array

In its application, LDEO stated that it was decided that the scientific objectives for most of the survey could not be met using a source smaller than the 36-airgun array, because of the need to image the crust-mantle boundary at a depth of 30 km beneath the continental shelf and slope. LDEO stated that it was decided that the 18-airgun array towed at a shallower depth (6 m vs. 9 m) would be adequate to image the boundary for the remaining portion of the survey (the southern and northernmost portions of the multi-channel hydrophone streamer (MCS) tracklines; see Figure 1 in LDEO's application). However, based on the addendum to the application, it appears that LDEO has changed its plan to use the 36-airgun configuration during the MCS portion of the survey and now proposes to use only the 18-airgun configuration to survey the MCS tracklines. Apparently, LDEO still plans to use the 36-airgun configuration during the OBS portion of the survey, which would occur in water depths as shallow as 20 m.

Neither LDEO nor NMFS provided justification regarding the need to use the full 36-airgun array during the OBS portion[1] of the survey. In the past, LDEO used the 18-airgun configuration with OBSs in water depths ranging from 3,500 to more than 5,000 m in depth off Spain (78 Fed. Reg. 34069). The Commission is unsure why the smaller 18-airgun array could not be used during the OBS portion of the proposed survey off North Carolina, especially when the water depths are as shallow as 20 m. If the water depths are not the primary factor for using the 36-airgun array during the OBS portion of the survey, then presumably the requirement for the larger array is dictated by the receiving devices. If that is the case, the Commission questions whether the MCS could be used in the shallow and intermediate water depths to obtain the needed data rather than using the OBSs. In any event, NMFS has indicated in previous proposed incidental harassment authorizations when smaller arrays could be used to achieve the same objective that the applicant would use such smaller devices, as was the case for the 18-airgun configuration used off of Spain (78 Fed Reg. 17376). Although LDEO apparently amended its proposed method for the MCS portion of the survey, that type of information is lacking in the *Federal Register* notice[2] and should be included as part of the mitigation measures. Absent both the justification for the use of the 36-airgun configuration for the OBS portion of the survey and acknowledgement of the use of the 18-airgun configuration for the MCS portion and its implied mitigating effects (if such is the reason), LDEO's process is not transparent and as such may not be justifiable. Therefore, <u>the Commission recommends</u> that NMFS require LDEO to justify the use of the 36-airgun configuration during the OBS portion of the survey. If the same quality of data can be obtained using the smaller 18-airgun configuration with the MCS or OBSs, then <u>the Commission recommends</u> that NMFS require LDEO to use the smaller airgun configuration to minimize impacts on marine mammals.

[1] Based on correspondence from LDEO, the Commission understands that the OBS portion of the survey would be surveyed twice, once to acquire data with the OBSs and once with the streamer.
[2] This normally is found under the "Planning Phase" portion of the "Proposed Mitigation" section of the notice.

Uncertainty in estimating exclusion and buffer zones

The Commission continues to have concerns regarding the method used to estimate exclusion and buffer zones (based on Level A and B harassment, respectively) and the numbers of takes for NSF-funded geophysical research. These concerns date back to 2010 but please refer to the Commission's 12 March, 19 April, and 24 June 2013 and 31 March and 23 July 2014 letters for detailed rationale. Briefly, LDEO performs acoustic modeling for geophysical research conducted by the *Langseth*. For at least 6 years (and likely more than the last 10 years), LDEO has estimated exclusion and buffer zones using a simple ray trace–based modeling approach that assumes spherical spreading, a constant sound speed, and no bottom interactions (Diebold et al. 2010). That model does not incorporate environmental characteristics of the specific study area including sound speed profiles and refraction within the water column, bathymetry/water depth, sediment properties/bottom loss, or absorption coefficients. However, LDEO continues to believe that its model generally is conservative when compared to in-situ sound propagation measurements of the R/V *Maurice Ewing*'s arrays (i.e., 6-, 10-, 12-, and 20-airgun arrays) and the R/V *Langseth*'s 36-airgun array from the Gulf of Mexico (Tolstoy et al. 2004, Tolstoy et al. 2009, Diebold et al. 2010[3]). LDEO also has noted the model is most directly applicable to deep water (> 1,000 m), although it uses the model, with the inclusion of substantial correction factors, in intermediate and shallow-water environments (100–1,000 m and < 100 m, respectively) as well. Diebold et al. (2010) noted the limited applicability of LDEO's model when sound propagation is dependent on water temperature, water depth, bathymetry, and bottom-loss parameters—this is especially important for estimating zones for surveys, such as the North Carolina survey, in which the various airgun configurations would be used in waters as shallow as 20 m and as deep as 5,300 m. They further indicated that modeling could be improved by including realistic sound speed profiles within the water column. In addition, Tolstoy et al. (2009) acknowledged that sound propagation depends on water depth, bathymetry, and tow depth of the array and that sound propagation varies with environmental conditions and should be measured at multiple locations.

To estimate the proposed exclusion and buffer zones for the survey off North Carolina, LDEO apparently used in-situ measurements for the 18-airgun array in shallow water only and used LDEO's model, scaling factors[4], correction factors[5], and/or low-energy proxies for the other airgun configurations (36-, 18-, and single airgun array) and water depths (shallow, intermediate, and deep water; see Table 1 in LDEO's application for specific details). Presumably, Diebold et al. (2010) served as the basis for the in-situ measurements of the 18-airgun array in shallow water. However, in the case of Diebold et al. (2010), the shallow-water hydrophone was positioned in 50 m of water, which is much deeper than 20 m of water proposed for the survey. The Commission questions the validity of using the Diebold et al. (2010) measurements given that the survey will be conducted in much shallower water[6]. In previous incidental harassment authorizations, LDEO has indicated that the model underestimates the zones in shallow water[7]. The Commission is not surprised by that finding since Diebold et al. (2010) stated the acoustic field in shallow water was dominated by near-vertically traveling reflected and refracted waves, information that is not used within LDEO's

[3] Diebold et al. (2010) also presented data on the 18-airgun array from the Gulf of Mexico.
[4] Based on assumed tow depth differences from LDEO's deep-water model.
[5] For intermediate water depths, LDEO multiplied the modeled deep-water results by a correction factor of 1.5.
[6] And the fact that the measurements originated from a different geographical area.
[7] When LDEO has used its model for shallow water depths, a correction factor of 14.7 has been used.

model. Accordingly, the Commission does not support use of either of the methods[8] to determine the sizes of the exclusion or buffer zones.

For deep water, LDEO has stated that its model overestimates the received sound levels at a given distance but is still valid for defining exclusion zones at various tow depths. However, LDEO indicated in its application that the calibration data show that at greater distances (4 to 5 km) sound reflected from the sea floor and refracted from the sub-seafloor dominate, while the direct arrivals become weak and/or incoherent (Figures 11, 12, and 16 in Appendix H of the NSF/USGS programmatic environmental impact statement for geophysical surveys (PEIS)). LDEO stated that aside from local topography effects, the region around the critical distance (~5 km in Figures 11 and 12 and ~4 km in Figure 16 in Appendix H of the NSF/USGS PEIS) is where the observed sound levels rise very close to the mitigation model curve. Although the observed sound levels occur primarily below the mitigation model curve, that finding further substantiates the fact that the model is not necessarily indicative of site-specific environmental conditions, including bathymetry and sound speed profiles. The reflective/refractive arrivals are the very measurements that should be accounted for in site-specific modeling and ultimately determine underwater sound propagation. Ignoring those factors is a serious flaw of LDEO's model. In addition, LDEO apparently applied scaling factors to empirical shallow-water zones based on modeled deep-water zones to account for tow depth differences. The Commission is unsure why LDEO would assume that the ratio of modeled zones in deep water would equate to empirical zones in shallow water, as those two quantities are not comparable and LDEO itself has indicated that the model underestimates received levels in shallow water.

Furthermore, the estimated exclusion zone for the proposed survey (36-airgun array towed at 9 m in depth) is smaller[9] than previously authorized and the buffer zone is larger[10] than previously authorized (75 Fed. Reg. 44770; 76 Fed. Reg. 75525, 49737; 77 Fed. Reg. 25693, 41755). This is a bit perplexing as the Commission is unaware of any changes to LDEO's model[11]. If the model has not changed, then perhaps the manner in which LDEO is using the model or the inputs to the model have changed. In any case, it is not clear why the zones have changed. NMFS did add a precautionary 3-dB buffer to the exclusion zones in shallow water (which, if the exclusion zones have been underestimated, may be less precautionary than originally intended). Additionally, the estimated shallow-water exclusion zone for the mitigation airgun is smaller than previously authorized or proposed to be authorized[12] (e.g., 77 Fed. Reg. 41755). Therefore, even with NMFS's added 3-dB precautionary buffer, the exclusion zone for the mitigation airgun in shallow water is smaller than previous incidental harassment authorizations. LDEO indicated in its application that the zone was based on empirically derived measurements from the Gulf of Mexico with a scaling factor applied to account for differences in tow depth. The Commission does not understand why LDEO has offered this explanation. For many years, LDEO has indicated that the zones associated

[8] Shallow-water empirical measurements in deeper waters than proposed by the survey and LDEO's model.
[9] 927 vs. 940 m for the 180-dB re 1 μPa threshold.
[10] 5,780 vs. 3,850 m for the 160-dB re 1 μPa threshold.
[11] Appendix H of the PEIS has been used in support of LDEO's model since it was available for public review in 2010 and, to the Commission's knowledge, has been unchanged since that time. Those figures have included the maximum sound pressure level trajectories and have been based on sound exposure levels, with a presumed 10 dB difference for sound pressure levels.
[12] 86 m was estimated for this authorization vs. 121 m that included the 3-dB buffer vs. 296 m that was previously authorized.

with the mitigation airgun have been model-estimated and that the tow depth has minimal effect on the maximum near-field output and the shape of the frequency spectrum for the single airgun. Thus, LDEO has assumed that the predicted exclusion zones are essentially the same at different tow depths (i.e., the same values are used for the mitigation gun being towed from 6–15 m in depth; 77 Fed. Reg. 25969). Due to these shortcomings and inconsistencies, the Commission continues to have concerns regarding the estimation of exclusion and buffer zones for NSF-funded geophysical surveys and highlights the need for transparency regarding the methods by which LDEO is estimating those zones. Therefore, the Commission recommends that NMFS require LDEO to explain why the proposed exclusion and buffer zones for the survey are not consistent with those used in past surveys that involved the same airgun configurations (36-, 18-, and single airgun(s)) and tow depths (9 or 6 m) and that occurred in the same water depths (shallow, intermediate, and deep water). Until that information is provided, neither the Commission nor the public can comment meaningfully on the proposed exclusion and buffer zones. Without such information NMFS presumably would not be able to determine that the zones were based on best available science and that the additional 3-dB buffer was in fact precautionary.

Because LDEO has failed to verify the use of its model in conditions other than the Gulf of Mexico, the Commission has recommended that NMFS or the relevant entity estimate exclusion and buffer zones using either empirical measurements from the particular survey site or a model that accounts for the conditions in the proposed survey area. The model should incorporate operational parameters (e.g., tow depth, source level, number/spacing of active airguns) and site-specific environmental parameters (e.g., sound speed profiles, refraction in the water column, bathymetry/water depth, sediment properties/bottom loss, and wind speed). In March 2013, LDEO indicated that it might be able to compare its model to hydrophone data collected during previous surveys in environmental conditions other than those in the Gulf of Mexico[13] (i.e., deep and intermediate waters in cold water environments that may have surface ducting conditions, shallow-water environments, etc.). The Commission understands that LDEO has been analyzing hydrophone data from waters off Washington State to allow comparisons of empirically derived estimates to model-estimated exclusion and buffer zones, but those results do not appear to have been published yet. The Commission is pleased to hear of this work and encourages LDEO to make such comparisons at various sites, not just in waters off Washington, if it intends to continue using a model that does not incorporate site-specific parameters. The Commission recommended in its 24 June 2013 letter that such comparisons be made prior to submitting applications for geophysical surveys to be conducted in 2014. The Commission further recommended that if LDEO and NSF either do not have enough data to compare LDEO's modeled results to other environments, or choose not to assess the accuracy of the model, then they should re-estimate the exclusion and buffer zones and associated takes of marine mammals using site-specific parameters (including sound speed profiles, bathymetry, and bottom characteristics) for all future applications that use LDEO's model. Neither approach was used for the proposed incidental harassment authorization.

NMFS has stated repeatedly that NSF, LDEO, and other relevant entities (USGS, Scripps Institution of Oceanography (Scripps)) are providing sufficient scientific justification for their take

[13] Diebold et al. (2010) supported such an approach, stating that streamer data can provide an accurate assessment of sound exposure levels at the relevant ranges for mitigation in shallow-water environments (≤ 100 m). They further indicated it seems logical and advantageous that those data be monitored in real time to fine tune a priori mitigation zones in shallow-water environments.

estimates. The Commission disagrees with this conclusion, given that the estimates are based on LDEO's model, various scaling and correction factors, unsupported proxies, and/or empirical measurements from the Gulf of Mexico. Recent activities have occurred in areas such as the North Atlantic and the Antarctic rather than the Gulf of Mexico. Environmental conditions in waters off the East Coast include presence of surface ducts, in-water refraction, and bathymetry and sediment characteristics that reflect sound[14]. Although a surface duct likely is present in the proposed survey area, none of the site-specific parameters are accounted for in LDEO's model[15].

In a recent sound exposure modeling workshop attended by representatives of numerous entities (including NMFS, LDEO, NSF, USGS, and the Commission), experts confirmed that sound speed profiles and bathymetry/sediment characteristics were the most important factors affecting underwater sound propagation and should be included in related modeling. While LDEO presented various aspects of its model during the workshop and indicated that the model was fast, inexpensive, and simple to use, none of those attributes support its applicability or accuracy. Further, LDEO indicated that the model is more closely related to a source model that compares airgun arrays and that it is not representative of modeling in the actual environment. Therefore, the Commission remains very concerned that the LDEO model is not based on best available science and does not support its continued use. For all of these reasons, <u>the Commission recommends</u> that NMFS (1) require LDEO to re-estimate the proposed exclusion and buffer zones and associated takes of marine mammals using site-specific (including sound speed profiles, bathymetry, and sediment characteristics at a minimum) and operational (including number of airguns, tow depth) parameters for the proposed incidental harassment authorization and (2) impose the same requirement for all future incidental harassment authorizations submitted by LDEO, NSF, USGS, Scripps, Antarctic Support Contract (ASC), or any other relevant entity.

In 2011[16], NSF and USGS modeled sound propagation under various environmental conditions in their PEIS. LDEO and NSF (in cooperation with Pacific Gas and Electric Company) also used a similar modeling approach in the recent incidental harassment authorization application and associated environmental assessment for a geophysical survey of Diablo Canyon in California (77 Fed. Reg. 58256). These recent examples indicate that LDEO, NSF, and related entities are capable of implementing the recommended modeling approach, if required to do so by NMFS. The Commission understands the constraints imposed by the current budgetary environment, but notes that other agencies that contend with similar funding constraints incorporate modeling based on site-specific parameters. LDEO, NSF, and related entities (USGS, Scripps, ASC) should be held to that same standard. NMFS recently indicated that it does not prescribe the use of any particular modeling package and does not believe it is appropriate to do so (79 Fed. Reg. 38499). The Commission agrees that NMFS should not instruct applicants to use specific contractors or modeling packages, but it should hold applicants to the same standard, primarily one in which site- and operation-specific environmental parameters are incorporated into the models.

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[14] Although not accounted for by LDEO's model.

[15] NMFS has acknowledged that although the acoustic energy within the third and fourth lobes (330–667 Hz) of the impulsive waveform would be trapped in the surface duct and propagated to greater distances, those lobes represent only a fraction of the total acoustic energy (specifically for the LDEO New Jersey survey; 79 Fed. Reg. 38500). The Commission notes that the impulsive waveform includes sound energy in frequencies even greater than 667 Hz, including contributions from mid- and high-frequency sound that may be trapped in the surface duct and propagated further than sound below 330 Hz.

[16] The record of decision was signed in 2012.

NMFS further indicated that based on empirical data (which illustrate the LDEO model's conservative exposure estimates for the Gulf of Mexico and preliminarily for waters off Washington), it found that LDEO's model effectively estimates sound exposures or number of takes and represents the best available information for NMFS to reach its determinations for the authorization. However, for the recent survey off New Jersey (79 Fed. Reg. 38499) and the proposed survey off North Carolina, NMFS increased the exclusion zone in shallow water by 3-dB. The Commission questions why, if NMFS believes the LDEO model is based on best available science, it then extended the exclusion zones to be precautionary. Further, the Commission is unsure why NMFS did not extend the buffer zones and the re-estimate the numbers of takes of marine mammals as well.

Group size and take estimates

In estimating the numbers of potential takes for the proposed incidental harassment authorization, LDEO used the Strategic Environmental Research and Development Program's (SERDP) spatial decision support system (SDSS) Marine Animal Model Mapper tool based on the U.S. Navy's OPAREA Density Estimates (NODE) model[17] to estimate marine mammal densities. NMFS increased the estimated takes for some species (primarily large whales) to average group sizes based on correspondence with various experts. However, NMFS did not apply the same method for other species for which the potential for taking exists but density data were lacking. In addition to the large whale species, the SERDP model did not include data for spinner dolphins[18], Fraser's dolphins, melon-headed whales, pygmy killer whales, false killer whales, or killer whales that have the potential to occur in the waters off North Carolina. Interestingly, USGS requested, and NMFS proposed to authorize, takes of those species for its survey that would precede LDEO's survey in the same general geographical area and at nearly the same time of year. For those species, USGS had estimated the numbers of takes based on average group size.

LDEO and NMFS also proposed to authorize the taking of only one bottlenose dolphin from both the Northern and Southern North Carolina Estuarine Systems (NNCE and SNCE) based on the calculated number of takes rather than accounting for average group size and thereby increasing the number of bottlenose dolphin takes for those two stocks. Bottlenose dolphins generally do not occur as single individuals and taking should not be authorized as such. Because the potential exists to take those species or stocks in numbers greater than what NMFS has proposed, the Commission recommends that NMFS authorize the taking of spinner dolphins, Fraser's dolphins, melon-headed whales, pygmy killer whales, false killer whales, killer whales, NNCE bottlenose dolphins, and SNCE bottlenose dolphins based on at least the average group size.

LDEO did not request the incidental taking of harbor seals based on the low likelihood of occurrence in the survey area in September and October, and NMFS concurred. However, NMFS's 2012 stock assessment report indicated that, although harbor seals are known to occur seasonally along the southern New England to New Jersey coasts from September through late May and scattered sightings and strandings have been reported as far south as Florida, a recently established

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[17] Those data originated from the waters within the U.S. EEZ only.
[18] Based on NMFS's 2013 Stock Assessment Report, spinner dolphins were observed within the proposed survey area off North Carolina in 2011.

seasonal haul-out site was documented in 2011 at Oregon Inlet, North Carolina (Todd Pusser, pers. comm.). Oregon Inlet is within the proposed survey area and if harbor seals are not only occurring in the area but hauling out at an established site, NMFS should include their incidental taking in the authorization. Therefore, the Commission recommends that NMFS consult with Mr. Pusser, the appropriate NMFS Science Center, and other researchers in the region (i.e., at University of North Carolina Wilmington and Duke University) to determine the number of harbor seals that could be harassed incidental to the proposed survey and authorize that number in the final authorization.

The Commission understands the LDEO would actually survey the OBS tracklines twice, once for acquiring OBS data and once for recording source shots with the MCS[19]. This has not been made clear in either the application or the *Federal Register* notice. However, it does not appear that LDEO, or subsequently NMFS, estimated the ensonified area based on repeating the OBS tracklines, which would likely occur on different days as the streamer would have to be deployed and lines re-surveyed. The Commission also is unsure whether LDEO would deploy the streamer after each OBS trackline to acquire the data concurrently or it would conduct the survey using the OBSs and then deploy the streamer to survey the OBS tracklines again and followed by the MCS tracklines. In either instance, the Commission cannot envision how the full extent of each OBS trackline could be surveyed twice within any given day. Accordingly, the Commission recommends that NMFS require LDEO to re-estimate the total numbers of takes based on the OBS portion of the survey being surveyed twice, which may be as simple as multiplying the takes estimated for the OBS portion of the survey by two.

The *Federal Register* notice indicated that LDEO did not include its normal 25 percent contingency for repeating some of the tracklines, accommodating the turning of the vessel, addressing equipment malfunctions, or conducting equipment testing to complete the survey[20]. That 25 percent contingency is applied to the line-kilometers of tracklines, inevitably increasing the numbers of takes. The Commission is skeptical that those activities would not be needed as contingency for the proposed survey, especially since the 25 percent contingency was included in LDEO's application. However, since such an increase has not been included in the proposed take estimation analysis in the *Federal Register* notice, the Commission recommends that NMFS specify explicitly in the final incidental harassment authorization that LDEO is not authorized to repeat tracklines, accommodate the turning radius of the vessel, address equipment malfunctions, or conduct equipment testing prior to commencing or during the survey. If a possibility exists that those activities would occur during the survey, then the Commission recommends that NMFS require LDEO to re-estimate the numbers of marine mammals that could be taken during the proposed survey and base its "small numbers" and "negligible impact" determinations on those revised take estimates.

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[19] Although the source repetition rate would be different for those two methods (approximately 65 and 22 s, respectively), the source level would be the same with the full 36-airgun array.

[20] However, LDEO did include the 25 percent contingency in its application. The Commission is unsure why the contingency was removed for the proposed authorization as published in the *Federal Register* notice. Regardless, it is difficult for the Commission and public to review and comment on any proposed action when the information in the application and *Federal Register* notice is not consistent. In the future, NMFS should address and clarify the reason for those inconsistencies in its *Federal Register* notice or require the applicant to amend its application accordingly. Otherwise, the authorization process includes a level of unnecessary confusion, which constitutes a lack of transparency.

NMFS has yet to develop a clear policy setting forth more explicit criteria and/or thresholds for making small numbers and negligible impact determinations, as recommended by the Commission. Such guidance would be particularly useful in a case like this, in which up to 22 percent of the pantropical spotted dolphin stock in the area could be taken incidentally during the proposed survey activities. In the addendum to LDEO's application, that percentage of the pantropical spotted dolphins was considered an overestimate because the stock assessment report estimates are based on surveys only in U.S. waters rather than the entire range. The Commission is unsure why that percentage would be considered an overestimation because the density estimates upon which the takes were based originated only from U.S. waters as well. In any event, the Commission understands that NMFS is in the process of developing both a clearer policy to outline the criteria for determining what constitutes "small numbers" and an improved analytical framework for determining whether an activity will have a "negligible impact" for the purpose of authorizing takes of marine mammals and that NMFS plans to engage the Commission in that process at the appropriate time (79 Fed. Reg. 13626). The Commission encourages NMFS to complete its policy development as quickly as possible and awaits a meeting to engage in that policy development process.

Mitigation and monitoring measures

NMFS would require LDEO to monitor the area near the survey vessel for at least 30 minutes before, during, and 30 minutes after airgun operations. NMFS also would require that when airguns have been powered or shut down because a marine mammal has been detected near or within a proposed exclusion zone, airgun activity will not resume until the marine mammal is outside the exclusion zone (i.e., the animal is observed to have left the exclusion zone or has not been seen or otherwise detected within the exclusion zone for 15 minutes in the case of small odontocetes and pinnipeds and 30 minutes in the case of baleen whales and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales). Those clearance times may be adequate for some species, but not all species. For small cetaceans, the Commission has recommended a clearance time of at least 15 minutes because their dive times are shorter and generally fall within that limit. For some large cetaceans, the proposed 30-minute clearance time may be inadequate, sometimes markedly so. Beaked and sperm whales, in particular, can remain submerged for periods far exceeding 30 minutes. Blainville's and Cuvier's beaked whales have been known to dive to considerable depths (> 1,400 m) and to remain submerged for more than 80 minutes (Baird et al. 2008). The grand mean dive duration for those species of beaked whales during foraging dives has been estimated at approximately 60 minutes (51.3 and 64.5 minutes for Blainville's and Cuvier's beaked whales, respectively; Baird pers. comm.). However, recent data on Cuvier's beaked whales revealed a maximum dive duration of more than 137 minutes and dive depths of more than 2,990 m, both of which set new mammalian dive records. Consistent with previous findings, Schorr et al. (2014) indicated a mean dive duration of 67.4 minutes. Sperm whales also dive to great depths and can remain submerged for up to 55 minutes (Drouot et al. 2004), with a grand mean dive time of approximately 45 minutes (Watwood et al. 2006).

In addition, observers may not detect marine mammals each time they return to the surface, especially cryptic species such as beaked whales, which are difficult to detect even under ideal conditions. Barlow (1999) found that "[a]ccounting for both submerged animals and animals that are otherwise missed by the observers in excellent survey conditions, only 23 percent of Cuvier's beaked whales and 45 percent of *Mesoplodon* beaked whales are estimated to be seen on ship surveys if they are located directly on the survey trackline." Moreover, Miller et al. (2009) determined that sperm whales continued on their course of travel during exposure to airgun sounds. None of those sperm whales diverted to avoid seismic activity at distances of 1–13 km from the vessel, and most whales traveled on a parallel course. Therefore, after either a power down or shutdown, the Marine Mammal Commission recommends that the National Marine Fisheries Service require a clearance time of 60 minutes for deep-diving species (i.e., beaked and sperm whales), if the animal is not observed to have left the exclusion zone.

In previous letters, the Commission has indicated that monitoring and reporting requirements should be sufficient to provide a reasonably accurate assessment of the manner of taking and the numbers of animals taken by the proposed activity, specifically to verify that only small numbers of marine mammals are being taken and that the impacts are negligible. The Commission continues to believe those assessments need to account for animals at the surface but not detected and for animals present but underwater and not available for sighting, which are accounted for by g(0) and f(0) values. NMFS's most recent response to the Commission's comments indicated that the MMPA implementing regulations require that applicants include monitoring that will result in "an increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities . . ." This increased knowledge of the level of taking could be qualitative or relative in nature, or it could be more directly quantitative (79 Fed. Reg. 38503). The Commission believes that NMFS misinterpreted its implementing regulations in its response. Those regulations state that applicants are to specify—

> The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities, and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity.

Although this portion of the regulations[21] is not particularly clear, it appears that the phrase "increased knowledge" is intended to modify the clause "of the species" and not "the level of taking or impacts on the populations of marine mammals that are expected to be present while conducting activities". If the phrase "increased knowledge of" is intended to apply throughout the remainder of the provision, as NMFS suggests, then the portion requiring the applicant to provide "suggested means of minimizing burdens…" makes no sense. A better interpretation of the provision is that the applicant is to suggest monitoring and reporting measures that will (1) increase the knowledge regarding the species and (2) provide the necessary information regarding the level of incidental taking that occurs and the impacts of such taking on the affected marine mammal populations. Such an interpretation is consistent with the statutory structure, which under section 101(a)(5)(D)(iv) requires that NMFS "modify, suspend, or revoke an authorization" if it finds, among other things, that the authorized taking is having more than a negligible impact or that more than small numbers

[21] The Commission also questions whether the cited regulation is even the relevant one upon which NMFS should be relying. It merely specifies what applicants should be suggesting when applying for an incidental take authorization. NMFS has an independent responsibility under the MMPA to specify monitoring and reporting requirements that are sufficient for it determine that the statutory requirements are being met.

of marine mammals are being taken. It is through the prescribed monitoring and reporting requirements that NMFS collects the information necessary to make those determinations. As such, those requirements need to be sufficient to provide accurate information on the numbers of marine mammals being taken and the manner in which they are taken, not merely better information on the qualitative nature of the impacts. Accordingly, the Commission continues to believe that appropriate g(0) and f(0) values are essential for making accurate estimates of the numbers of marine mammals taken during surveys. To be applicable for the proposed survey, the corrections should be based on the ability of the protected species observers to detect marine mammals rather than a hypothetical optimum derived from scientific studies (e.g., from NMFS's shipboard surveys).

Therefore, the Commission again recommends that NMFS consult with LDEO, NSF, and other relevant entities (e.g., USGS, Scripps, ASC) to develop, validate, and implement a monitoring program that provides a scientifically sound, reasonably accurate assessment of the types of marine mammal takes and the actual numbers of marine mammals taken by incorporating applicable g(0) and f(0) values. NMFS recently stated that although it does not generally believe that post-activity take estimates using f(0) and g(0) are *required* to meet the monitoring requirement of the MMPA, in the context of the NSF and LDEO's monitoring plan, NMFS agreed that developing and incorporating a way to better interpret the results of their monitoring (perhaps a simplified or generalized version of g(0) and f(0)) is a good idea. NMFS further stated it would consult with the Commission and NMFS scientists prior to finalizing the recommendations (79 Fed. Reg. 38503). The Commission welcomes such a meeting.

The Commission looks forward to collaborating with NMFS on the various guidance documents and issues raised in this letter. Please contact me if you have questions concerning the Commission's recommendations.

Sincerely,

Rebecca J. Lent

Rebecca J. Lent, Ph.D.
Executive Director

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0648-XD394

Sat, Aug 30, 2014 at 1:05 PM

A great big "NO" to allowing the NSF in collaboration with Lamont-Doherty to "take" marine animals that have been affected by the airgun blasts. We are against permits being granted for this "so called" scientific research. They obviously know that marine life will be affected due to the 800 hours of explosions since they want to "take" the creatures affected. So, NO to all of these proposals.

Allen and Kathy Fitz
Nags Head, NC

Fw: public comment on federal rgister the seismic massive storm that will hemorrhage all whales an ddolphins in the atlantic ocean

Sat, Aug 2, 2014 at 1:27 PM

Reply-To: Jean Public <jeanpublic1@yahoo.com>
To: "itp.cody@noaa.gov" <itp.cody@noaa.gov>, "vicepresident@whitehouse.gov" <vicepresident@whitehouse.gov>, "americanvoices@mail.house.gov" <americanvoices@mail.house.gov>, "info@pewtrusts.org" <info@pewtrusts.org>, "info@oceana.org" <info@oceana.org>, "info@opsociety.org" <info@opsociety.org>, "info@wdc.greenpeace.org" <info@wdc.greenpeace.org>, "info@sweashepherd.org" <info@sweashepherd.org>, "contact@harpseals.org" <contact@harpseals.org>, "info@peta.org" <info@peta.org>
Cc: "humanelines@hsus.org" <humanelines@hsus.org>, "info@idausa.org" <info@idausa.org>, "info@lohv.org" <info@lohv.org>, "info@cok.net" <info@cok.net>, "info@godscreaturesministry.org" <info@godscreaturesministry.org>

deny any permit to lamont which has done seismic surveys in this area before so there is no necessity to do themn now. no matter what they sayon their permit all of these surveys are for the help of oil and gas profiteers. whales, dolphins, all marine life are harmed and killed by seismic waves, which bring on brain hemorrhages to kill these poor animals, which are under assault by the greedy of this world. we do not need to study our oceans off the atlantic ocean coast. there is no need for this destructive survey. deny the permit. save the taxpayers dollars from being spent in this destructive endeavor. this comment is for the public record please receipt. jean public

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they will wash up dead on the beaches

[Federal Register Volume 79, Number 147 (Thursday, July 31, 2014)]
[Notices]
[Pages 44549-44578]
From the Federal Register Online via the Government Printing Office [www.gpo.gov]
[FR Doc No: 2014-17998]

[[Page 44549]]

Vol. 79

Thursday,

No. 147

(no subject)

Wed, Aug 20, 2014 at 1:44 AM

0648-xd394

As a resident of N.C. that has and oceanfront motel on Hatteras Island, as well as being a commercial fisherman that has served on three Take Reduction Teams on marine mammals (bottlenose, harbor porpoise and presently the PLTRT) there is probably no one more upset with this proposed endeavor than myself. After all, this so callled scientific research into continental drift might fool a few, but certainly not many, and doubtfully no one that is aware that the Obama administration has already opened the door for leasing offshore areas to oil exploration.

Furthermore, as and involved commercial fisherman that has spent 10 hours in a room fighting over one half of one PBR .....i find it extremely incredible that and agency that professes to have such concern for marine mammals would allow this potentially catastrophic intrusion into a so called special research area (CHSRSA) .....and area which i have to call into every time i go fishing because of the agencies supposed concern for both short fin and long fin pilot whales. Interestingly enough, the impact analysis on these two species which are probably the most numerous and likely to be the most impacted overall are given little if any review on the EIS.

While much ado is made of the fact that and observer will be on the vessel at all times, no mention is made of the fact that this operation will 24/7....and how much does anyone expect and observer to actually observe in the dark of night?

One does not need a crystal ball to see our future....they need only look towards the Gulf of Mexico after the Deepwater Horizon disaster. The implications there include greatly reduced abundance of oysters which in itself is probably the greatest barometer to the health of the marine ecosystem. From there you can include dolphin deaths, a greatly impacted shrimp fishery, probable implications to the health of and important spawning ground for Western bluefin tuna etc. etc.. But of course this agency always has a trump card for any such disaster....they can always look to commercial and recreational fisheries to save the day with increased restrictions in such a case to show their professional concern.

This all really is becoming clearer now. The biggest obstacle to industry access in fisheries is the many Pew funded NGO's (not to mention Pew itself) which is represented on every fisheries council in the nation in some form. Obviously Pew (Sun Oil) has figured out that the best defense is a good offense, not to mention that the single greatest potential liability in the case of another Deepwater disaster are the many commercial and recreational fisheries that dot our coast.

I could go on for hours but quite obviously since ithe permit has already been issued it is wasted effort. One other thing won't likely change after this...or the distrust of a agency that speaks out of both sides of it's mouth.

jeff oden
Hatteras N.C.

TOWN OF KILL DEVIL HILLS

Post Office Box 1719, 102 Town Hall Drive
Kill Devil Hills, North Carolina 27948
252-449-5300
www.kdhnc.com

August 29, 2014

Ms. Jolie Harrison
Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

RE: 0648-XD394, Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014

Dear Ms. Harrison:

On behalf of the Town of Kill Devil Hills Board of Commissioners, I am writing to comment on the application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation, for an Incidental Harassment Authorization to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the northwest Atlantic Ocean off the North Carolina coast from September through October, 2014. According to the NOAA July 31, 2014 notice, the seismic survey will take place in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles [mi]) off the coast of Cape Hatteras, North Carolina.

We were stunned and disappointed to hear about this application to use air guns to relentlessly blast the marine life off Dare County's coast in the name of science. With little public notice and a comment period only open until September 2, we consider ourselves lucky to know about this application at all. It appears to us that this application has been accelerated, without full disclosure to the public.

As a municipality located on a barrier island, we must be a good steward of our fragile and pristine environment. Whether it is monitoring Kill Devil Hills' water quality or protecting the turtles that nest on our

beautiful beach, we take great pride in doing everything we can to ensure that future generations will also be able to experience the magnificence of the Outer Banks.

Our area is home to many wildlife species, including the endangered right whale. Are these surveys so important that your organization is willing to ignore the major impacts to our ecosystem that will occur? Though the application states that the testing is not related to oil and natural gas exploration, we have a hard time believing that.

We strongly believe that more research should be completed to understand fully the impacts of seismic testing and how we can mitigate those impacts. Further information about the impacts of manmade sound on the underwater environment and its inhabitants and the nature and effects of seismic testing is needed before blasting should be conducted. How do we know if the impacts are immediate and dramatic or subtle and delayed?

We understand that alternative technologies to seismic airgun testing exist, which may be more costly, but less harmful to marine life. We would like to see these alternatives be given more consideration during the application process.

In closing, please deny this application. Seismic airgun testing causes catastrophic impacts to the marine ecosystem, including injury or death whales and dolphins. This, in turn, will set the stage for even more negative impacts to our area.

Thank you for your consideration.

Sincerely,

Sheila F. Davies
Mayor

cc: Dare County Board of Commissioners
Director, NC Department of Environment and Natural Resources, Division of Coastal Management
File

TOWN OF KILL DEVIL HILLS

Post Office Box 1719, 102 Town Hall Drive
Kill Devil Hills, North Carolina 27948
252-449-5300
www.kdhnc.com

August 29, 2014

Mr. Braxton Davis
Director
NC Department of Environment and Natural Resources
Division of Coastal Management
400 Commerce Avenue
Morehead City, NC 28557

RE: 0648-XD394, Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014

Dear Director Davis:

On behalf of the Town of Kill Devil Hills Board of Commissioners, I am writing to comment on the application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation, for an Incidental Harassment Authorization to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the northwest Atlantic Ocean off the North Carolina coast from September through October, 2014. According to the NOAA July 31, 2014 notice, the seismic survey will take place in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, North Carolina.

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Thank you for your consideration.

Sincerely,

Sheila F. Davies

Sheila F. Davies
Mayor

cc: Dare County local governments
Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service
File

Marcus Langseth Science Oversight Committee (MLSOC)
Dr. Dale Sawyer, Chair
Professor, Department of Earth Science
Rice University MS-126
6100 Main Street
Houston, TX 77005
mlsoc@mail.unols.org

Jolie Harrison, Supervisor
Incidental Take Program
Permits and Conservation Division,
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910
ITP.Cody@noaa.gov

August 31, 2014

Subject: *0648-XD394 Comment on Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October, 2014.*

Dear Ms. Harrison:

The members of the Marcus Langseth Science Oversight Committee (MLSOC) are pleased to submit the following comments to the National Marine Fisheries Service about the application for an Incidental Harassment Authorization for the proposed seismic program on the Atlantic Continental margin offshore North Carolina This 2D program uses the *R/V Marcus G Langseth (R/V Langseth)*, a unique asset of the National Academic Fleet with its specially designed capabilities to conduct the proposed seismic program, to achieve its primary objective of investigating how this part of the continental margin separated from Africa. *R/V Langseth* is owned by the National Science Foundation (NSF) and operated by Lamont Doherty Earth Observatory (LDEO). MLSOC supports the NMFS commitment to science-based decisions in its regulatory process.

The MLSOC is a committee within the University National Oceanographic Laboratories System (UNOLS) and consists of a diverse group of professionals, including geophysicists, geologists, oceanographers, and marine engineers, who provide advice on the scientific operations of *R/V Langseth.* The committee's members have extensive experience in seismic operations around the world aboard *R/V Langseth*, and other seismic vessels, as well as knowledge and experience in mitigation and monitoring identified and/or required under the National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). One role of the Committee is to advise both the National Science Foundation (NSF) and the ship operator Lamont Doherty Earth Observatory (LDEO) on safe, efficient, cost-effective, and scientifically compelling operations of *R/V Langseth*.

The proposed *R/V Langseth* survey is part of an onshore-offshore coordinated experiment that has been planned for more than 5 years, through a series of workshops, proposals, and working groups. The offshore GeoPRISMS program, to study the processes that form and modify continental margins, identified the Eastern North American Margin (ENAM) as its primary site for studying rift initiation and evolution. The onshore component, the *Earthscope* program, consists of 400 portable seismometers deployed on a uniform grid that is systematically covering the U.S., entering eastern North America in 2012, and moving to Alaska in 2015. The purpose of *Earthscope* is to study the crust and lithospheric foundation of North America. The synergy of combining these two large programs is to promote cross-disciplinary learning and approaches to scientific collaboration that are not possible with single Principal-Investigator driven proposals and research. Both of these programs are community driven science, in that the workshops and planning are open to participation from all geoscientists and involve immediate release of the data. Immediate release of the data enables the broadest possible benefit to accrue from the experiment and maximizes the science and education derived from them.

Planning for the proposed *R/V Langseth* survey began in 2010. The GeoPRISMS program, which began in October, 2010, held a workshop in November, 2010 to develop an implementation plan for the rift initiation component. A year later, in October, 2011, geoscientists from Earthscope and ENAM met to identify and optimize common scientific interests. The implementation plan for GeoPRISMS identified three corridors across the North American margin to study, and the final proposal submitted for funding (in late 2012) focused on one corridor off North Carolina. Review of the proposal led to modifications that are incorporated into the current plan. Additional planning has occurred since 2012 to coordinate the logistics and permitting for the onshore and offshore components of the experiment. In addition to *R/V Langseth*, a second ship, *R/V Endeavor* is utilized to deploy and recover Ocean Bottom Seismographs (OBS) for the experiment. The OBS were deployed, in spring, 2014, to passively record seismic information prior to and during the ENAM experiment.

As a U.S. research vessel, *R/V Langseth* operates entirely within the U.S. regulatory process, and, when appropriate, international laws, required for understanding and mitigating the potential impacts of sound in the environment. NEPA requires proposed agency actions (in this case, NSF, which is proposing a seismic survey) to make the best effort to avoid adverse effects, minimize them, and mitigate them as part of assessing the environmental consequences of the project. The Environmental Assessment (EA), and the associated application for an Incidental Harassment Authorization (IHA) for this seismic experiment on the southeastern U.S. Atlantic margin, lay out the program, its potential consequences, possible alternatives, the rationale for why the proposed action is the most efficient and safe program, and mitigation measures that would minimize any potential adverse impacts. Among the factors considered in developing the research plan are:

a. Minimum energy source size to accomplish scientific objectives
b. Mitigation and shut down procedures specific to species
c. Protected Species Visual Observers (PSVO) observations for a standard amount of time, generally 30 minutes prior to the start of the survey to clear a specified area around the vessel, and to monitor marine animal occurrence during seismic operations.

d. Startup of the energy source includes ramp-up procedures over a standard amount of time (generally 30 min.) that serves to alert animals of the activities and allows them to vacate the area if disturbed.
e. No start-up of the seismic source during poor visibility or at night unless at least one airgun has been operating.
f. PSVOs, independent biologists, have authority to shut down the seismic source when marine mammals or sea turtles are detected in or about to enter designated exclusion zones.
g. Passive Acoustic Monitoring (PAM) and infrared sensors during day and night to complement visual monitoring.
h. Additionally, the airguns would be shut down if a North Atlantic right whale were seen at any distance from the vessel.

For the ENAM survey, the proponents propose to use two sizes of airgun arrays, an 18-airgun array with volume of 3300 in^3 for work on the continental shelf, and a 36-airgun array with volume of 6600 in^3 for the deep-water portions on the continental slope and rise. *Use of the smaller airgun array in shallow water on the continental shelf represents a compromise in achieving scientific objectives and reducing the impacts on marine animals.* Sound propagation in shallow water is more complicated to predict than in deep water, and the use of the smaller airgun array in shallow water recognizes this difficulty by being a more conservative source system than would be used in deep water. However, the smaller array diminishes the ability to record seismic signals across the entire onshore-offshore instrumentation array.

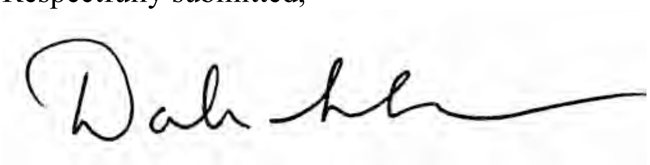
Marine seismic data are an essential and irreplaceable tool for scientific research in the oceans. Seismic images provide an unparalleled view of structures in the sediments, crust, and upper mantle beneath the seafloor. Data from the ENAM experiment will advance our understanding of fundamental geologic processes such as rifting, plate tectonics, volcanism, faulting, sediment deposition, and submarine landslides. ENAM researchers will also use these data to map dynamic features in the Earth, such as ground water flow, seafloor fluid and gas seeps, chemical and physical alteration of rocks, and the movement of water masses in the ocean.

If seismic surveys for basic research such as that proposed for ENAM using *R/V Langseth* are not permitted, the future of this unique national asset and the innovative research that it enables will be lost. If basic research seismic studies are halted, the U.S. will have lost a vital tool for studying the Earth. Marine seismic surveys are critical to our understanding of coastal geohazards, such as earthquakes, tsunamis, and submarine landslides. They enable government officials to make informed policy decisions that protect the safety of citizens and resilience of infrastructure.

NSF and LDEO have followed the appropriate IHA process and have conformed with the associated requirements. Based on the information and analysis provided by NSF and LDEO, the proposed activities meet the criteria established for issuance of an IHA. Therefore, the MLSOC urges NMFS to approve this application for an IHA.

R/V Langseth, and its predecessor, *R/V Ewing*, completed more than a decade's worth of academic/government seismic programs with the highest standards of mitigation and monitoring and without the dire, unfounded results purported by opponents of the activities (e.g., no marine mammal mass strandings). As a consequence of past activities, academic scientists have provided significant contributions to society through results which have enhanced our understanding of the Earth, Earth processes, and geohazards. Additionally, observations made by the PSVOs aboard seismic expeditions are contributing to better understanding of the distribution and behavior of marine mammals and sea turtles. We encourage NMFS – as a science based agency – to use science to make informed decisions, perform its regulatory duties, and issue IHAs in an appropriate and timely manner.

Respectfully submitted,



Dr. Dale Sawyer, Chair MLSOC
Rice University

Members:
Paul Baker, Duke University
Nathan Bangs, University of Texas at Austin
Deborah Hutchinson, U.S. Geological Survey
William Lang, Resource Access International
David Scholl, University of Alaska
Alexander Shor, University of Hawaii
Maurice Tivey, Woods Hole Oceanographic Institution

Ex-officio:
Maya Tolstoy, Lamont-Doherty Earth Observatory
Suzanne Carbotte, Lamont-Doherty Earth Observatory

0648-XD394

BONNIE MONTELEONE

Tue, Sep 2, 2014 at 7:15 PM

Jolie Harrison, Chief, Permits and Conservation Division,
Office of Protected Resources, National Marine Fisheries Service
1315 East-West Highway, Silver Spring, MD 20910

Dear Chief Harrison,

Below are the grounds by which seismic testing should not occur off of the Outer Banks/Cape Hatteras region. Though the Federal Register and the Lamont-Doherty reports attempt to quall concerns, they do not address the unique characteristics that makes Cape Hatteras an important foraging habitat for a multitude of marine life especially endangered species . Seismic testing at any degree induces unnecessary stress on the already declining whale population.

1. The Federal Register's Revised Take Table as of July 25, 2014 is not completely accurate. According to their list, North Atlantic right and fin whales have a 0% take risk (both of which are endangered species). Fin whales are reportedly seen year round off of Hatteras. Right whales migrate in the fall from Bay of Fundy to Florida to calve. Though aerial surveys report rare sightings, they are RARE as a species. We cannot assume because we don't see them, they are not in the Cape Hatteras vicinity. Right whales have been seen off the coast of Fort Fisher, NC in early November making it possible that they could be feeding in the nutrient rich water off of Cape Hatteras in October. (http://www.starnewsonline.com/article/20091112/articles/911129985?p=1&tc=pg&tc=ar)But regardless, seismic testing has been reported to travel 100,000 miles which spans the distance from the Bay of Fundy to Florida. (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.)

2. Due to the steep slope off of Cape Hatteras that causes nutrient rich upwelling, the cold waters of the Labrador Current, and the warm waters of the Gulf Stream, this location is an unusually dynamic area for foraging unlike any other region on the entire east coast. "In the pelagic and mid-water depths there is high diversity of verte-brates, migratory birds, mammals, and turtles as well as fish. On the bottom there is also diversity of invertebrates." (Blake, J. A et al., Gooday, A. J. et al, Hecker, B, Milliman, J. D.and Rhodas, D. C, et al) This is a foraging hotbed for an unusually high density of species. The seismic testing that will occur there will create enough noise to disrupt eating, mating, and navigation for 33 days straight, "792 hours of continuous airgun operations" according to the Lamont-Doherty report. Because it is a feeding site to many endangered species such as fin and the North Atlantic right whales, hawksbill, Kemp's ridley, loggerhead, and leatherback sea turtles, by law this area should be protected by the Endangered Species Act and listed as a priority ocean area for protection in the Mid-Atlantic. (www.nmfs.voaa.gov/pr/speicis/esa/listed.htm)

3. Due to the unique diversity of marine biota, the Outer Banks' economy is heavily impacted by the success of the fish stocks. Airguns have been shown to dramatically depress catch rates of various commercial species. (Engas, A. et al., 1996)

4. Because beaked whales are deep divers, they are found in areas where there are canyons and are heavily impacted by these surveys due to sound bouncing off the canyon walls. (Sounding the Depths, pg. 11) Cuvier's beaked whales are seen in this coastal region year round, traveling north and south along Hatteras Canyon off Cape Hatteras, and could potentially be more at risk for this reason. "In general, the heads of canyons are

known to be nursery areas for many fish and crustaceans, including commercially important ones. The sessile corals, sponges, and anemones found in the northern canyons have restricted distributions in that they must live attached to hard substrates. Hence populations within the canyons could represent crucial stock populations of sessile organisms." (http://www.nrdc.org/water/oceans/priority/recheck.asp)

5. The Lamont-Doherty report states the testing will be as high as 180 decibels. " . . . a 174-decibel rumble . . . . about as strong as a commercial jet at takeoff, measured about three feet away." (Sounding the Depths, pg. 4) Prolonged exposure to continuous loud noise is known to cause hearing loss to humans as well as marine mammals. This hearing impairment is known as "threshold shift." (Sound the Depths II, pg. 13) Though marine mammals have eyes and a sense of smell, the sense they rely on the most is sound to navigate, forage for food, mate, care for their offspring, and protect themselves from predators. To introduce sound that interferes with the most important sensory for 33 days straight is similar to blinding people with flood lights continuously for 24 hours, for 33 days. How could people feed, care for their children, or stay out of harms way? It is our moral, scientific, and legislative duty to protect this region more so than other areas along the east coast.

6. The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in or an 18-airgun array with a total discharge of volume of ~3300. "A single airgun array can disrupt vital behavior in endangered whales over an area of at least 100,000 square nautical miles in size." (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.) This underscores the harassment seismic testing will cause to the most endangered whale in the world – the North Atlantic right whale.

7. Other anthropogenic impacts that compromise the large whale populations are fishing gear entanglement and boat strikes. Right whales and fin whales are the most commonly reported species in the context of population size prone to vessel strikes. "Compared with the spatial extent of regulations, vessel-strike mortality continues to be highest in the mid-Atlantic coast." (Van Der Hoop, J. M. et al. 2012) Seismic testing will add yet another stressor on the already in periled species.

8. Sargassum is considered an essential fish habitat and is charged by law to minimize any adverse effects on such habitat. (Fishing North Carolina's Outer Banks: The complete Guide to Catching More, pg. 72). Sargassum found off North Carolina's coast is home to 81 fish species. Most of these fishes are juveniles that meander from the Gulf Stream. Commercially important dolphin fish, amberjacks, and tuna have also been documented to use this unique habitat as well as marine mammals (dolphins) and juvenile loggerhead sea turtles many of which are endangered. (http://oceanexplorer.noaa.gov/explorations/03edge/background/sargassum/sargassum.html) Influenced by the currents, large windrows of Sargassum mats consistently form just off of Cape Hatteras. The airgun blasts are not limited to just reaching the bottom but are also reported to be heard by mariners; thus, the Sargassum ecosystem stands to be impacted by the airgun operations. The NC Outer Banks fishing industry relies heavily on the Sargassum habitat. Communication with members from Pirates Cove Marina, the fishermen fear the negative impacts on fishing especially in hunting marlin.

Please consider this very unique aquatic region as a priority ocean area for protection in the Mid-Atlantic both for marine life and the fishing community, and not allow seismic testing incidental harassment to ever occur in this region.

Thank you for your consideration.

Bonnie Monteleone

Robert C. Edwards
Mayor

Susie Walters
Mayor Pro Tem

Cliff Ogburn
Town Manager

Town of Nags Head

Post Office Box 99
Nags Head, North Carolina 27959
Telephone 252-441-5508
Fax 252-441-0776
www.nagsheadnc.gov

M. Renée Cahoon
Commissioner

John Ratzenberger
Commissioner

Marvin Demers
Commissioner

August 19, 2014

Ms. Jolie Harrison
Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

RE: 0648-XD394, Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014

Dear Ms. Harrison:

On behalf of Nags Head's Board of Commissioners, I am writing to comment on the application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation (Foundation), for an Incidental Harassment Authorization (Authorization) to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the northwest Atlantic Ocean off the North Carolina coast from September through October, 2014. According to the NOAA July 31, 2014 notice, the seismic survey will take place in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, North Carolina.

We were stunned and disappointed to hear about this application to use air guns to relentlessly blast the marine life off Dare County's coast in the name of science. With little public notice and a comment period only open until September 2, we consider ourselves lucky to know about this application at all. It appears to us that this application has been accelerated, without full disclosure to the public.

As a municipality located on a barrier island, we must be a good steward of our fragile and pristine environment. Whether it is monitoring Nags Head's water quality or protecting the turtles that nest on our beautiful beach, we take great pride in doing everything we can to ensure that future generations will also be able to experience the magnificence of the Outer Banks.

Our area is home to many wildlife species, including the endangered right whale. Are these surveys so important that your organization is willing to ignore the major impacts to our ecosystem that will occur? Though the application states that the testing is not related to oil and natural gas exploration, we have a hard time believing that.

As you can see by the resolution our Board adopted April 2, 2014, we strongly believe that more research should be completed to fully understand the impacts of seismic testing and how we can mitigate those impacts. Further information about the impacts of manmade sound on the underwater environment and its inhabitants and the nature and effects of seismic testing is needed before blasting should be conducted. How do we know if the impacts are immediate and dramatic or subtle and delayed?

We understand that alternative technologies to seismic airgun testing exist, which may be more costly, but less harmful to marine life. We would like to see these alternatives be given more consideration during the application process.

In closing, please deny this application. Seismic airgun testing causes catastrophic impacts to the marine ecosystem, including injury or death whales and dolphins. This, in turn, will set the stage for even more negative impacts to our area.

Thank you for your consideration.

Sincerely,

Bob Edwards

Robert C. Edwards
Mayor

cc: Dare County Board of Commissioners
Bobby Outten, Manager, Dare County

Enclosure

RCE/rlt

Resolution No. 14-04-007
Town of Nags Head
Opposition to seismic testing
BOC Meeting April 2, 2014

1961

A Resolution of the Board of Commissioners of the Town of Nags Head, North Carolina Expressing opposition to seismic testing as proposed in the Bureau of Ocean Energy Management (BOEM) Programmatic Environmental Impact Statement (PEIS) - Option A and Option B

WHEREAS, seismic testing as proposed in the Bureau of Ocean Energy Management ("BOEM") Programmatic Environmental Impact Statement alternative A and alternative B has the potential to harm marine life; and

WHEREAS, seismic testing as proposed in BOEM Programmatic Environmental Impact Statement alternative A and alternative B has the potential to impact recreational and commercial fishing; and

WHEREAS, the Town of Nags Head is a municipality in Dare County where a major economic force is tourism related to the coastal environment; and

WHEREAS, the Town of Nags Head endeavors to be a good steward of the coastal environment and its resources; and

WHEREAS, the full impacts of seismic testing as proposed in BOEM Programmatic Environmental Impact Statement alternative A and alternative B are not yet fully understood by scientists, the Oil & Gas industry, or BOEM, and

WHEREAS, the Town of Nags Head believes that more research should be done to fully understand all impacts of seismic testing and options for mitigation those impacts; and

WHEREAS, the Town of Nags Head does not believe seismic testing as currently proposed in alternative A or alternative B of BOEM's Programmatic Environmental Impact Statement is the safest way to map oil & gas deposits in the mid-Atlantic region.

NOW, THEREFORE, BE IT RESOLVED, the Board of Commissioners of the Town of Nags Head, North Carolina, is opposed to seismic testing as proposed in in alternative A or alternative B of BOEM's Programmatic Environmental Impact Statement until such time as all testing options are evaluated and proper assurances for the protection of marine life are established.

This resolution adopted the 2nd of April 2014.

Robert C. Edwards

Robert C. Edwards, Mayor
Town of Nags Head

ATTEST

Carolyn F. Morris

Carolyn F. Morris, Town Clerk

THE TOWN OF NAGS HEAD N.C. 1961

NRDC
THE EARTH'S BEST DEFENSE

NATURAL RESOURCES DEFENSE COUNCIL

Via Electronic Mail

September 2, 2014

Ms. Jolie Harrison
Chief, Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Email: ITP.Cody@noaa.gov

Re: **Comments on the proposed Incidental Harassment Authorization for Lamont-Doherty Earth Observatory and National Science Foundation survey in northwest Atlantic Ocean off the North Carolina coast**

Dear Ms. Harrison:

On behalf of our organizations and our more than one million members, we write to submit comments on the proposed Incidental Harassment Authorization (IHA) for the take of marine mammals related to a proposed Lamont-Doherty Earth Observatory (Lamont-Doherty) and National Science Foundation (NSF) geophysical seismic survey in the northwest Atlantic Ocean off Cape Hatteras, North Carolina, September 15 through October 31, 2014. 79 Fed. Reg. 44550 (July 13, 2014).

Our organizations are profoundly concerned about NMFS's intention to permit high-intensity seismic surveys to operate 24/7 for weeks on end in this highly sensitive Atlantic region because of the significant environmental harm of airgun exploration itself, the sensitivity and endangered status of numerous marine species found within the proposed study area, and the cumulative impact of this and other planned activity in the Atlantic. We are also deeply troubled by the poor analysis undertaken in support of this project, which should have received far more rigorous review, and by NMFS' conclusion of the public comment process only thirteen days before the requested authorization period begins—a practice we have seen before with NSF authorizations—making it highly unlikely that approval of the authorization as it stands, regardless of the evidence and recommendations the public supplies, is anything other than a foregone conclusion.

It is undisputed that sound is a fundamental element of the marine environment. Whales, fish, and other wildlife depend on it for breeding, feeding, navigating, and avoiding predators – in short, for their survival and reproduction – and the proposed action would degrade the acoustic environment along particularly rich waters, home to noise-sensitive species off the coast of Cape Hatteras. To conduct the survey, Lamont-Doherty/NSF plans to use 36 or 18 high-volume airguns, firing intense impulses of compressed air—almost as loud as explosives—roughly every 65 or 22 seconds, 24 hours per day, for weeks on end. In addition, Lamont-Doherty/NSF intends to operate a multi-beam echosounder—a system similar to the one found to have likely caused a mass stranding of melon-headed whales on Madagascar—and a sub-bottom profiler continuously during the seismic operations.

Increasingly, the available science demonstrates that these blasts disrupt baleen whale behavior and impair their communication on a vast scale; that they harm a diverse range of other marine mammals; and that they can significantly impact fish and fisheries, with unknown but potentially substantial effects on coastal communities. Given the location of the proposed multi-year survey, it could well affect endangered species and populations already depleted through fisheries interactions. Indeed, even with its erroneous methodology, NMFS estimates that high percentages of several regional marine mammal stocks will be taken, including roughly 22% of pantropical spotted dolphins.

The MMPA dictates that, before permitting this activity, NMFS must ensure that the project employs mitigation to obtain the least practicable impact. Unfortunately, the proposed project falls far short of this standard. Instead, it provides an analysis that consistently tends to understate impacts and fails to require available mitigation measures. The survey needlessly harms marine mammals in direct disregard of the Marine Mammal Protection Act and recklessly impacts fish and sea turtles as well.

Given the intense controversy over seismic surveys in the Atlantic region, it is a matter of some amazement to all of our organizations that NMFS did not subject this survey application to meaningful scrutiny. We urge that NMFS deny the IHA or Lamont-Doherty/NSF withdraw its application, and that—at minimum—Lamont-Doherty/NSF revise its proposed mitigation measures in the ways discussed below.

I. BACKGROUND: ENVIRONMENTAL IMPACTS

A large seismic airgun array can produce effective peak pressures of sound higher than those of virtually any other man-made source save explosives;[1] and although airguns are vertically oriented within the water column, horizontal propagation is so significant as to make them, even under present use, one of the leading contributors to low-frequency

[1] National Research Council, *Ocean Noise and Marine Mammals* (2003).

ambient noise thousands of miles from any given survey.[2] Indeed, the enormous scale of this acoustic footprint has now been confirmed by studies of seismic in numerous regions around the globe, including the Arctic, the northeast Atlantic, Greenland, and Australia.

It is well established that the high-intensity pulses produced by airguns can cause a range of impacts on marine mammals, fish, and other marine life, including broad habitat displacement, disruption of vital behaviors essential to foraging and breeding, loss of biological diversity, and, in some circumstances, injuries and mortalities.[3] Consistent with their acoustic footprint, most of these impacts are felt on an extraordinarily wide geographic scale – especially on endangered baleen whales, whose vocalizations and acoustic sensitivities overlap with the enormous low-frequency energy that airguns put in the water. For example, a single seismic survey has been shown to cause endangered fin and humpback whales to stop vocalizing – a behavior essential to breeding and foraging – over an area at least 100,000 square nautical miles in size, and can cause baleen whales to abandon habitat over the same scale.[4]

Similarly, airgun noise can also mask the calls of vocalizing baleen whales over vast distances, substantially compromising their ability to communicate, feed, find mates, and engage in other vital behavior.[5] The intermittency of airgun pulses hardly mitigates this effect since their acoustic energy spreads over time and can sound virtually continuous at distances from the array.[6] According to recent modeling from Cornell and NOAA, the highly endangered North Atlantic right whale is particularly vulnerable to masking effects from airguns and other sources given the acoustic and behavioral characteristics of its calls.[7] As discussed further below, the exposure levels implicated in all of these

[2] Nieukirk, S.L., Stafford, K.M., Mellinger, D.K., Dziak, R.P., and Fox, C.G., Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean, *Journal of the Acoustical Society of America* 115: 1832-1843 (2004).

[3] *See*, *e.g.*, Hildebrand, J.A., Impacts of anthropogenic sound, *in* Reynolds, J.E. III, Perrin, W.F., Reeves, R.R., Montgomery, S., and Ragen, T.J., eds., *Marine Mammal Research: Conservation beyond Crisis* (2006); Weilgart, L., The impacts of anthropogenic ocean noise on cetaceans and implications for management. *Canadian Journal of Zoology* 85: 1091-1116 (2007).

[4] Clark, C.W., and Gagnon, G.C., Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales (2006) (IWC Sci. Comm. Doc. IWC/SC/58/E9); Clark, C.W., pers. comm. with M. Jasny, NRDC (Apr. 2010); *see also* MacLeod, K., Simmonds, M.P., and Murray, E., Abundance of fin (*Balaenoptera physalus*) and sei whales (*B. Borealis*) amid oil exploration and development off northwest Scotland, *Journal of Cetacean Research and Management* 8: 247-254 (2006).

[5] Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., van Parijs, S., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems as a function of anthropogenic sound sources (2009) (IWC Sci. Comm. Doc. SC/61/E10).

[6] *Id.*; Weilgart, L. (ed.), Report of the workshop on alternative technologies to seismic airgun surveys for oil and gas exploration and their potential for reducing impacts on marine mammals, 31 Aug. – 1 Sept., 2009, Monterey, Calif. (2010) (available at www.okeanos-stiftung.org/okeanos/download.php?id=19).

[7] Clark et al., Acoustic masking in marine ecosystems as a function of anthropogenic sound sources; Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems: intuitions, analysis, and implication, *Marine Ecology Progress Series* 395: 201-222 (2009).

studies are lower – indeed orders of magnitude lower on a decibel scale – than the threshold used to evaluate airgun behavioral impacts in the proposed IHA. Repeated insult from airgun surveys, over months and seasons, would come on top of already urbanized levels of background noise and, cumulatively and individually, would pose a significant threat to populations of marine mammals.

Airguns are known to affect a broad range of other marine mammal species beyond the endangered great whales. For example, sperm whale foraging appears to decline significantly on exposure to even moderate levels of airgun noise, with potentially serious long-term consequences;[8] and harbor porpoises have been seen to engage in strong avoidance responses fifty miles from an array.[9] Seismic surveys have been implicated in the long-term loss of marine mammal biodiversity off the coast of Brazil.[10] Broader work on other sources of undersea noise, including noise with predominantly low-frequency components, indicates that beaked whale species would be highly sensitive to seismic noise as well.[11]

Airgun surveys also have important consequences for the health of fisheries. For example, airguns have been shown to dramatically depress catch rates of various commercial species (by 40-80%) over thousands of square kilometers around a single array,[12] leading fishermen in some parts of the world to seek industry compensation for their losses. Other impacts on commercially harvested fish include habitat abandonment – one hypothesized explanation for the fallen catch rates – reduced reproductive performance, and hearing loss.[13] Even brief playbacks of predominantly low-frequency

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[8] Miller, P.J.O., Johnson, M.P., Madsen, P.T., Biassoni, N., Quero, M., and Tyack, P.L., Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico, *Deep-Sea Research I* 56: 1168-1181 (2009).

[9] Bain, D.E., and Williams, R., Long-range effects of airgun noise on marine mammals: responses as a function of received sound level and distance (2006) (IWC Sci. Comm. Doc. IWC/SC/58/E35).

[10] Parente, C.L., Pauline de Araújo, J., and Elisabeth de Araújo, M., Diversity of cetaceans as tool in monitoring environmental impacts of seismic surveys, *Biota Neotropica* 7(1) (2007).

[11] Tyack, P.L., Zimmer, W.M.X., Moretti, D., Southall, B.L., Claridge, D.E., Durban, J.W., Clark, C.W., D'Amico, A., DiMarzio, N., Jarvis, S., McCarthy, E., Morrissey, R., Ward, J., and Boyd, I.L. (2011), Beaked whales respond to simulated and actual Navy sonar, PLoS ONE 6(3): e17009. Doi:10.1371/journal.pone.0017009; Soto, N.A., Johnson, M., Madsen, P.T., Tyack, P.L., Bocconcelli, A., and Borsani, J.F. (2006), Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (Ziphius cavirostris)? Mar. Mamm. Sci. 22: 690-699.

[12] Engås, A., Løkkeborg, S., Ona, E., and Soldal, A.V., Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*), *Canadian Journal of Fisheries and Aquatic Sciences* 53: 2238-2249 (1996); *see also* Skalski, J.R., Pearson, W.H., and Malme, C.I., Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes ssp.*), *Canadian Journal of Fisheries and Aquatic Sciences* 49: 1357-1365 (1992).

[13] McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K., Marine seismic surveys: analysis and propagation of air-gun signals, and effects of air-gun exposure on humpback whales, sea turtles, fishes, and squid (2000) (report by Curtin U. of Technology); McCauley, R., Fewtrell, J., and Popper, A.N., High intensity anthropogenic sound damages fish ears, *Journal of the Acoustical Society of America* 113: 638-642 (2003); Scholik, A.R.,

noise from speedboats have been shown to significantly impair the ability of some fish species to forage.[14] Recent data suggest that loud, low-frequency sound also disrupts chorusing in black drum fish, a behavior essential to breeding in this commercial species.[15] Several studies indicate that airgun noise can kill or decrease the viability of fish eggs and larvae.[16]

The amount of disruptive activity under consideration in this proposed IHA is substantial, especially when put into the context of cumulative impacts in the region from other activities.

II. PURPOSE AND NEED OF STUDY

The stated purpose of the study, as set forth in the Draft Environmental Assessment (DEA), is 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.

In the paltry 1-paragraph discussion of the purpose and need for the project, the Draft Environmental Assessment offers no analysis of the ability to obtain this information by modeling or alternate means, no discussion of related survey data that may be available for extrapolation or reprocessing, nor any prediction of the scientific uniqueness and value of the findings. Indeed, there is little to substantiate the immediate need for this study, other than vague statements about NSF's "need to fund seismic surveys" and "need to foster a better understanding of Earth processes." Without such basic information, it is impossible to ascertain the need for this study, or for any portion of the study—an essential consideration for the agency in meeting its regulatory mandate under the MMPA's mitigation provision.

III. MITIGATION & IMPACTS

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and Yan, H.Y., Effects of boat engine noise on the auditory sensitivity of the fathead minnow, *Pimephales promelas*, *Environmental Biology of Fishes* 63: 203-209 (2002).

[14] Purser, J., and Radford, A.N., Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (Gasterosteus aculeatus), PLoS One, 28 Feb. 2011, DOI: 10.1371/journal.pone.0017478 (2011).

[15] Clark, C.W., pers. comm. with M. Jasny, NRDC (Apr. 2010).

[16] Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren, T., and Toklum, K., Effecter av luftkanonskyting på egg, larver og yngel (Effects from airgun shooting on eggs, larvae, and fry), *Fisken og Havet* 3:1-83 (1996) (Norwegian with English summary); Dalen, J., and Knutsen, G.M., Scaring effects on fish and harmful effects on eggs, larvae and fry by offshore seismic explorations, *in* Merklinger, H.M., *Progress in Underwater Acoustics* 93-102 (1987); Banner, A., and Hyatt, M., Effects of noise on eggs and larvae of two estuarine fishes, *Transactions of the American Fisheries Society* 1:134-36 (1973); L.P. Kostyuchenko, Effect of elastic waves generated in marine seismic prospecting on fish eggs on the Black Sea, *Hydrobiology Journal* 9:45-48 (1973).

The requested action has the potential for temporary or permanent hearing loss and other physical effects including stranding and death; masking and reduced effectiveness of communication; vessel strike and collision; entanglement; and stress and behavioral disturbance of marine mammals. In order to issue an Incidental Take Authorization (ITA) under section 101(a)(5)(D) of the MMPA, NMFS must set forth mitigation that ensures a means of effecting the least practicable impact. The mitigation here falls far short of that high bar on various fronts.

A. Failure to Consider Time-Area Restrictions

Time and area restrictions designed to protect high-value habitat are one of the most effective means to reduce the potential impacts of noise and disturbance, including noise from oil and gas exploration.[17] It was for this express reason that NOAA, in 2011, established a working group on Cetacean Density and Distribution Mapping, to define marine mammal hotspots for management purposes using predictive habitat modeling and other means.[18] Incredibly, the proposed IHA does not consider any areas for closures or seasonal planning for any species other than for North Atlantic right whales, and provides no justification for the particular trackline configuration mapped in its addendum—and particularly why that design, as opposed to other potential designs, represents the least practicable adverse impact on marine mammals. More specifically:

1. Cape Hatteras Special Research Area

The continental shelf break off Cape Hatteras features a major oceanic front created by the Gulf Stream, which plumes into the Atlantic and merges with Labrador Current, creating conditions for warm-core rings and high abundance of marine mammals and fish.[19] Among the many species that are drawn to this area in high abundance are long-

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[17] *See, e.g.*, Agardy, T., Aguilar Soto, N., Cañadas, A., Engel, M., Frantzis, A., Hatch, L., Hoyt, E., Kaschner, K., LaBrecque, E., Martin, V., Notarbartolo di Sciara, G., Pavan, G., Servidio, A., Smith, B., Wang, J., Weilgart, L., Wintle, B., and Wright, A, A global scientific workshop on spatio-temporal management of noise, Report of workshop held in Puerto Calero, Lanzarote, June 4-6, 2007 (2007); Dolman, S., Aguilar Soto, N., Notabartolo di Sciara, G., Andre, M., Evans, P., Frisch, H., Gannier, A., Gordon, J., Jasny, M., Johnson, M., Papanicolopulu, I., Panigada, S., Tyack, P., and Wright, A., Technical report on effective mitigation for active sonar and beaked whales (2009) (working group convened by European Cetacean Society); OSPAR Commission, Assessment of the environmental impact of underwater noise (2009) (report issued as part of OSPAR Biodiversity Series, London, UK); Convention on Biological Diversity, Scientific synthesis on the impacts of underwater noise on marine and coastal biodiversity and habitats (2012) (UNEP/CBD/SBSTTA/16/INF/12).

[18] Memorandum from Dr. Jane Lubchenco, Undersecretary of Commerce for Oceans and Atmosphere, to Nancy Sutley, Chair, Council on Environmental Quality at 2 (Jan. 19, 2010).

[19] Churchill, J., Levine, E., Connors, D., and Cornillon, P., Mixing of shelf, slope and Gulf Stream water over the continental slope of the Middle Atlantic Bight, *Deep Sea Research Part I: Oceanographic Research Papers*, 40: 1063-1085 (1993); Hare, J., Churchill, J., Cowen, R., Berger, T., Cornillon, P., Dragos, P., Glenn, S.M., Govoni, J.J., and Lee, T.N., Routes and rates of larval fish transport from the southeast to the northeast United States continental shelf, *Limnology and Oceanography* 47: 1774-1789 (2002); Garrison, L., Swartz, S., Martinez, A., Burks, C., and Stamates, J., A marine mammal assessment survey of the southeast US continental shelf: February-April 2002 (2003) (NOAA Technical Memorandum

and short-finned pilot whales and Risso's dolphin, whose interactions with the pelagic longline fishery have exceeded the insignificance threshold for potential biological removal and triggered the formation of a take reduction team under the MMPA.[20] The Cape Hatteras Special Research Area, designated by NMFS as a tool to manage the marine mammal-fishery interactions, captures the majority of the most crucial habitat, having some of the highest densities of cetaceans in the entire region and being one of the most important sites for charter, commercial, and recreational pelagic fisheries.[21] It lies between 35° N. lat. and 36° 25' N. lat. on the north and south, and 74° 35' W. long. and 75° W. long. on the east and west, representing the northwest portion of the proposed study area.

2. Other areas

NMFS has not attempted any systematic analysis of marine mammal habitat for purposes of establishing time-area closures within the study area, despite the availability of predictive habitat models and direct survey data. For example, over the past few years, researchers have developed at least two predictive models to characterize densities of marine mammals in the area of interest: the NODE model produced by the Naval Facilities Engineering Command Atlantic, and the Duke Marine Lab model produced under contract with the Strategic Environmental Research and Development Program. Until Duke has produced its new cetacean density model pursuant to NOAA's CetMap program, NMFS should use these sources, which represent best available science, to identify important marine mammal habitat and ensure the least practicable impact. Species of particular importance, aside from the North Atlantic right whale, include the five other large whale species listed under the Endangered Species Act, *i.e.*, blue, fin, sei, humpback, and sperm whales; the three odontocete stocks that are the subject of a regional take reduction team; and beaked whales, whose vulnerability to anthropogenic noise is well recognized and which occur in this region in relatively high densities.

B. Failure to Ensure Marine Mammal Take Remains Below Estimates

At some point between the submission of its application and NMFS' issuance of the proposed IHA, Lamont Doherty/NSF elected to remove the 25% contingency that it typically adds to its tracklines to account for line changes, vessel turns, equipment malfunctions, and other factors, with the effect of reducing the total area ensonified (to 160 dB) by approximately 36 percent. The consequences can be read in the revised take estimates: significant reductions in species take virtually across the aboard.

NMFS-SEFSC-492); Waring, G., Josephson, E., Fairfield-Walsh, C., and Maze-Foley, K., U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2008 (2009) (NOAA Tech Memo NMFS NE 210); 74 Fed. Reg. 23349, 23349-23358 (May 19, 2009).

[20] 74 Fed. Reg. 23349, 23350.

[21] 74 Fed. Reg. 23349; NMFS, Environmental Assessment, Regulatory Impact Review, and Final Regulatory Flexibility Analysis for the Final Pelagic Longline Take Reduction Plan (Jan. 2009) (produced by NMFS Southeast Regional Office).

Of course our organizations do not oppose the modification of tracklines to reduce ensonification of the marine environment and minimize harm to marine mammals; indeed, we have strongly recommended such measures on numerous other occasions. The modifications proposed by NMFS, however, are questionable. It remains unclear, for example, how the tracklines that were omitted from IHA Figure 1 can plausibly be eliminated, as they appear necessary to turn the source vessel. On the contrary, circumstances suggest that NMFS' modifications, far from reducing impacts to their least practicable level as the MMPA requires, were instead undertaken to lower the agency's take estimates, particularly of pantropical spotted dolphins, to levels more easily approved under the MMPA's "small numbers" standard.

We therefore fully concur with the Marine Mammal Commission that any IHA issued for this project expressly deny authorization "to repeat tracklines, accommodate the turning radius of the vessel, address equipment malfunctions, or conduct equipment testing prior to commencing or during the survey."[22] Alternatively, NMFS should expressly limit LDEO/NSF to both the specified tracklines and the specified number of line-kilometers, and require cessation of the activity when the latter is reached.

C. Failure to Adequately Consider Reasonable Mitigation and Monitoring Measures

The proposed IHA does not adequately consider, or fails to consider at all, a number of other reasonable measures that could significantly reduce take from the proposed activities. These measures include, but are not limited to:

1. Survey design standards and review

NMFS should require that the airgun survey vessel use the lowest practicable source level, minimize horizontal propagation of the sound signal, and minimize track lines consistent with the purposes of the survey.[23] While cursory consideration is given to the source level, little explanation of the conclusion that a 36-airgun array is required is offered. We would note that, in the past, NMFS has recognized that MMPA mitigation begins "during the planning phases," as, for example, with consideration of whether the same research objectives could be accomplished using a smaller source. Thus, for a 2013 survey off

[22] Comments of Marine Mammal Commission at 9 (Aug. 18, 2014).
[23] Parsons, E.C.M., Dolman, S.J., Jasny, M., Rose, N.A., Simmonds, M.P., and Wright, A.J., A critique of the UK's JNCC seismic survey guidelines for minimising acoustic disturbance to marine mammals: Best practice? *Marine Pollution Bulletin* 58: 643-651 (2009); Burns, J., Clark, C., Ferguson, M., Moore, S., Ragen, T., Southall, B., and Suydam, R., Expert panel review of monitoring and mitigation protocols in applications for incidental harassment authorizations related to oil and gas exploration, including seismic surveys, in the Chukchi and Beaufort Seas (2010) (NMFS Expert Panel Review 2010); Brower, H., Clark, C.W., Ferguson, M., Gedamke, J., Southall, B., and Suydam, R., Expert panel review of monitoring protocols in applications for incidental harassment authorizations related to oil and gas exploration in the Chukchi and Beaufort Seas, 2011: Statoil and ION Geophysical (2011) (NMFS Expert Panel Review 2011).

Spain, Lamont Doherty/NSF used two 18-airgun arrays operating in ping-pong mode rather than a single, high-source-level, 36-gun array. 78 Fed. Reg. 17359, 17376 (Mar. 21, 2013). Here NMFS has failed to engage in that analysis—an analysis that should have taken place months ago.

2. Multi-beam echosounder

NMFS should also require use of an alternative multi-beam echosounder to the one presently proposed, which uses a peak frequency between 10.5 kHz and 13 kHz. An industrial multibeam echosounder employed by Exxon occurred in close spatial and temporal association with a mass stranding of melon-headed whales off Madagascar, in 2008;[24] a comparable multibeam sonar system—with a center frequency of 15.5 kHz and associated source levels of 237 dB—was used by a Lamont-Doherty Earth Observatory research survey prior to the Gulf of California beaked whale strandings in September 2002, with which the survey was closely correlated, and may have played a role in that event as well.[25] Regardless of the potential for strandings in the present case, it is clear that high-power, lower-frequency echosounders have the potential to impact marine mammal behavior, especially of odontocetes, over a wide spatial scale—and to a far greater extent than has previously been supposed for this category of sound source.[26] Given the acoustic characteristics of the Langseth's echosounder, use of an alternative for part or all of the survey must be considered.

3. Sound source validation

Relatedly, NMFS should require Lamont-Doherty/NSF to validate the assumptions about propagation distances used to establish safety zones and calculate take (*i.e.*, at minimum, the 160 dB and 180 dB isopleths, but preferably, through modeling, out to more reasonable impact distances). Such analysis is essential particularly where, as in the case of the proposed multi-beam echosounder, NMFS has based its analysis on dubious assumptions that run counter to the propagation analysis in the Madagascar stranding report (Southall et al. 2013). Sound source validation has been required of Arctic operators for several years, as part of their IHA compliance requirements, and has proven

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[24] Southall, B.L., Rowles, T., Gulland, F., Baird, R. W., and Jepson, P.D. 2013. Final report of the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar.

[25] Cox, T.M., Ragen, T.J., Read, A.J., Vos, E., Baird, R.W., Balcomb, K., Barlow, J., Caldwell, J., Cranford, T., Crum, L., D'Amico, A., D'Spain, G., Fernández, A., Finneran, J., Gentry, R., Gerth, W., Gulland, F., Hildebrand, J., Houser, D., Hullar, T., Jepson, P.D., Ketten, D., MacLeod, C.D., Miller, P., Moore, S., Mountain, D., Palka, D., Ponganis, P., Rommel, S., Rowles, T., Taylor, B., Tyack, P., Wartzok, D., Gisiner, R., Mead, J., and Benner, L., Understanding the impacts of anthropogenic sound on beaked whales. 7 *J. Cetacean Res. Manage.* 177-187 (2006); Hildebrand, J., Impacts of anthropogenic sound, *in* Ragen, T.J., Reynolds III, J.E., Perrin, W.F., Reeves, R.R., and Montgomery, S. (eds.), *Marine Mammal Research: Conservation beyond Crisis* 101-123 (2006).

[26] The point is echoed by Southall et al., Final Report of the Independent Scientific Review Panel.

useful for establishing more accurate, *in situ* measurements of safety zones and for acquiring information on noise propagation.[27]

4. Adequate safety zone distances

NMFS should reconsider the size of the safety zone. The proposed IHA proposes establishing a safety zone of 180 dB re 1 μPa (with a 500 m minimum) around the seismic array. Gedamke et al. (2011), whose lead author is the present director of NMFS' Bioacoustics Program, has put traditional means of estimating safety zones into doubt. That paper demonstrates through modeling that, when uncertainties about impact thresholds and intraspecific variation are accounted for, a significant number of whales could suffer temporary threshold shift (*i.e.*, hearing loss) beyond 1 km from a relatively small seismic array (source energy level of 220 dB re 1 $\mu Pa^2(s)$) – a distance that seems likely to exceed NMFS's estimates.[28] Moreover, a recent dose-response experiment indicates that harbor porpoises are substantially more susceptible to temporary threshold shift than the two species, bottlenose dolphins and belugas, that had previously been tested.[29] And a number of recent studies suggest that the relationship between temporary and permanent threshold shift may not be as predictable as previously believed.[30]

Finally, NMFS should consider establishing larger shutdown zones for certain target species. Although time/area closures are a more effective means of reducing cumulative exposures of wildlife to disruptive and harmful sound, these expanded safety zones have value in minimizing disruptions, and potentially in reducing the risk of hearing loss and injury, outside the seasonal closure areas.[31] Visual sighting of any individual right whale at any distance should trigger shut-down; for other species, shut-down should occur if aggregations are observed within the 160 dB isopleth around the sound source.

5. Adequate real-time monitoring

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[27] *See*, *e.g.*, Burns et al., Expert Panel Review (2010), *supra*; Brower et al., Expert Panel Review (2011), *supra*.

[28] Gedamke, J., Gales, N., and Frydman, S., Assessing risk of baleen whale hearing loss from seismic surveys: The effect of uncertainty and individual variation, *Journal of the Acoustical Society of America* 129: 496-506 (2011).

[29] Lucke, K., Siebert, U., Lepper, P.A., and Blanchet, M.-A., Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli, *Journal of the Acoustical Society of America* 125: 4060-4070 (2009).

[30] Kastak, D., Mulsow, J., Ghoul, A., Reichmuth, C., Noise-induced permanent threshold shift in a harbor seal [abstract], *Journal of the Acoustical Society of America* 123: 2986 (2008) (sudden, non-linear induction of permanent threshold shift in harbor seal during TTS experiment); Kujawa, S.G., and Liberman, M.C., Adding insult to injury: Cochlear nerve degeneration after "temporary" noise-induced hearing loss, *Journal of Neuroscience* 29: 14077-14085 (2009) (mechanism linking temporary to permanent threshold shift).

[31] *See* MMS, Final Programmatic Environmental Assessment, Arctic Outer Continental Shelf Seismic Surveys – 2006, OCS EIS/EA MMS 2006-038 at 110-111 (June 2006) (noting sensitivity of baleen whale cow-calf pairs).

It is well established that real-time visual shipboard monitoring is difficult for all marine mammal and sea turtle species, especially at night and during high sea states and fog.[32] Supplemental methods that have been used on certain other projects include hydrophone buoys and other platforms for acoustic monitoring, aerial surveys, shore-based monitoring, and the use of additional small vessels. Here, the real-time monitoring effort proposed in the IHA is inadequate.

While NMFS seems to require two observers for the airgun survey during the majority of the time– the minimum number necessary to maintain 360-degree coverage around the seismic vessel –it otherwise sets forth requirements that are inconsistent with survey conventions and with prior studies of observer effectiveness. *First*, NMFS would allow visual and acoustic observers to work at four-hour stretches. That four-hour work cycle doubles the amount of time conventionally allowed for marine mammal observation aboard NMFS survey vessels, and is even less appropriate for conditions where, as here, an animal's health is at stake. *Second*, NMFS offers no details about the training requirements of its vessel-based observers. Yet, as UK data have demonstrated, use of observers with no meaningful experience in marine mammal observation, such as ships' crew, results in extremely low levels (approaching zero percent) of detection and compliance.[33] NMFS should require field experience in marine mammal observation of any observer.

Finally, the proposed IHA makes no consideration of limiting activities in low-visibility conditions or at night, which can reduce the risk of ship-strikes and near-field noise exposures.

6. Technology-based mitigation

New technology represents a promising means of reducing the environmental footprint of seismic exploration. Industry experts and biologists participating in a September 2009 workshop on airgun alternatives reached the following conclusions: that airguns produce a great deal of "waste" sound and generate peak levels substantially higher than needed for offshore exploration; that a number of quieter technologies are either available now for commercial use or can be made available within the next five years; and that

[32] *See*, *e.g.*, Barlow, J., and Gisiner, R., Mitigation and monitoring of beaked whales during acoustic events, *J. Cetacean Res. Manage.* 7: 239-249 (2006); Parsons, E.C.M., Dolman, S.J., Jasny, M., Rose, N.A., Simmonds, M.P., and Wright, A.J., A critique of the UK's JNCC seismic survey guidelines for minimising acoustic disturbance to marine mammals: Best practice? *Marine Pollution Bulletin* 58: 643-651 (2009).

[33] Stone, C.J., The effects of seismic surveys on marine mammals in UK waters: 1998-2000 (2003) (Joint Nature Conservation Committee Report 323); *see also* Parsons et al., A critique of the UK's JNCC seismic survey guidelines, *supra*. It is worth noting that the "inexperienced" marine mammal observers involved in the UK study usually still received some basic training. Stone, The effects of seismic surveys, *supra*.

governments should accelerate development and use of these technologies through both research and development funding and regulatory engagement.[34]

Among the technologies discussed in the 2009 workshop report are engineering modifications to airguns, which can cut emissions at frequencies not needed for exploration; controlled sources, such as marine vibroseis, which can dramatically lower the peak sound currently generated by airguns by spreading it over time; various non-acoustic sources, such as electromagnetic and passive seismic devices, which in certain contexts can eliminate the need for sound entirely; and fiber-optic receivers, which can reduce the need for intense sound at the source by improving acquisition at the receiver.[35] An industry-sponsored report by Noise Control Engineering made similar findings about the availability of greener alternatives to seismic airguns, as well as alternatives to a variety of other noise sources used in oil and gas exploration.[36]

Considerable current effort is focused on developing quieting technologies for use in offshore exploration. Last winter, BOEM convened an international workshop on noise-reduction alternatives for deep-penetration seismic exploration, pile-driving for offshore construction, and shipping for offshore development in general. Findings of that workshop, which were released in a BOEM report, emphasize the promise of vibroseis.[37] Last June, parties to *NRDC v. Jewell* entered into a settlement agreement that establishes a timeframe for industry development and testing of three vibroseis prototypes;[38] and Geo-Kinetics has made substantial recent progress in bringing its own vibroseis unit to commercial viability, with an array potentially becoming available later this year. In 2012, BP North America patented a different noise-reduction method—one that uses software to stagger bursts of airgun fire, in order to reduce the effective source level of the array.[39]

The proposed IHA, however, fails to include any requirement to use or test the use of new technologies in the USGS Atlantic survey.

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[34] Weilgart, L. ed., Report of the workshop on alternative technologies to seismic airgun surveys for oil and gas exploration and their potential for reducing impacts on marine mammals, 31 Aug. – 1 Sept., 2009, Monterey, Calif. (2010), *available at* www.okeanos-stiftung.org/okeanos/download.php?id=19.

[35] *Id.*

[36] Spence, J., Fischer, R., Bahtiarian, M., Boroditsky, L., Jones, N., and Dempsey, R., Review of existing and future potential treatments for reducing underwater sound from oil and gas industry activities (2007) (NCE Report 07-001) (prepared by Noise Control Engineering for Joint Industry Programme on E&P Sound and Marine Life). Despite the promise indicated in the 2007 and 2010 reports, neither NMFS nor BOEM has attempted to develop noise-reduction technology for seismic or any other noise source, aside from BOEM's failed investigation of mobile bubble curtains.

[37] CSA Ocean Sciences, Quieting Technologies for Reducing Noise During Seismic Surveying and Pile Driving Workshop. Summary Report for the US Dept. of the Interior (2014) (BOEM rep. no. 2014-061).

[38] Settlement Agreement, NRDC v. Jewell, Case No. 2: 10-cv-01882 (E.D. La.) (settlement filed June 18, 2013).

[39] A. Ross and R.L. Abma, Offshore prospecting signal processing controlled source signaling, U.S. Patent 20,120,147,701 (June 14, 2012) (*available at*: http://www.faqs.org/patents/app/ 20120147701).

IV. IMPACTS ANALYSIS

A. Failure to Set Proper Thresholds for Marine Mammal Take

In addition to not implementing measures that would reduce take, NMFS has underestimated marine mammal take from the proposed study. The reasons for this are manifold, but lie principally in the agency's mistaken adoption of a 160 dB threshold for Level B take and its failure to adequately calculate impacts from masking. Nor has NMFS performed a sensitivity analysis to determine how significantly its take and impact estimates would differ if some of its core assumptions – such as its 160 dB threshold – are wrong.

1. Illegal threshold for behavioral take

NMFS uses a single sound pressure level (160 dB re 1 μPa (RMS)) as a threshold for behavioral, sublethal take in all marine mammal species from seismic airguns. This approach simply does not reflect the best available science, and the choice of threshold is not sufficiently conservative in several important respects. Indeed, five of the world's leading biologists and bioacousticians working in this field have characterized the present threshold, in a comment letter to NMFS, as "overly simplified, scientifically outdated, and artificially rigid."[40] *See* 40 C.F.R. § 1502.22. NMFS must use a more conservative threshold for the following reasons:

The agency's use of a single, non-conservative, bright-line threshold for all species flies in the face of recent science and is untenable. In particular, the 160 dB threshold is non-conservative, since the scientific literature establishes that behavioral disruption can occur at substantially lower received levels for some species.

For example, a single seismic survey has been shown to cause endangered fin and humpback whales to stop vocalizing – a behavior essential to breeding and foraging – over an area at least 100,000 square nautical miles in size, and can cause baleen whales to abandon habitat over the same scale.[41] Similarly, a low-frequency, high-amplitude fish mapping device was found to silence humpback whales at distance of 200 km, where received levels ranged from 88 to 110 dB; and several other studies clearly indicate disruption of biologically significant behaviors in baleen whales are drastically lower

[40] Clark, C., Mann, D., Miller, P., Nowacek, D., and Southall, B., Comments on Arctic Ocean Draft Environmental Impact Statement at 2 (Feb. 28, 2012).

[41] Clark, C.W., and Gagnon, G.C., Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales (2006) (IWC Sci. Comm. Doc. IWC/SC/58/E9); Clark, C.W., pers. comm. with M. Jasny, NRDC (Apr. 2010); *see also* MacLeod, K., Simmonds, M.P., and Murray, E., Abundance of fin (*Balaenoptera physalus*) and sei whales (*B. Borealis*) amid oil exploration and development off northwest Scotland, *Journal of Cetacean Research and Management* 8: 247-254 (2006).

received levels than considered here.[42] Sperm whale foraging success, as measured by buzz rate, appears to decline significantly on exposure to airgun received levels above 130 dB (RMS), with potentially serious long-term consequences.[43] Harbor porpoises are known to be acutely sensitive to a range of anthropogenic sources, including airguns. They have been observed to engage in avoidance responses fifty miles from a seismic airgun array – a result that is consistent with both captive and wild animal studies showing them abandoning habitat in response to pulsed sounds at very low received levels, well below 120 decibels (re 1 µPa (RMS)).[44] Beaked whales, though never tested experimentally for their response to airgun noise, have shown themselves to be sensitive to various types of anthropogenic sound, going silent, abandoning their foraging, and avoiding sounds at levels of 140 dB and potentially well below.[45]

Little if any of these data were available in 1999, when the High Energy Seismic Survey panel issued the report on which the 160 dB threshold is purportedly based;[46] since that time, the literature on ocean noise has expanded enormously due to massive increases in research funding from the U.S. Navy, the oil and gas industry, and other sources. The evidentiary record for a lower threshold in this case substantially exceeds the one for mid-frequency sonar in *Ocean Mammal Institute v. Gates*, 546 F. Supp.2d 960, 973-75

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[42] See, e.g., Risch, D., Corkeron, P.J., Ellison, W.T., and van Parijs, S.M., Changes in humpback whale song occurrence in response to an acoustic source 200 km away, PLoS ONE 7(1): e29741. doi:10.1371/journal.pone.0029741 (2012); Cerchio, S., Strindberg, S., Collins, T., Bennett, C., and Rosenbaum, H., Seismic surveys negatively affect humpback whale singing activity off Northern Angola, *PLoS ONE* 9(3): e86464. doi:10.1371/journal.pone.0086464 (2014); Castellote, M., Clark, C.W., and Lammers, M.O., Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise, *Biological Conservation* 147: 115-122 (2012).

[43] Miller, P.J.O., Johnson, M.P., Madsen, P.T., Biassoni, N., Quero, M., and Tyack, P.L., Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico, *Deep-Sea Research I* 56: 1168-1181 (2009).

[44] *E.g.*, Bain, D.E., and Williams, R., Long-range effects of airgun noise on marine mammals: responses as a function of received sound level and distance (2006) (IWC Sci. Comm. Doc. IWC/SC/58/E35); Kastelein, R.A., Verboom, W.C., Jennings, N., and de Haan, D., Behavioral avoidance threshold level of a harbor porpoise (Phocoena phocoena) for a continuous 50 kHz pure tone, *Journal of the Acoustical Society of America* 123: 1858-1861 (2008); Kastelein, R.A., Verboom, W.C., Muijsers, M., Jennings, N.V., and van der Heul, S., The influence of acoustic emissions for underwater data transmission on the behavior of harbour porpoises (Phocoena phocoena) in a floating pen, *Mar. Enviro. Res.* 59: 287-307 (2005); Olesiuk, P.F., Nichol, L.M., Sowden, M.J., and Ford, J.K.B., Effect of the sound generated by an acoustic harassment device on the relative abundance and distribution of harbor porpoises (Phocoena phocoena) in Retreat Passage, British Columbia, *Mar. Mamm. Sci.* 18: 843-862 (2002).

[45] Soto, N.A., Johnson, M., Madsen, P.T., Tyack, P.L., Bocconcelli, A., and Borsani, J.F., Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (*Ziphius cavirostris*)? *Mar. Mamm. Sci.* 22: 690-699 (2006); Tyack, P.L., Zimmer, W.M.X., Moretti, D., Southall, B.L., Claridge, D.E., Durban, J.W., Clark, C.W., D'Amico, A., DiMarzio, N., Jarvis, S., McCarthy, E., Morrissey, R., Ward, J., and Boyd, I.L., Beaked whales respond to simulated and actual Navy sonar, *PLoS ONE* 6(3):e17009.doi:10.13371/journal.pone.0017009 (2011) (beaked whales); California State Lands Commission, Draft Environmental Impact Report (EIR) for the Central Coastal California Seismic Imaging Project at H-47 (2012) (CSLC EIR No. 758).

[46] High Energy Seismic Survey Team, High energy seismic survey review process and interim operational guidelines for marine surveys offshore Southern California (1999).

(D.Hawaii 2008), in which a Hawaiian District Court judge invalidated a NMFS threshold that ignored documented impacts at lower received levels as arbitrary and capricious.

In addition, using a single sound pressure level of 160-dB for harassment represents a major step backward from recent authorizations. For Navy sonar activity, NMFS has incorporated into its analysis linear risk functions that endeavor to account for risk and individual variability and to reflect the potential for take at relatively low levels. Using a single sound pressure level of 160-dB for harassment represents a major step backward from recent authorizations. For Navy sonar activity, NMFS has incorporated into its analysis linear risk functions that endeavor to account for risk and individual variability and to reflect the potential for take at relatively low levels.[47]
The use of a multi-pulse standard for behavior harassment is non-conservative, since it does not take into account the spreading of seismic pulses over time beyond a certain distance from the array.[48] NMFS' own Open Water Panel for the Arctic – which has included some of the country's leading marine bioacousticians – has twice characterized the seismic airgun array as a mixed impulsive/continuous noise source and has stated that NMFS should evaluate its impacts on that basis.[49] That analysis is supported by the masking effects model referenced above, in which several NMFS scientists have participated; by a number of papers showing that seismic exploration in the Arctic, the east Atlantic, off Greenland, and off Australia has raised ambient noise levels at significant distances from the array;[50] and, we expect, by the modeling efforts of NOAA's Sound Mapping working group, whose public release is supposed to occur in early July. NMFS should not ignore this science.

The threshold's basis in the root mean square ("RMS") of sound pressure, rather than in peak pressure, is non-conservative. Studies have criticized the use of RMS for seismic because of the degree to which pulsed sounds must be "stretched," resulting in significant potential underestimates of marine mammal take.[51]

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[47] *See, e.g.*, 74 Fed. Reg. 4844, 4844-4885 (Jan. 27, 2009).
[48] *See* Expert Panel Review 2011.
[49] *Id.*; *see also* Expert Panel Review 2010.
[50] Gedamke, J., Ocean basin scale loss of whale communication space: potential impacts of a distant seismic survey, Biennial Conference on the Biology of Marine Mammals, November-December 2011, Tampa, FL (2011) (abstract); Nieukirk, S.L., Klinck, H., Klinck, K., Mellinger, D.K., and Dziak, R.P., Seismic airgun sounds and whale vocalization recorded in the Fram Strait and Greenland Sea, Biennial Conference on the Biology of Marine Mammals, November-December 2011, Tampa, FL (2011) (abstract); Nieukirk, S.L., Mellinger, D.K., Moore, S.E., Klinck, K., Dziak, R.P., Goslin, J., Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009, *Journal of the Acoustical Society of America* 131:1102- 1112 (2012); Nieukirk, S.L., Stafford, K.M., Mellinger, D.K., Dziak, R.P., and Fox, C.G., Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean, *Journal of the Acoustical Society of America* 115: 1832-1843 (2004); Roth, E.H., Hildebrand, J.A., Wiggins, S.M., and Ross, D., Underwater ambient noise on the Chukchi Sea continental slope, *Journal of the Acoustical Society of America* 131:104-110 (2012).
[51] Madsen, P.T., Marine mammals and noise: Problems with root-mean-squared sound pressure level for transients, *Journal of the Acoustical Society of America* 117:3952-57 (2005).

Finally, NMFS must consider that even behavioral disturbance can amount to Level A take if it interferes with essential life functions through secondary effects. For example, displacement from migration paths can result in heightened risk of ship strike or predation; and some sound sources can cause beaked whales to change their behavior, resulting in pathologies consistent with decompression sickness. NMFS must take into account the best available science and set lower thresholds for Level A take, which, as noted above, would lead to larger exclusion zones around the survey.

NMFS must revise the thresholds and methodology used to estimate take from airgun use. Specifically, we urge the following:

i. NMFS should employ a combination of specific thresholds for which sufficient species-specific data are available and generalized thresholds for all other species.[52] These thresholds should be expressed as linear risk functions where appropriate. If a single risk function is used for most species, the 50% take parameter for all the baleen whales and odontocetes occurring in the area should not exceed 140 dB (RMS), per the February 2012 recommendation from Dr. Clark and his colleagues. At least for sensitive species such as harbor porpoises and beaked whales, NMFS should use a threshold well below that number, reflecting the high levels of disturbance seen in these species at 120 dB (RMS) and below. Recent analysis by the California State Lands Commission provides another alternative, differentiating among low-frequency, mid-frequency, and high-frequency cetaceans in a manner that is generally consistent with Southall et al (2007).[53]

ii. Data on species for which specific thresholds are developed should be included in deriving generalized thresholds for species for which less data are available.

iii. In deriving its take thresholds, NMFS should treat airgun arrays as a mixed acoustic type, behaving as a multi-pulse source closer to the array and, in effect, as a continuous noise source further from the array, per the findings of the 2011 Open Water Panel cited above.

iv. Behavioral take thresholds for the impulsive component of airgun noise should be based on peak pressure rather than on RMS, or dual criteria based on both peak pressure and RMS should be used. Alternatively, NMFS should

[52] By "thresholds," we mean either bright-line thresholds or linear risk functions.

[53] California State Lands Commission, Draft Environmental Impact Report at Chap. 4.4 and App. H, *supra*; *see also* Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran. J.J., Gentry, R.L., Greene, C.R., Jr., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., and Tyack, P.L., Marine mammal noise exposure criteria: Initial scientific recommendations, *Aquatic Mammals* 33:411-521 (2007).

use the most biologically conservative method of calculating RMS, following Madsen (2005). (See section IV.C. below for additional detail.)

2. Erroneous "small numbers" and "negligible impact" determinations

Any authorization to take marine mammals must result in the incidental take of only "small numbers of marine mammals of a species or population stock," and can have no more than a "negligible impact" on species and stocks.[54] The thresholds used in the proposed IHA do not reflect the best available science and the proposal does not meet the MMPA's requirement that authorized take only affect small numbers of animals and have a negligible impact.

NMFS has also blatantly disregarded the MMPA's prohibition on allowing the take of more than small numbers of marine mammals.[55] The proposed survey will take thousands of marine mammals, including more than small numbers of some stocks. For example, the proposed take for pantropical spotted dolphins is 737.[56] This amounts to 22.13% of the stock even accepting the underestimation produced by NMFS' erroneous take methodology. Although there is no numerical cut-off for "small numbers,"[57] courts have concluded that "[a] definition of 'small number' that permits the potential taking of as much as 12% of the population of a species is plainly against Congress' intent."[58] NMFS must use the best available science in making its negligible impact and small numbers determinations.

Finally, NMFS' reliance on marine mammal avoidance of the seismic survey to mitigate the take of marine mammals is improper. Rather, displacement of marine mammals by noise pollution is itself harassment. Furthermore, displacement of whales can drive them into shipping lanes increasing the likelihood of a collision with a vessel, or into fishing areas and risk entanglement.

3. Failure to analyze masking effects or set thresholds for masking

The proposed IHA fails to consider masking effects from the mixed impulsive/continuous noise source airguns because of the "intermittent" nature of seismic pulses. But this characterization fails to account for the spreading of seismic pulses at distances from the array.[59] NMFS' own Open Water Panel for the Arctic – which has included some of the country's leading marine bioacousticians – has twice characterized the seismic airgun array as a mixed impulsive/continuous noise source and has stated that NMFS should evaluate its impacts on that basis.[60] That analysis is supported by, *inter alia*, a number of papers showing that seismic exploration in the Arctic, the east Atlantic, off Greenland,

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[54] *See* 16 U.S.C. § 1371(a)(5)(D)(i).
[55] 16 U.S.C. § 1371(a)(5)(D)(i).
[56] The potential biological removal for pantropical spotted dolphins is 17. National Marine Fisheries Service, Draft Stock Assessment Reports (2013).
[57] *See* H.R. Rep. No. 97-228 (1981), reprinted in 1981 U.S.C.C.A.N. 1458, 1469 ("[small numbers] is not capable of being expressed in absolute numerical limits.").
[58] *Natural Res. Def. Council v. Evans*, 279 F. Supp. 2d at 1129, 1152 (N.D. Cal. 2003).
[59] *See* Expert Panel Review 2011.
[60] *Id.*; *see also* Expert Panel Review 2010.

and off Australia has raised ambient noise levels at significant distances from the array.[61] Masking of natural sounds begins when received levels rise above ambient noise at relevant frequencies.[62] Accordingly, NMFS must evaluate the loss of communication space – and consider the extent of acoustic propagation – at far lower received levels than the proposed IHA currently employs.

Researchers at NOAA and Cornell have created a model that quantifies impacts on the communication space of marine mammals. That published model has already been applied to shipping noise off Massachusetts and off British Columbia, and the same researchers involved in the Massachusetts study have applied it to airgun surveys as well.[63] Additionally, researchers at BP, working with colleagues at the University of California and the North Slope Borough, are applying the model to an analysis of masking effects from seismic operations in the Beaufort Sea.[64] Remarkably, the proposed IHA – instead of applying the Cornell/NOAA model – simply states that masking effects on marine mammals would be "minor." Failure to adequately account for the toll of masking ultimately affects the accuracy of the agency's take and negligible impact findings.

4. Failure to set proper thresholds for hearing loss

[61] Gedamke, J., Ocean basin scale loss of whale communication space: potential impacts of a distant seismic survey, Biennial Conference on the Biology of Marine Mammals, November-December 2011, Tampa, FL (2011) (abstract); Nieukirk, S.L., Klinck, H., Klinck, K., Mellinger, D.K., and Dziak, R.P., Seismic airgun sounds and whale vocalization recorded in the Fram Strait and Greenland Sea, Biennial Conference on the Biology of Marine Mammals, November-December 2011, Tampa, FL (2011) (abstract); Nieukirk, S.L., Mellinger, D.K., Moore, S.E., Klinck, K., Dziak, R.P., Goslin, J., Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009, *Journal of the Acoustical Society of America* 131:1102- 1112 (2012); Nieukirk, S.L., Stafford, K.M., Mellinger, D.K., Dziak, R.P., and Fox, C.G., Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean, *Journal of the Acoustical Society of America* 115: 1832-1843 (2004); Roth, E.H., Hildebrand, J.A., Wiggins, S.M., and Ross, D., Underwater ambient noise on the Chukchi Sea continental slope, *Journal of the Acoustical Society of America* 131:104-110 (2012).

[62] Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., van Parijs, S., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems as a function of anthropogenic sound sources (2009) (IWC Sci. Comm. Doc. SC/61/E10); Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems: intuitions, analysis, and implication, *Marine Ecology Progress Series* 395: 201-222 (2009). *See also* Castellote, M., Clark, C.W., and Lammers, M.O., Potential negative effects in the reproduction and survival on fin whales (*Balaenoptera physalus*) by shipping and airgun noise (2010) (IWC Scientific Committee Doc. No. SC/62/E3).

[63] Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., van Parijs, S., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems as a function of anthropogenic sound sources (2009) (IWC Sci. Comm. Doc. SC/61/E10); Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems: intuitions, analysis, and implication, *Marine Ecology Progress Series* 395: 201-222 (2009); Williams, R., Ashe, E., Clark, C.W., Hammond, P.S., Lusseau, D., and Ponirakis, D., Inextricably linked: boats, noise, Chinook salmon and killer whale recovery in the northeast Pacific, presentation given at the Society for Marine Mammalogy Biennial Conference, Tampa, Florida, Nov. 29, 2011 (2011).

[64] Fleishman, E., and Streever, B., Assessment of cumulative effects of anthropogenic underwater sound: project summary and status, at 2 (2012).

As you know, NMFS is presently revising its criteria for temporary and permanent auditory impacts and, by extension, direct tissue injury.[65] Several of the signatories to this letter, based on consultation and review by three bioacousticians, have submitted extensive comments on the draft criteria, which address, among other issues, new data that have appeared since the Southall et al. study was published in 2007. These include, for example, data indicating that harbor porpoises experience threshold shift on exposure to airgun signals at substantially lower levels than the two mid-frequency cetaceans (bottlenose dolphins and beluga whales) previously tested.[66] None of these considerations, and few of the relevant studies appearing since 2007, appear to be discussed in the IHA notice.

Hearing loss remains a very significant risk where, as here, the agency has not required aerial monitoring as standard mitigation, appears unwilling to restrict operations in low-visibility conditions, has set safety zone bounds that are inadequate to protect high-frequency cetaceans, and has not firmly established seasonal exclusion areas for biologically important habitat. NMFS should take a conservative approach and apply a more precautionary standard.

5. Failure to set proper thresholds for high- and mid-frequency sources

NMFS has also failed to adequately consider the potential impacts from or set an appropriate take threshold for the survey's multi-beam echosounder and sub-bottom profiler. NMFS mentions but then discounts the 2008 mass stranding in Madagascar of 100 melon-headed whales associated with the use of a 12 kHz multi-beam echosounder. This echosounder is similar of identical to the one proposed for use in this project. Instead, NMFS simply suggests that the risk "may be very low" because these systems are used worldwide and there is a lack of direct evidence – other than the melon-headed whale incident, of course – of other such responses. To essentially discount and ignore such a significant stranding is in stark conflict with NMFS' obligation under the MMPA to use best available science in evaluating impacts. Nor does NMFS attempt to quantify takes from either system.

6. Failure to Include a Contingency Estimate

As noted above, NMFS has allowed Lamont Doherty/NSF to downgrade its take estimates based on certain questionable changes to its activity plan, eliminating its contingency plans for reshoots, vessel turns, equipment malfunctions, and other factors. Omitting these takes runs counter to common sense—and is not justifiable unless NMFS

[65] NOAA, Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts (Dec. 23, 2013).

[66] Lucke, K., Siebert, U., Lepper, P.A., and Blanchet, M.-A., Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli, *Journal of the Acoustical Society of America* 125: 4060-4070 (2009).

expressly bars the proponents from running more line-kilometers than set forth in the IHA or from engaging in any "contingent" activities, as discussed above.

7. Failure to Adequately Assess Cumulative Impacts of the Activity

In its Draft Environmental Assessment – upon which the proposed IHA relies – Lamont-Doherty/NSF failed to adequately analyze the cumulative impacts of its survey. An agency must take a hard look at the cumulative impacts of the proposed action and determine and provide a meaningful analysis of the environmental impacts of these activities. "NEPA always requires that an environmental analysis for a single project consider the cumulative impacts of that project together with 'past, present and reasonably foreseeable future actions.'" CEQ's regulations for implementing NEPA emphasize that "[c]umulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

The agency has failed to meet the statutory requirements of NEPA and its regulations because it improperly limited the scope of the EA and failed to include sufficient information on the cumulative impacts of the project on marine mammals, fish, and sea turtles. The agency's cumulative impacts analysis improperly discounts cumulative impacts because the noise pollution is temporary. This rationale is flawed because impacts can accumulate even if there is no accumulation of sound.

Acoustic disturbance can result in long-term avoidance or abandonment of habitat, particularly in naïve populations. For example, following a single Navy exercise in the Northern Bahamas, in 2000, 14 beaked whales and several other marine mammals stranded and virtually the entirety of the population disappeared from the area. Even if animals do not suffer death or permanent injury or habitat abandonment from a single event, recurring acoustic disturbance increases the likelihood that a seismic survey will interfere with essential functions such as breeding, feeding, and communications. Therefore, noise pollution even when temporary can have cumulative effects on animal populations.

Moreover, regional populations or stocks of marine mammals, or other wildlife, may be repeatedly exposed to disturbance from seismic, sonar, and ship noise. NMFS and Lamont-Doherty/NSF must analyze both the auditory and behavioral impacts of repeated exposure to noise pollution on a population that may alter behavior. Repeated exposure that causes temporary threshold shift could amplify the impact of a subsequent exposure. In some animals, temporary threshold shift can result in permanent threshold shift. Lamont-Doherty/NSF must at least evaluate intermittent exposure to multiple seismic and other acoustically disturbing activities.

The cumulative impacts analysis must include a full evaluation of the cumulative impacts of oil and gas seismic surveys planned for and anticipated in the Atlantic; the USGS/NSF seismic survey off the North and Mid-Atlantic and any other NSF, Lamont-Doherty, or USGS planned surveys; and military training and testing sonar activities. The failure to evaluate the cumulative impacts of temporally and spatially adjacent activities in the environmental assessment falls short of NEPA's requirements and results in a misrepresentation of the activities ultimate impact.

Additionally, concurrent activities can accumulate sound in habitat, and the EA's determination that project is only a "minor contribution" to overall noise is flawed. NOAA has already developed cetacean noise maps for the Atlantic area where this project occurs. It shows that certain areas are already ensonified by vessel traffic at levels that are near the thresholds for some acoustically sensitive species. Lamont-Doherty/NSF and NMFS must analyze the noise pollution cumulatively with the project. While the EA describes other proximate activities, it lacks meaningful analysis of the cumulative impacts of these projects.

8. Failure to Analyze Impacts on Fish and Other Species of Concern

The survey considered in the proposed IHA has the potential to detrimentally affect multiple fish species, harm vital fish habitat, and conflict with multiple fisheries. Indeed, airgun surveys are known to significantly affect the distribution of some fish species, which can impact commercial and recreational fisheries and could also displace or reduce the foraging success of marine mammals that rely on them for prey. As one study has noted, fishermen in various parts of the world have complained for years about declines in their catch rates during oil and gas airgun surveys, and in some areas have sought industry compensation for their losses.[67] Airguns have been shown experimentally to dramatically depress catch rates of some commercial fish species, by 40 to 80% depending on catch method, over thousands of square kilometers around a single array.[68] Large-scale displacement is likely to be responsible for the fallen catch rates: studies have shown both horizontal (spatial range) and vertical (depth) displacement in a number of other commercial species on a similar spatial scale.[69] Impacts on fisheries were found to last for some time beyond the survey period, not fully recovering within 5 days of post-survey monitoring.[70] Airguns also have been shown to substantially reduce catch rates of rockfish, at least to the distances (less than 5 km) observed in the experiment.[71]

[67] McCauley *et al.*, Marine seismic surveys: analysis and propagation of air-gun signals, and effects of air-gun exposure.

[68] Engås, A., Løkkeborg, S., Ona, E., and Soldal, A.V., Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*), *Canadian Journal of Fisheries and Aquatic Sciences* 53: 2238-2249 (1996); *see also* Løkkeborg, S., Ona, E., Vold, A., Pena, H., Salthaug, A., Totland, B., Øvredal, J.T., Dalen, J. and Handegard, N.O., Effects of seismic surveys on fish distribution and catch rates of gillnets and longlines in Vesterålen in summer 2009 (2010) (Institute of Marine Research Report for Norwegian Petroleum Directorate).

[69] Slotte, A., Hansen, K., Dalen, J., and Ona, E., Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast, *Fisheries Research* 67:143-150 (2004).

[70] Engås *et al.*, Effects of seismic shooting.

[71] Skalski, J.R., Pearson, W.H., and Malme, C.I., Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes ssp.*), *Canadian Journal of Fisheries and Aquatic Sciences* 49: 1357-1365 (1992).

Yet the IHA ignores the potential for acoustic impacts on Essential Fish Habitat and assumes without support that effects on both fish and fisheries would be localized and "minor." NMFS must improve its scant analysis.

V. COMPLIANCE WITH OTHER STATUTES

A. Magnuson-Stevens Fishery Conservation and Management Act ("Magnuson Act")

Lamont-Doherty/NSF did not provide any meaningful analysis of the proposed action's impacts on essential fish habitat. NMFS has a statutory obligation to consult on the impact of federal activities on essential fish habitat under the Magnuson-Stevens Fishery Conservation and Management Act ("Magnuson Act").

The Magnuson Act requires consultation with NMFS when actions to be permitted, funded, or undertaken by a federal agency may adversely affect essential fish habitat. The statute defines adverse effect as "any impact that reduces quality and/or quantity of EFH [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions." The essential fish habitat consultation should include an evaluation of the effects of the action on essential fish habitat and proposed mitigation. Upon receipt of an essential fish habitat assessment, NMFS is required to provide essential fish habitat conservation recommendations for federal actions that would adversely affect essential fish habitat. As required by Section 305(b)(4) of the Magnuson Act, the Federal agency must respond with a description of measures proposed for avoiding, mitigating, or offsetting the impact of the activities on essential fish habitat and explain its reasons for not following any essential fish habitat conservation recommendations.

The EFH consultation here is inadequate because it assumes that noise does not affect habitat. This is in error because noise pollution is indeed a habitat concern. The EA is similarly inadequate in that it wrongly concludes that "[t]here would be no anticipated negative impacts on Essential Fish Habitat (EFH)."

As discussed above, the impacts of seismic surveys on fish are documented. Sound can impact fish habitat because it can alter the ability of fish to communicate, avoid predators, and locate prey. Studies indicate auditory damage can result from noise, including airguns. Seismic surveys alter the habitat in ways that cause displacement and disturbance of fish and decreased catch, as well as mortality to fish eggs and larvae. Therefore, seismic surveys do impair essential fish habitat. The acoustic environment is a key element of habitat. Indeed, NMFS recently recognized that the best scientific data indicates that sound can be an essential characteristic of habitat. Accordingly, the agency identified noise as a primary constituent element of critical habitat for beluga whales.

The agencies should have identified which areas of essential fish habitat are within the project area and evaluated the impact of the proposed project on those habitat areas. NMFS failure to do so violates the MSA.

B. Endangered Species Act ("ESA")

Section 7(a)(2) of the ESA requires federal agencies to "insure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the adverse modification of habitat of such species . . . determined . . . to be critical . . . ." To accomplish this goal, agencies must consult with the delegated agency of the Secretary of Commerce or Interior whenever their actions "may affect" a listed species. NMFS has the discretion to impose terms, conditions, and mitigation on any authorization.

The ESA not only bans the acts of parties directly causing a take, but also bans the acts of third parties whose acts bring about the taking. NMFS may not approve the seismic survey unless it first obtains authorization for take under the ESA.

NMFS' decision to issue an incidental harassment authorization is an action triggering the duty to comply with section 7 of the ESA. The ESA's consultation requirement applies to Federal agencies taking any action. NMFS states that it is engaged in formal consultation on the proposed seismic survey.

As described thoroughly above, the seismic survey puts several ESA-listed species at risk. The proposed seismic surveys can have harmful impacts on listed marine mammals, which must be fully and accurately vetted through the consultation process. Accordingly, NMFS must complete consultation using best available science and obtain any take authorizations before authorizing the proposed seismic survey here. Moreover, NMFS must adopt robust mitigation measures such as those described in the alternatives section above to avoid adverse impacts to listed species.

C. Coastal Zone Management Act ("CZMA")

The CZMA requires that applicants for federal permits to conduct an activity affecting a natural resource of the coastal zone of a state "shall provide in the application to the licensing or permitting agency a certification that the proposed activity complies with the enforceable policies of the state's approved program and that such activity will be conducted in a manner consistent with the program." The marine mammals and fish that will be affected by the seismic survey are all "natural resources" protected by the coastal states' coastal management programs. Accordingly, impacted states should be given the opportunity to review the IHA for consistency with their coastal management programs.

VI. CONCLUSION

For the above reasons, and in light of the serious potential impacts of the proposed study, we urge that NMFS deny the IHA or Lamont-Doherty/NSF withdraw its application. At minimum, Lamont-Doherty/NSF should revise its proposed mitigation measures in the ways discussed above, including by redrawing its survey lines to reflect well-established areas of heightened biological significance and by providing meaningful site-specific analysis.

Very truly yours,

Michael Jasny
Director, Marine Mammal Protection
NRDC

Miyoko Sakashita
Senior Attorney and Oceans Director
Center for Biological Diversity

18 September 2014

Dr. Jolie Harrison
Chief, Permits and Conservation Division
Office of Protected Resources, NMFS
1315 East-West Highway
Silver Spring, MD 20910

Dear Dr. Harrison,

I am writing to comment upon NOAA's proposed authorization for "Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014". My major concerns center around the potential impacts on beaked whales within the proposed seismic survey area.

Multiple survey efforts off Cape Hatteras, North Carolina have documented year-round presence of beaked whales (*Ziphius cavirostris* and *Mesoplodon* spp., OBIS SEAMAP publically available data) in the proposed survey area. Within that area, beaked whales are non-randomly distributed. They are found exclusively along the deep continental shelf edge and beyond. Their very geographically-specific distribution patterns suggest that animals may not be able to respond to seismic activity by simply moving away from the area, as is suggested in the authorization document.

Beaked whale abundances are very difficult to assess, for the reasons well-articulated in NOAA's Stock Assessment Reports. I am unclear, though, as to how the stock abundances for beaked whales were determined. Table 1 in the authorization document lists the abundance estimate for each beaked whale species as 7,092 individuals. The stated best estimate for Cuvier's beaked whale (*Z. cavirostris*) is 6,532 individuals (minimum 5,021; PBR = 50). The 7,092 (minimum 4,632; PBR 46) estimate in Table 1 is for combined *Mesoplodon* spp. from Florida to the Bay of Fundy. While this is currently the best available estimate, this number simply *does not represent* the true abundance of *any one* species. Thus, the total population of each potentially impacted *Mesoplodon* species is an overestimate, and the potential impact on any single species, an underestimate.

Beaked whales are known prolonged, deep divers (e.g. Tyack *et al.* 2006; Schorr *et al.* 2014). Thus, visual monitoring efforts, even with prolonged 30 minute survey windows, are insufficient to assure no beaked whales are in the exclusion zone. The addition of passive acoustics is important, but it is unclear as to whether the tow depth (approximately 20 m) is sufficient to detect beaked whale vocalizations, which usually occur only beyond 400 m depth. Thus, more detailed information on effective monitoring of these deep diving species would be valuable.

Lastly, beaked whales are also known to experience atypical mass stranding events when exposed to other anthropogenic sound sources, specifically military mid-frequency sonar (reviewed by Cox *et al*. 2006). The sound sources used in seismic surveys are of similar amplitude ("246 to 253 decibels (dB) re: 1 μPa $_{\text{(peak to peak)}}$"; information from authorization document), although the frequency of airgun output is much lower. There are, simply put, insufficient data available on beaked whale responses to these types of anthropogenic sounds.

I am appreciative of the serious consideration the Lamont-Doherty – NSF investigators have given to monitoring and mitigation steps, and the extra requirements that NOAA has demanded for this activity to be authorized. I do believe, though, that the potential impacts on beaked whales are unknown, and that special consideration needs to be given to this group of cetaceans in any authorization. I hope that the regional stranding organizations are also notified if this activity does occur, and that NOAA has a robust response plan, should it be required.

Sincerely,

D. Ann Pabst
Professor, Biology and Marine Biology
University of North Carolina Wilmington

0648-XD394

Ginger Taylor Tue, Sep 2, 2014 at 11:42 PM

I, Ginger Taylor of 6205 Mallard Drive, Wilmington, NC 28403 do hereby oppose seismic testing of any nature and especially off the coast of Cape Hatteras, NC. Therefore, I also oppose the proposal to issue an Authorization to Lamont-Doherty to incidentally take, by Level Be harassment only, 24 species of marine mammals during the specifed activity that is scheduled to take place September 15, 2014 - October 31, 2015 for said reasons listed below:

1. The Federal Register's Revised Take Table as of July 25, 2014 is not completely accurate. According to their list: North Atlantic right whales and fin have a 0% take risk both of which are endangered species. Surveys done by Duke and UNCW report sightings of many marine mammals are actually higher in the fall due to migration patterns. Fin and Cuvier's beaked whales are reportedly seen year round while Humpback whales are seen in the fall and winter. Right whales migrate in the fall from Bay of Fundy to Florida to calve. Though aerial surveys report rare sightings, they are RARE as a species. We cannot assume because we don't see them, they are not in the Cape Hatteras vicinity. An aerial survey reported seeing right whales off the coast of Fort Fisher, NC in early November 2009; therefore, right whales are making their way just North of Fort Fisher and could potentially be feeding in a popular feeding sight off Cape Hatteras in October. (http://www.starnewsonline.com/article/20091112/articles/911129985?p=1&tc=pg&tc=ar) But regardless, seismic testing has been reported to travel 100,000 miles which spans the distance from the Bay of Fundy to Florida. (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.)

> 2. Due to the steep slope off of Cape Hatteras that causes nutrient rich upwelling, the cold waters of the Labrador Current, and the warm waters of the Gulf Stream, this location is an unusually dynamic area for foraging unlike any other region on the entire east coast. "In the pelagic and mid-water depths there is high diversity of verte-brates, migratory birds, mammals, and turtles as well as fish. On the bottom there is also diversity of invertebrates." (Blake, J. A et al., Gooday, A. J. et al, Hecker, B, Milliman, J. D.and Rhodas, D. C, et al) This is a foraging hotbed for an unusually high density of species. The seismic testing that will occur there will create enough noise to disrupt eating, mating, and navigation for 33 days straight, "792 hours of continuous airgun operations" according to the Lamont-Doherty report. Because it is a feeding site to many endangered species such as fin and the North Atlantic right whales, hawksbill, Kemp's ridley, loggerhead, and leatherback sea turtles, by law this area should be protected by the Endangered Species Act and listed as a priority ocean area for protection in the Mid-Atlantic. (www.nmfs.voaa.gov/pr/speicis/esa/listed.htm) As Sylvia Earle suggests, "A Hope Spot!"

> 3. Due to the unique diversity of marine biota, the Outer Banks' economy is heavily impacted by the success of the fish stocks. Airguns have been shown to dramatically depress catch rates of various commercial species. (Engas, A. et al., 1996)

> 4. Because beaked whales are deep divers, they are found in areas where there are canyons and are heavily impacted by these surveys due to sound bouncing off the canyon walls. (Sounding the Depths, pg. 11) Cuvier's beaked whales are seen in this coastal region year round, traveling north and south along Hatteras Canyon off Cape Hatteras, and could potentially be more at risk for this reason.

> 5. The Lamont-Doherty report states the testing will be as high as 180 decibels. " . . . a 174-decibel rumble . . . . about as strong as a commercial jet at takeoff, measured about three feet away." (Sounding the Depths, pg. 4) Prolonged exposure to continuous loud noise is known to cause hearing loss to humans as well as marine mammals. This hearing impairment is known as "threshold shift." (Sound the

Depths II, pg. 13) Though marine mammals have eyes and a sense of smell, the sense they rely on the most is sound to navigate, forage for food, mate, care for their offspring, and protect themselves from predators.   To introduce sound that interferes with the most important sensory for 33 days straight is similar to blinding people with flood lights for 24 hours for 33 days. How could people feed, care for their children, or stay out of harms way? It is our moral, scientific, and legislative duty to protect this region more so than other areas along the east coast.

> 6.   The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in or an 18-airgun array with a total discharge of volume of ~3300. “A single airgun array can disrupt vital behavior in endangered whales over an area of at least 100,000 square nautical miles in size.” (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.) This underscores the harassment seismic testing will cause to the most endangered whale in the world – the North Atlantic right whale.

> 7.   Other anthropogenic impacts that compromise the large whale populations are fishing gear entanglement and boat strikes. Right whales and fin whales are the most commonly reported species in the context of population size prone to vessel strikes. “Compared with the spatial extent of regulations, vessel-strike mortality continues to be highest in the mid-Atlantic coast.” (Van Der Hoop, J. M. et al. 2012) Seismic testing will add yet another stressor on the already in periled species.

0648-XD394

Linda Ward

Tue, Sep 2, 2014 at 3:37 PM

I am writing to urge the denial of an application to take marine animals during seismic surveying off Hatteras Island, NC this fall (2014). It is distressing to think that an application even exists to use air guns to blast the marine life off Dare County, NC coast in the name of science. Please consider further research about the impacts of manmade sound on the underwater environment and its inhabitants.

Linda J. Ward, M.Sci.

Sent from my iPad

Comments 0648-XD394 proposed incidental harassment authorizatio n

Meira Warshauer Tue, Sep 2, 2014 at 10:29 PM

I request the NOAA reject the Lamont-Doherty permit application for incidental take off Cape Hatteras in Sept/Oct 2014 the following reasons:

1. Cape Hatteras is home to an unusually large number of species of marine life, because of the convergence of currents from cold waters, the Labrador Current, and warms waters of the Gulf Stream, as well as the upwelling from deep canyons near the continental shelf. The airguns will disrupt their feeding patterns, communication channels, and in the case of certain cetaceans, their diving and breathing patterns as well. Carried out continuously over the span of 33 days, the airguns will cause long term disruption of survival activities for fish, turtles, and cetaceans.

2. Cetaceans are especially sensitive to sound stimuli. The pulses will invade their primary feeding area and cause significant harassment. It is being presented as though the noise will be a short-term inconvenience, but for many species of cetaceans, there is no research on how the noise will affect them. (Federal Register vol. 79, no. 147, p. 44558) Disruption of survival patterns can hardly be viewed as a mere inconvenience.

3. The Cape Hatteras area includes deep canyons where beaked whales may be diving. The noise can trigger a panic response causing them to surface too quickly, and suffer the bends, which can lead to fatality. While the Lamont Doherty claims to have a track record of no associated fatalities, we would not like Cape Hatteras to be the exception to that record.

The over 30 stranded mammals on Cape Hatteras from Naval sonar operation in 2005 is a troublesome precedent. While the Navy’s techniques may differ from the L.D. operation, the sensitivity of the cetacean population in the area remains a concern. The airguns will bring unnecessary stress to already declining populations of identified cetaceans in the area. Cuvier’s beaked whales, for example, have been sighted year round. Right whales were sighted as far south as Fort Fisher in early Novmeber, 2009.

(http://www.starnewsonline.com/article/20091112/articles/911129985?p=2&tc=pg)

Fin whales are also seen in the area, as are others.

4. The proposed mitigation of stopping the airguns if cetaceans are observed is inadequate, since the animals could be outside the sighting area, but still harmed by the airgun due to the greater range of sound in the acoustically efficient sea and canyons.

--
Meira Warshauer

Jolie Harrison

Chief, Permits and Conservation Division

Office of Protected Resources, NMFS

1315 East-West Highway

Silver Spring, MD 20910

<u>Comments on Seismic Testing off the Outer Banks of North Carolina in Sept and Oct, 2014: 0648-XD394</u>

William McLellan
UNC Wilmington

This proposal to conduct seismic surveys off the Outer Banks of North Carolina greatly concerns me for two reasons.

The first concern is with the use of full scale industrial seismic exploration vessels in the exact habitat that we have found high beaked whale abundances. For the past three years, a joint program with Duke University and UNC Wilmington has been conducting monthly aerial surveys for seasonal distribution and vessel operations focused on tagging and identification of marine mammals. The aerial surveys track from the coastal shelf east over the first and second shelf breaks to pelagic waters. Sightings data have been uploaded to OBIS SEAMAP, presented at annual Navy meetings with NOAA staff present, and recently been forwarded to senior NOAA research staff from the NE Science Center. The proposed tracklines for seismic testing track directly over the highest density of beaked whale sightings, but the proposal barely mentions the potential for beaked whale interactions. In essence, beaked whales will be present within the seismic testing area for the entire sampling period. In my opinion, standard operating procedures to shut down seismic activity when marine mammals are sighted are not effective when mitigating interactions specifically with beaked whales. Beaked whale dive times have now been extended to over two hours for Cuvier's beaked whales (*Ziphius cavirostris*) (Schorr *et al.* 2014). Our Lab recently published myoglobin data for cetaceans collected from strandings from the exact locations associated with these seismic surveys. One of animals presented in the recent publication (Velten *et. at* 2013) was an adult female True's beaked whale (*Mesoplodon mirus*) testing out with the highest level of myoglobin EVER measured in a mammal. This extreme level of myoglobin implies this animal could dive on a breath hold for extended periods of time. The combined dive time lengths and potential for extended breath hold diving violate the ability for vessel based observers to shut down seismic operations based on visual sightings of animals surfacing near the operations vessel.

If seismic operations are not able to alter their testing as beaked whales are encountered in real time there is a likelihood that those beaked whales will be directly affected by the seismic energy inputs into the surrounding ocean. While the proposal states there will be little effect on local marine mammals, there have been many publications that link anthropogenic sound sources, both commercial and military, with morbidity and mortality of cetaceans, especially beaked whales. The location of beaked whales continuously in the same space and time as the proposed seismic surveys suggests there could be negative interactions between these two. As the Marine Mammal Stranding Coordinator for the State of North Carolina I am extremely troubled by the use of seismic testing off the coast of North Carolina and the possibility of cetacean strandings. We are still responding to the largest Unusual Mortality Event ever investigated on the east coast, which has involved over 1400 bottlenose dolphins (*Tursiops truncatus*) and nearly 300 in North Carolina. The North Carolina stranding network received NO Prescott stranding grant support in 2013. Yet, this seismic activity could increase beaked whales and other cetacean strandings that are known to inhabit these waters. Strandings of these species require vastly more time, effort and resources than is exerted for response to the more common bottlenose and other dolphins species. Beaked whales require a team to commit 2-3 days of stranding response, diagnostic testing and necropsy effort for each individual animal. I have personally spent one week per each beaked whale stranding that has occurred in the state over the past 3-4 years. Short-finned pilot whales (*Globicephala macrorhynchus*) also overlap the geographic region of the proposed seismic tests. In 2005, a mass stranding of 35 short-finned pilot whales occurred along the coast near the site of the proposed seismic tests. This mass stranding event was investigated by NOAA as it occurred coincident with Navy sonar exercises. NOAA's report (Hohn *et al.* 2006) stated that it could not be determined whether there was or was not a causal link between the exposure to anthropogenic sound source and the stranding event. It is frankly unacceptable that this seismic activity will be conducted with no plan to investigate strandings and no additional support provided to the state stranding network. Funded science cannot simply push responsible oversight off to unfunded scientists!

The second concern is simply the compressed timing for this public comment period. The proposal states seismic activity will begin off Cape Hatteras in the middle of September, 2014. The current comment period ends on Sept 2, 2014 which leaves less than two weeks to compile and act on suggestions proposed during the comment period. The proposed seismic activities should be postponed until all comments are received and acted upon. If that does not take place it brings in to question the validity of the entire comment process.

Literature Cited

Hohn, A. A., Rotstein, D. S., Harms, C. A., and Southall, B. L. (2006). Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whales (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005. NOAA Technical Memorandum NMFS-SEFSC-537

Schorr, G.S., Falcone, E.A., Moretti, D.J., and R.D. Andrews. 2014. First long-term behavioral records from Cuvier's beaked whales (*Ziphius cavirostris*) reveal record-breaking dives. PLOS One 9(3)e92633.

Velten, B.P., Dillaman, R. M., Kinsey, S. T., McLellan, W. A. and D. A. Pabst. 2013. Novel locomotor muscle design in extreme deep-diving whales. *Journal of Experimental Biology*. 216:1862-1871.

APPENDIX G: CZMA Consistency Letters

NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

September 11, 2014

Braxton Davis
Director, NC Division of Coastal Management
Department of Environment and Natural Resources
400 Commerce Avenue
Morehead City, NC 28557-3421

RE: CD14-037 – Consistency Concurrence Concerning the Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September-October 2014 (DCM#20140033)

Dear Mr. Davis:

The National Science Foundation (NSF) was pleased to receive the North Carolina Division of Coastal Management's (DCM) letter of concurrence that the NSF proposed marine geophysical survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras is consistent to the maximum extent practicable with the enforceable policies of North Carolina's approved Coastal Management Program (CMP). We appreciate the interest identified by the DCM to request implementation of the monitoring and mitigation measures identified in the Final Programmatic Environmental Impact Statement (PEIS) issued in February 2014 by the Bureau of Ocean Energy Management (BOEM). Although not linked to the enforceable policies of the NC CMP, NSF has reviewed the monitoring and mitigation measures in the BOEM PEIS, and the subsequent Record of Decision issued in July 2014, relative to seismic surveys and will implement those to the maximum extent practical. As the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) has regulatory jurisdiction in federal waters over marine mammals pursuant to the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq.*) and the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), however, NSF will be required to adhere to any specific monitoring and mitigation requirements identified in the Incidental Harassment Authorization and Incidental Take Statement. Additionally, as NMFS has regulatory jurisdiction for essential fish habitat in federal waters pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 *et seq.*), NSF will be required to comply with the specific conservation recommendations established by NMFS for the proposed research activities. As encouraged by DCM, NSF will also attempt to minimize impacts to offshore industries; as noted in the Draft EA, significant impacts to fisheries (recreational and commercial) and scuba diving would not be anticipated.

NSF is especially appreciative of the assistance and cooperation demonstrated by the DCM staff with the federal consistency process. We recognize that the CZMA process associated with the proposed activities was complicated and time consuming; the DCM staff were critical in the successful and timely completion of the CZMA process for the proposed activities.

Sincerely,

Holly Smith

Holly Smith
Environmental Compliance Officer

cc:
Doug Huggett, NC Division of Coastal Management
Kerry Kehoe, NOAA Office of Ocean and Coastal Resource Management

North Carolina Department of Environment and Natural Resources
Division of Coastal Management

Pat McCrory
Governor

John E. Skvarla, III
Secretary

September 8, 2014

Holly Smith
Environmental Compliance Officer
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

SUBJECT: **CD14-037**– Consistency Concurrence Concerning the Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off the North Carolina coast (DCM#20140033)

Dear Ms. Smith:

We received your consistency submission on June 20, 2014 concerning the Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off the North Carolina coast. We have evaluated the proposed project for consistency with our State's coastal management program.

North Carolina's coastal zone management program consists of, but is not limited to, the Coastal Area Management Act, the State's Dredge and Fill Law, Chapter 7 of Title 15A of North Carolina's Administrative Code, and the land use plans of the coastal counties and municipalities that the proposed project may affect. It is the objective of the North Carolina Division of Coastal Management (DCM) to manage the State's coastal resources to ensure that proposed federal activities are compatible with safeguarding and perpetuating the biological, social, economic and aesthetic values of the State's coastal waters.

To better understand the possible concerns with your proposed activity, we placed a public notice in several newspapers throughout the North Carolina coastal region and solicited input from State agencies that have a regulatory interest. Three North Carolina agencies, including the Department of Administration, the Division of Water Resources, and the Division of Marine Fisheries, as well as several private organizations and individuals provided comments. The Division of Marine Fisheries and the public expressed concerns about the project's potential impact to marine life and the offshore fishing and diving industries. The Department of Administration noted that rights of entry or licenses may be required or activities performed on state owned land and the Division of Water Resources recommended that you coordinate with the United States Army Corps of Engineers concerning identification of any jurisdictional features and required permitting. We trust that you will take these into consideration. Copies of all referenced responses, comments, and concerns have been attached for your information.

400 Commerce Ave., Morehead City, NC 28557-3421
Phone: 252-808-2808 \ FAX: 252-247-3330Internet: www.nccoastalmanagement.net

DCM reviewed the information you provided and find that the proposed project is consistent, to the maximum extent practicable, with the relevant enforceable polices of North Carolina's approved coastal management program when performed in accordance with the final Atlantic Geological and Geophysical (G&G) Activities Programmatic Environmental Impact Statement (PEIS) that the Bureau of Ocean Energy Management (BOEM) established for oil and gas exploration. Therefore, we require that you follow all mitigation measures in the Atlantic G&G Activities PEIS, which are more stringent than those included in the Draft EA for the proposed project and in the NSF PEIS/Overseas EIS for Marine Seismic Research, when conducting marine geophysical surveys off North Carolina's coast.

For example, when using airgun arrays, you must, along with other mitigation measures, conduct at least 60 minutes of visible monitoring for marine mammals before start-up, use a passive acoustic monitor (with no exceptions), have at least two protected species visual observers during daylight hours, and avoid the area within 20 nautical miles of our coastline between November 1 and April 30. Likewise, setbacks of 152 m (500 ft) are required when conducting seafloor-disturbing activities, such as using ocean bottom seismometers, anchors or other bottom-disturbing devices, in areas with *Lophelia* coral reefs, unless modified by consultations with the National Oceanic and Atmospheric Administration (NOAA) under the National Marine Sanctuaries Act. Plans proposing activities near low-relief hard/live bottom features must include survey coverage extending to 1,000 m (3,280 ft) from the location of proposed bottom-disturbing activity.

This letter of concurrence is contingent upon the National Science Foundation agreeing with all of the requirements stated above. Should you decide not to accept these conditions, this letter effectively becomes a letter of objection, and a letter of non-agreement should be submitted to DCM. A revised consistency determination may be necessary if the proposed project is modified. This may take the form of either a supplemental consistency determination pursuant to 15 CFR 930.46 or a new consistency determination pursuant to 15 CFR 930.36. Likewise, if further project assessments reveal environmental effects not previously considered, a supplemental consistency certification may be required.

We would also greatly appreciate any effort on your part to minimize the project's impact to the offshore industries as they contribute significantly to the coastal economy. We recommend, where practical, that you relocate proposed survey transects to avoid South Atlantic Fishery Management Council-designated Habitat Areas of Particular Concern (HAPC) and coordinate the survey to avoid interfering with saltwater fishing tournaments. A list of the saltwater fishing tournaments planned off North Carolina's coast this fall is attached. Please contact Carole Willis, carole.y.willis@ncdenr.gov, or Randy Gregory, randy.gregory@ncdenr.gov, with the Division of Marine Fisheries at 252-726-7021 if you have any questions related to these tournaments.

Thank you for your consideration of the North Carolina Coastal Management Program. If you have any questions, please contact Daniel Govoni at 252-808-2808 x215.

Sincerely,

Braxton Davis
Director, NC Division of Coastal Management

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Coastal Management

Pat McCrory
Governor

John E. Skvarla, III
Secretary

August 19, 2014

TO: Daniel Govoni, NCDCM Assistant Major Permits Coordinator

FROM: Jessi Baker, NCDCM Fisheries Resource Specialist JRB

THROUGH: Dr. Louis Daniel, NC Division of Marine Fisheries Director

SUBJECT: National Science Foundation Consistency Determination and Draft Environmental Assessment for Marine Geophysical Surveys off Cape Hatteras, NC

The Division of Coastal Management, Fisheries Resource Specialist has reviewed the National Science Foundation (NSF) Consistency Determination and Draft Environmental Assessment for Marine Geophysical Surveys off Cape Hatteras, NC. The NSF plans to conduct marine seismic surveys off the NC coast as a part of research investigating how the continental crust stretched and separated during the opening of the Atlantic Ocean.

Project description

Seismic surveys would be conducted from September 15 to October 22, 2014 aboard the R/V *Langseth* approximately 6 to 430 km off the North Carolina coast in depths ranging from 20 to 4300m. The surveys will cover 6,350 km of transect lines while towing various airgun arrays and hydrophones and deploying seismometers on the seafloor. Airguns are an energy source for seismic surveys that produce sound at a maximum of approximately 250 decibels. The vessel will be travelling at approximately 8.5 km/hour (4-5 kt) and airguns will fire either every 22 or 65 s, depending on the transect line. Each shot lasts for less than 1 s.

The Consistency Determination and EA make several references to the National Science Foundation/US Geological Survey Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research (PEIS) for additional information, so many of the comments below are with reference to the PEIS.

According to the PEIS, the known effects of seismic survey sounds on fish and fisheries include masking of other sounds, disturbance, stress, hearing or detection impairment, auditory tissue damage, non auditory injury, mortality, and impediments to fishing activity (Table 3.3-6). Concerns regarding the impacts of the noise associated with the use of airgun arrays can be separated into physical impacts to fish and impacts to the offshore fishing industry in coastal NC.

Fish Impacts

The PEIS reports impacts to fish ranging from mortality to injury to behavioral responses. Section 3.3.4 and Appendix D of the PEIS describe the relevant research on effects of airguns on fish and note that there has been a minimal amount of research on these topics that makes drawing conclusions of any type of effect to fish populations problematic. Of the few studies available, reported physiological effects ranged from increased levels of stress-related chemicals in blood, long-term damage to hearing structures, mortality to fish, eggs, and larvae, to no damage. The PEIS concludes that mortality or serious injury is possible within a few meters of airgun blasts and no population scale effect is anticipated.

Several of the studies summarized in Appendix D of the PEIS report a change in fish behavior between received sound levels of approximately 160 and 200 dB. The EA provides graphical depictions of the distance from the airgun blast where exposure to sounds of 180 and 160 dB is anticipated in Figures 2-5. Based on Table 1 in the EA, the area with exposure to 180 dB is estimated to have a radius of 2,060 m (over 2.5 mile wide area) in depths less than 100 feet. The area with exposure to 160 dB could have a radius of 22,600 m (over 28 mile wide area) in depths less than 100 feet. The radii decrease with increasing depth ranges.

Extensive hard bottom habitat exists on the continental shelf off of North Carolina in both state and federal waters. Hard bottom habitat is a critical habitat for many commercially and recreationally important fisheries, particularly the snapper-grouper complex. The South Atlantic Fishery Management Council has designated a subset of Essential Fish Habitat as Habitat Areas of Particular Concern (EFH-HAPC). Specific areas are designated EFH-HAPC if considered particularly important for managed species or species complexes due to importance of ecological functions provided, and are at risk due to their rarity or sensitivity to human degradation. Several of these hard bottom areas are directly traversed by the proposed transects as shown in Figure 1, including HAPCs namely Big Rock, 10-Fathom Ledge, The Point, Charleston Bump Complex, and Cape Fear *Lophelia* Banks. Others are in very close vicinity to transects including Cape Lookout *Lophelia* Banks. Disturbance in these areas of concentrated fish use that results in displacement of fish could impact local fish abundance by deterring foraging, refuge, and spawning activities in preferred habitat areas.

Lophelia coral banks are located in water depths greater than 300 m and individuals can be up to 1,000 years old. These fragile coral reefs thrive in complete darkness and have an exceptionally slow growth rate. The Lophelia coral banks located off Cape Lookout, NC, may be the northernmost deep-water coral banks along the U.S. East Coast.

In addition, marine mammals and sea turtles are an important component of NC's coastal ecosystem, and state and federal fishery agencies go to great extent to reduce fishery related takes. Of particular concern is the high number of estimated takes due to this project of 18,384 dolphins and whales per year (Table 9, p.65). A take is defined as numbers of individuals that could be exposed to 160 dB or more. The relative percentages of takes in the regional populations reported in Table 9 are as high as 6 and 9% for Bottlenose and Roughtoothed dolphins and 16 and 34 % for Atlantic spotted and Pantropical spotted dolphin in US waters, respectively. Additional mitigation measures to reduce takes should be considered to reduce these numbers.

<u>Fisheries Impacts</u>

Fisheries can be impacted in many ways besides actual physiological damage to the fish, including reduced catch due to fish displacement, direct interaction with fishing activities, and change in fish distributions in the water column. Studies described in PEIS section 3.3.4.4. (p.3-47) found that catch declined in the onset of surveys and remained depressed during and after the surveys ended. Although it is recognized that survey activities may be ongoing in areas with potential user-conflicts for only a few days, if the lasting effects result in fish displacement, changes in fish distribution, or more severe physiological impacts, then the impacts to fishing and diving could last well into the winter.

North Carolina coastal areas support industries critical to our entire state's economy, including our fishing industry. With over 8,200 licensed commercial fishermen and close to 800 seafood dealers throughout our coastal area, the commercial fishing industry generates an estimated 5,180 jobs with an annual income exceeding $105 million and an overall economic impact of $255 million (NCDMF, fisheries landings data2014)(NOAA 2014[a]). Recreational fishing is also very important economically and culturally in coastal North Carolina. Approximately 1.7 million anglers take over 5 million fishing trips annually in North Carolina's coastal waters (NOAA 2014[b]). This recreational fishing activity produces an estimated 18,200 jobs, $692 million in income and $1.87 billion in overall economic impacts for the state economy (NOAA 2014[b]). The economic impacts of the state's fishing industry and the rich cultural heritage of our coastal areas demonstrate the immense importance of protecting and sustaining the natural resources of our coast.

In the Fisheries section of the EA beginning on page 40, it would be more representative of potential impacts to list species by ex-vessel value than by weight since offshore fisheries catch may have a relatively small weight but a high value per pound. Certain species groups, such as tunas and other highly migratory pelagic species and snapper-grouper species that are not presently included will become more significant relative to the other mentioned species if examined by value. In particular, the extremely low allowable regional catch levels (NC through FL) for snapper grouper species constrain harvests to quantities that may appear relatively minor, but provide significant economic benefit to individual fishery participants as well as communities. These updates should also be made to Table 6 (p. 42). Not only are these groups of species important due to their relatively high value, they also are relevant to the discussion of potential impacts, as the fisheries targeting them take place in the area where the seismic surveys will occur.

In North Carolina, September and October are prime offshore fishing months and popular for diving, with much of this activity occurring greater than 3 miles offshore. Popular offshore species during this time of year include white marlin, king mackerel, dolphin, tuna, and wahoo as evidenced by the many recreational and charter boat trips as well as tournaments targeting these species. Table 7 in the EA and the associated text should be updated to include tournaments listed in the attached tables. In addition, interactions with commercial fishing activities that span large areas (eg. long line fishery) could result in displacement of fishing operations or entanglement with gear.

The statement on page 70 that "only a small percentage of the recreational dive sites are within 25 km of the survey track lines" needs to be corrected based on Figure 6, which depicts almost all popular dive sites within the 25 km buffer. This buffer shown in Figure 6 is of concern because if diving is not recommended in these areas, then a significant number of popular dive sites will be unavailable.

<u>Other concerns</u>

The PEIS, dated June 2011, does not include the coast off of North Carolina as a Detailed or Quantitative Analysis Area (DAA or QAA) as described in section 2.3 and is, therefore, not discussed in the Affected Environment sections of each sub-chapter. Although the information in the PEIS is relevant regarding fish hearing and research regarding fish and seismic testing, some important rare habitats are not covered, namely Lophelia coral banks. Some discussion of potential impacts to these rare and fragile habitats should be included in the EA.

On page 4 of the EA, water depths in the survey area are stated to be 30-4300 m but according to the maps in Figures 1 and 6, surveys will extend well into waters with depths less than 20 meters.

<u>Avoidance, minimization, mitigation for impacts to fish and fisheries</u>

We recognize that many marine species may be impacted by these surveys and that efforts have already been taken to reduce impacts to some species through the survey timing, relatively brief time period, limited seafloor coverage, and measures to avoid marine mammals and sea turtles once underway. However, further steps are necessary to avoid or minimize impacts to fish and fisheries and could include a change in survey timing, avoidance of important habitats, and monitoring.

Moving the surveys to winter would greatly reduce conflicts with fishing and diving operations in these areas. Recognizing that North Atlantic right whale utilizes areas off NC from winter to spring, we recommend conducting surveys in November.

Important known habitats and HAPCs should not be directly traversed by the survey transects. These areas should be avoided with a buffer of at least as wide as the distances with received sound levels of 180 dB for that depth. This results in buffers of approximately 2.6 miles for depths less than 100m, 1.7 miles for depths between 100-1000m and 1.2 miles for depths greater than 1000m based on the information provided in Table 1 of the EA and discussed above. This buffer is necessary to reduce the largest impacts (directly under the airguns) to habitats where commercially and recreationally important fish are known to aggregate.

In known locations of *Lophelia* coral reefs or other hard bottom, deployment of ocean bottom seismometers or any other bottom-disturbing activities should not be allowed.

The PEIS states that the sound associated with seismic survey activities could cause behavioral, physiological, and pathological effects in fish but there is "insufficient knowledge to establish objective criteria for determining potential for adverse impacts". Due to this lack of knowledge, if impacts cannot be avoided or minimized, monitoring should be established in areas known to be highly utilized by certain fish species. Monitoring could include remotely operated underwater vehicle (ROV) observation or in situ video recording and traditional hook-and-line sampling in important areas before, during, and after seismic survey. Monitoring areas should at least include portions of the Big Rock, 10-Fathom Ledge, The Point, and Cape Fear Lophelia Banks HAPCs. Considering this is the first large scale use of airguns in this area, this monitoring would be a relatively simple way to provide preliminary data observing fish and fisheries impacts that would guide the management of future seismic surveys off the coast of North Carolina.

Section 3.3.4.4 of the PEIS describes how effects can be minimized through adjustments to tracklines, timing of surveys, and communication with fishers. The summary of section 3.3 Marine Fishes states that in areas where commercially important fisheries are known to occur, pre-survey planning would be conducted to minimize adverse impacts. NCDCM and NCDMF look forward to working with NSF to make these adjustments to the proposed seismic surveys in order to minimize impacts to the fish and fisheries of North Carolina.

Thank you for the opportunity to provide input on this project. If you have any comments or questions, please call Jessi Baker at 252-808-2808 ext. 213 or via email at jessi.baker@ncdenr.gov.

Literature Cited

NOAA (National Oceanic and Atmospheric Administration). *Understanding the Commercial Fisheries and Recreational Fisheries Economic Impact Estimates.* 2014[a]. National Marine Fisheries Service. U.S. Dept. Commerce. http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/Understanding_fisheries_economic_impact_estimates.pdf

NOAA (National Oceanic and Atmospheric Administration). *Fisheries Economics of the United States, 2012.* 2014. National Marine Fisheries Service. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-137. http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012.pdf

North Carolina Department of Environment and Natural Resources

Pat McCrory
Governor

John E. Skvarla, III
Secretary

MEMO

To: Daniel Govoni, Assistant Major Permits Coordinator

Through: Robert Tankard, Assistant Regional Supervisor - Water Quality Regional Operation Section, Division of Water Resources

From: Anthony Scarbraugh, Environmental Senior Specialist AS

Subject: **Comments on Atlantic Ocean off Cape Hatteras Marine Geophysical Survey**

Date: July 21, 2014

Review of the subject project found no mention of possible existence or impacts to jurisdictional wetlands, streams, and/or waters within the footprint of the proposed land based activities. Therefore, this Office recommends coordinating with the United States Army Corps of Engineers (USACOE) concerning identification of any jurisdictional features and the required permitting that may be involved prior to the implementation of this project. If you should have any questions or require additional information you may e-mail me at anthony.scarbraugh@ncdenr.gov or 252-948-3924.

Division of Water Resources – Water Quality Regional Operations Section – Washington Regional Office
943 Washington Square Mall, Washington, NC 27889
Phone: 252-946-6481 \ Fax: 252-975-3716\ Internet: www.ncdenr.gov

North Carolina
Department of Administration

Pat McCrory, Governor
Bill Daughtridge, Jr., Secretary

State Property Office

July 24, 2014

To: Daniel Govoni

From: Joy Wayman
Real Property Agent

Re: Marine Geophysical Survey
Applicant: National Science Foundation

Reply: If the activities are located on State-owned land or if the project requires any structure and/or equipment on State-owned land - easements, rights-of-entry, license or other legal documents will be required from the State Property Office prior commencement of any work.

Mailing Address:
1321 Mail Service Center
Raleigh, N.C. 27699-1321

Telephone (919) 807-4650
Fax (919) 733-1431
State Courier #52-71-78

Location:
116 West Jones Street
Raleigh, North Carolina

Walker, Michele

From: angela huskey <adhuskey@gmail.com>
Sent: Thursday, August 21, 2014 1:09 PM
To: Walker, Michele
Subject: Seismic Testing

Please help stop the seismic Testing that is to take place off the coast of NC!
This is a critical time with sea turtle hatchling trying to make it out to the ocean. Mature turtles still laying.
Our right whales around the east coast.
Our fishing industry will hurt greatly from this testing.
It has been proven the sound waves make all sea life vulnerable. It effects there eating, hunting, breeding. They live from detecting sound waves. That's how they feed, breed.
Please stop the madness! There are plenty other options for oil and gas.
Support wind energy! That would create 1000, s of jobs.
They would have to come into the ports. They would have to be assembled, taken out to the ocean, assembles and maintained.
It's a lot better not only for our environment but for our wonderful sea life that we are fortunate to have on the east coast and especially NC.
We now have beaches that are classified as critical habitats for our awesome sea turtles.
Please help stop this first step into drilling for oil and gas off of our wonderful coast!
Thank you,
Angela Huskey

Walker, Michele

From: Pabst, D. Ann <pabsta@uncw.edu>
Sent: Wednesday, August 20, 2014 11:56 AM
To: Walker, Michele
Cc: Pabst, D. Ann
Subject: RE: Hello Dr. Walker - a quick question regarding NOAA permit authorization for 0648-XD394 Seismic Testing Off NC
Attachments: Pabst letter to NOAA Permits regarding Authorization 0648-XD394.pdf

Hello Michele,

Attached and embedded below please find my comments to NOAA, which I wish to share with you.

Best wishes – Ann

18 September 2014

Dr. Jolie Harrison
Chief, Permits and Conservation Division
Office of Protected Resources, NMFS
1315 East-West Highway
Silver Spring, MD 20910

Dear Dr. Harrison,

I am writing to comment upon NOAA's proposed authorization for "Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014". My major concerns center around the potential impacts on beaked whales within the proposed seismic survey area.

Multiple survey efforts off Cape Hatteras, North Carolina have documented year-round presence of beaked whales (*Ziphius cavirostris* and *Mesoplodon* spp., OBIS SEAMAP publically available data) in the proposed survey area. Within that area, beaked whales are non-randomly distributed. They are found exclusively along the deep continental shelf edge and beyond. Their very geographically-specific distribution patterns suggest that animals may not be able to respond to seismic activity by simply moving away from the area, as is suggested in the authorization document.

Beaked whale abundances are very difficult to assess, for the reasons well-articulated in NOAA's Stock Assessment Reports. I am unclear, though, as to how the stock abundances for beaked whales were determined. Table 1 in the authorization document lists the abundance estimate for each beaked whale species as 7,092 individuals. The stated best estimate for Cuvier's beaked whale (*Z. cavirostris*) is 6,532 individuals (minimum 5,021; PBR = 50). The 7,092 (minimum 4,632; PBR 46) estimate in Table 1 is for combined *Mesoplodon* spp. from Florida to the Bay of Fundy. While this is currently the best available estimate, this number simply *does not represent* the true abundance of *any one* species. Thus, the total population of each potentially impacted *Mesoplodon* species is an overestimate, and the potential impact on any single species, an underestimate.

Beaked whales are known prolonged, deep divers (e.g. Tyack *et al.* 2006; Schorr *et al*. 2014). Thus, visual monitoring efforts, even with prolonged 30 minute survey windows, are insufficient to assure no beaked whales are in the exclusion zone. The addition of passive acoustics is important, but it is unclear as to whether the tow depth (approximately 20 m) is sufficient to detect beaked whale vocalizations, which usually occur only beyond 400 m depth. Thus, more detailed information on effective monitoring of these deep diving species would be valuable.

Lastly, beaked whales are also known to experience atypical mass stranding events when exposed to other anthropogenic sound sources, specifically military mid-frequency sonar (reviewed by Cox *et al*. 2006). The sound sources used in seismic surveys are of similar amplitude ("246 to 253 decibels (dB) re: 1 μPa (peak to peak)" ; information from authorization document), although the frequency of airgun output is much lower. There are, simply put, insufficient data available on beaked whale responses to these types of anthropogenic sounds.

I am appreciative of the serious consideration the Lamont-Doherty – NSF investigators have given to monitoring and mitigation steps, and the extra requirements that NOAA has demanded for this activity to be authorized. I do believe, though, that the potential impacts on beaked whales are unknown, and that special consideration needs to be given to this group of cetaceans in any authorization. I hope that the regional stranding organizations are also notified if this activity does occur, and that NOAA has a robust response plan, should it be required.

Sincerely,

D. Ann Pabst
Professor, Biology and Marine Biology
University of North Carolina Wilmington

D. Ann Pabst
Biology and Marine Biology
University of North Carolina Wilmington
601 S. College Rd.
Wilmington, NC 28403
Phone: 910-962-7266
Fax: 910-962-4066
pabsta@uncw.edu

From: Walker, Michele [mailto:michele.walker@ncdenr.gov]
Sent: Tuesday, August 19, 2014 12:42 PM
To: Pabst, D. Ann
Subject: RE: Hello Dr. Walker - a quick question regarding NOAA permit authorization for 0648-XD394 Seismic Testing Off NC

I have attached our public notice seeking comment on the NSF consistency review. Yes, comments may be sent via email to me.

We also have information regarding the request on our website, www.nccoastalmanagment.net. The link is under What's New on the right side of the page, and is titled National Science Foundation Consistency Review.

Thank you for taking the time to comment. We appreciate your input.

Michele

From: Pabst, D. Ann [mailto:pabsta@uncw.edu]
Sent: Tuesday, August 19, 2014 12:01 PM
To: Walker, Michele
Cc: Pabst, D. Ann
Subject: Hello Dr. Walker - a quick question regarding NOAA permit authorization for 0648-XD394 Seismic Testing Off NC

Hello Dr. Walker,

I submitted comments on the NOAA permit authorization for 0648-XD394 Seismic Testing Off NC yesterday and received an email from NOAA Permits that the "North Carolina Division of Coastal Management is also soliciting public comments on a federal-consistency determination for the seismic survey under the Coastal Zone Management Act."

May I ask if there is a link on your website announcing this request? If not, may I confirm that you would be an appropriate recipient of such a comment letter?

Thank you for your assistance – Ann Pabst

D. Ann Pabst
Biology and Marine Biology
University of North Carolina Wilmington
601 S. College Rd.
Wilmington, NC 28403
Phone: 910-962-7266
Fax: 910-962-4066
pabsta@uncw.edu

18 September 2014

Dr. Jolie Harrison
Chief, Permits and Conservation Division
Office of Protected Resources, NMFS
1315 East-West Highway
Silver Spring, MD 20910

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I am appreciative of the serious consideration the Lamont-Doherty – NSF investigators have given to monitoring and mitigation steps, and the extra requirements that NOAA has demanded for this activity to be authorized. I do believe, though, that the potential impacts on beaked whales are unknown, and that special consideration needs to be given to this group of cetaceans in any authorization. I hope that the regional stranding organizations are also notified if this activity does occur, and that NOAA has a robust response plan, should it be required.

Sincerely,

D. Ann Pabst
Professor, Biology and Marine Biology
University of North Carolina Wilmington

Walker, Michele

From: momratz@gmail.com
Sent: Wednesday, August 20, 2014 10:59 AM
To: Walker, Michele
Subject: Re: today's news

Hi Michele,
I suspect that you are not the right person to respond to on this Seismic Testing but I don't know who to send to.
My concerns are not only about the fish and marine mammals but also you stated that they would be in Oregon Inlet. I hope not! I am fearful that the bridge will be further damaged and perhaps fall in. Just a thought that I hope someone at DCM has asked about the potential dangers to the bridge.
Thanks,
Annette Ratzenberger, Nags Head

From: Michele Walker
Sent: Wednesday, August 20, 2014 8:42 AM

Reminder: The information below is an aggregate of news items/editorials for today. Any opinions are not necessarily endorsed by DCM or DENR.

Flooding is more than a nuisance
http://hamptonroads.com/2014/08/flooding-more-nuisance

State commitment boosts Oak Island dredge project
http://www.starnewsonline.com/article/20140819/ARTICLES/140819635/1017/news0102?Title=State-commitment-boosts-Oak-Island-dredge-project

Council to discuss solutions to Freeman Park dune erosion
http://www.starnewsonline.com/article/20140819/ARTICLES/140819660/1015/news0101?p=all&tc=pgall

Dare County moves ahead with plan to widen Buxton beach
http://outerbanksvoice.com/2014/08/19/dare-county-moves-ahead-with-plan-to-widen-buxton-beach/

NC Reviews Coastal Seismic Testing Proposal
http://wunc.org/post/nc-reviews-coastal-seismic-testing-proposal

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Michele Walker, Public Information Officer
N.C. Dept. of Environment & Natural Resources
Office of Public Affairs/Division of Coastal Management
1601 Mail Service Center, Raleigh, NC 27699-1601
Phone/Fax #: 919-707-8604
E-mail: Michele.Walker@ncdenr.gov

Walker, Michele

From: Bev Veals <bev5k@mac.com>
Sent: Tuesday, August 19, 2014 12:21 PM
To: Walker, Michele
Subject: Seismic Testing Via National Science Foundation

Dear Ms. Walker, with all due respect — NO! Please do not let the National Science Foundation do this to our coast of NC. If you look into the funding or the National Science Foundation, it is heavily funded by subsidiaries of the koch brothers, and those of us keeping an eye on the oil and gas exploration aspect of the Atlantic know that Koch Industries would like to have first dibs at it.

If you need further proof of the potential conflict of interest, look into funding for NOVA, a popular PBS program. it is funded by the David H. Koch Foundation for Science and the National Science Foundation. They work hand in hand in the name of "science". This is NOT a good idea.

In addition, if you look into studies done by NOAA regarding the impact of noise in the ocean, a study that was assisted by Duke University' Marine Geospatial Ecology Lab, the sounds we have now with normal boat and construction noise is having a drastic impact on fisheries and cetaceans now. http://cetsound.noaa.gov/participants.html

Peasse DO NOT allow this seismic testing to occur. It is 1) a potential conflict of interest and 2) a crucial and devastating blow to our recovering dolphin population which is having issues now due to a virus that ran along the eastern seaboard. This is just the tip of the iceberg with what I feel is wrong with this request.

Thank you.

Bev Veals
730 Settlers Ln
Kure Beach, NC

Walker, Michele

From: Govoni, Daniel
Sent: Friday, September 05, 2014 10:57 AM
To: 'BONNIE MONTELEONE'
Cc: Walker, Michele
Subject: RE: Lamont Doherty proposal to conduct research using airguns off the coast of North Carolina

Dear Ms. Monteleone,

Thank you for your email dated 9/5/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: BONNIE MONTELEONE [mailto:bonmon11@hotmail.com]
Sent: Friday, September 05, 2014 10:50 AM
To: Govoni, Daniel
Subject: Lamont Doherty proposal to conduct research using airguns off the coast of North Carolina

I petition the Division of Coastal Management to find this proposal inconsistent with coastal zone management for the region to be affected along the east coast especially off of North Carolina for the following reasons:

1. Due to the unique diversity of marine biota, the Outer Banks' economy is heavily impacted by the success of the fish stocks. Airguns have been shown to dramatically depress catch rates of various commercial species. (Engas, A. et al., 1996)

2. The Federal Register's Revised Take Table as of July 25, 2014 is not completely accurate. According to their list, North Atlantic right and fin whales have a 0% take risk (both of which are endangered species). Fin whales are reportedly seen year round off of Hatteras. Right whales migrate in the fall from Bay of Fundy to Florida to calve. Though aerial surveys report rare sightings, they are RARE as a species. We cannot assume because we don't see them, they are not in the Cape Hatteras vicinity. Right whales have been seen off the coast of Fort Fisher, NC in early November making it possible that they could be feeding in the nutrient rich water off of Cape Hatteras in October. Furthermore, right whales do not travel in families and are far less audible than other whales making the potential of them being in the region yet undetected much greater.(http://www.starnewsonline.com/article/20091112/articles/911129985?p=1&tc=pg&tc=ar)But regardless, seismic testing has been reported to travel 100,000 miles which spans the distance from the Bay of Fundy to Florida. (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.)

3. Due to the steep slope off of Cape Hatteras that causes nutrient rich upwelling, the cold waters of the Labrador Current, and the warm waters of the Gulf Stream, this location is an unusually dynamic area for foraging unlike any other region on the entire east coast. "In the pelagic and mid-water depths there is high diversity of verte-brates, migratory birds, mammals, and turtles as well as fish. On the bottom there is also diversity of invertebrates." (Blake, J. A et al., Gooday, A. J. et al, Hecker, B, Milliman, J. D.and Rhodas, D. C, et al) This is a foraging hotbed for an unusually high density of species. The seismic testing that will occur there will create enough noise to disrupt eating, mating, and navigation for 33 days straight, "792 hours of continuous airgun operations" according to the Lamont-Doherty report. Because it is a feeding site to many endangered species such as fin and the North Atlantic right whales, hawksbill, Kemp's ridley, loggerhead, and leatherback sea turtles, by law this area should be protected by the Endangered Species Act and listed as a priority ocean area for protection in the Mid-Atlantic. (www.nmfs.voaa.gov/pr/speicis/esa/listed.htm)

4. Because beaked whales are deep divers, they are found in areas where there are canyons and are heavily impacted by these surveys due to sound bouncing off the canyon walls. (Sounding the Depths, pg. 11) Cuvier's beaked whales are seen in this coastal region year round, traveling north and south along Hatteras Canyon off Cape Hatteras, and could potentially be more at risk for this reason. "In general, the heads of canyons are known to be nursery areas for many fish and crustaceans, including commercially important ones. The sessile corals, sponges, and anemones found in the northern canyons have restricted distributions in that they must live attached to hard substrates. Hence populations within the canyons could represent crucial stock populations of sessile organisms." (http://www.nrdc.org/water/oceans/priority/recheck.asp)

5. The Lamont-Doherty report states the testing will be as high as 180 decibels. " . . . a 174-decibel rumble . . . . about as strong as a commercial jet at takeoff, measured about three feet away." (Sounding the Depths, pg. 4) Prolonged exposure to continuous loud noise is known to cause hearing loss to humans as well as marine mammals. This hearing impairment is known as "threshold shift." (Sound the Depths II, pg. 13) Though marine mammals have eyes and a sense of smell, the sense they rely on the most is sound to navigate, forage for food, mate, care for their offspring, and protect themselves from predators. To introduce sound that interferes with the most important sensory for 33 days straight is similar to blinding people with flood lights continuously for 24 hours, for 33 days. How could people feed, care for their children, or stay out of harms way? It is our moral, scientific, and legislative duty to protect this region more so than other areas along the east coast.

6. The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in or an 18-airgun array with a total discharge of volume of ~3300. “A single airgun array can disrupt vital behavior in endangered whales over an area of at least 100,000 square nautical miles in size.” (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.) This underscores the harassment seismic testing will cause to the most endangered whale in the world – the North Atlantic right whale.

7. Other anthropogenic impacts that compromise the large whale populations are fishing gear entanglement and boat strikes. Right whales and fin whales are the most commonly reported species in the context of population size prone to vessel strikes. “Compared with the spatial extent of regulations, vessel-strike mortality continues to be highest in the mid-Atlantic coast.” (Van Der Hoop, J. M. et al. 2012) Seismic testing will add yet another stressor on the already in periled species.

8. *Sargassum* is considered an essential fish habitat and is charged by law to minimize any adverse effects on such habitat. (Fishing North Carolina’s Outer Banks: The complete Guide to Catching More, pg. 72). *Sargassum* found off North Carolina’s coast is home to 81 fish species. Most of these fishes are juveniles that meander from the Gulf Stream. Commercially important dolphin fish, amberjacks, and tuna have also been documented to use this unique habitat as well as marine mammals (dolphins) and juvenile loggerhead sea turtles many of which are endangered. (http://oceanexplorer.noaa.gov/explorations/03edge/background/sargassum/sargassum.html) Influenced by the currents, large windrows of Sargassum mats consistently form just off of Cape Hatteras. The airgun blasts are not limited to just reaching the bottom but are also reported to be heard by mariners; thus, the *Sargassum* ecosystem stands to be impacted by the airgun operations. The NC Outer Banks fishing industry relies heavily on the Sargassum habitat. Communication with members from Pirates Cove Marina, the fishermen fear the negative impacts on fishing especially in hunting marlin.

Please consider this very unique aquatic region as a priority ocean area for protection in the Mid-Atlantic both for marine life and the fishing community, and not allow seismic testing incidental harassment to ever occur in this region.

Thank you for your consideration.

Bonnie Monteleone

Wilmington, NC 28403

910-962-3450

www.theplasticocean.blogspot.com

Walker, Michele

From: jmerriner@ec.rr.com
Sent: Sunday, August 17, 2014 10:06 PM
To: Walker, Michele
Cc: mhooper9@ec.rr.com
Subject: Carteret County Crossroads comment re NSF Seismic Survey

Michele Walker,
This note pertains to proposed NSF supported seismic studies off the NC coast scheduled for September-October 2014.
Carteret County Crossroads has questions/misgivings about the reliability of methodology for sighting of marine mammals, sea turtles and aggregations of other significant biota in the survey area. We understand that the dB levels produced by the air gun array can range from 160-180 dB. These levels can harm MM and Endangered/threatened species, ie would be considered harassments or maybe takes of the animals. Other animals such as finfishes with airbladders would be subject to the concussive forces and possibly harmed.
With those aspects as background, we are concerned about the detection mechanism(s) for animals in the range while the air guns are operated. We note that visual scanning and acoustic monitoring would be employed but question their utility over the distances of potential organismal impact (up to 2 miles). Confirmed Marine Mammal
sightings are difficult at those ranges even on a calm day. We conclude
that a number of MMs and protected species likely will be impacted in the survey, but their presence will not detected by the scientific parties.

Yours, John V. Merriner, Sect. Carteret County Crossroads
P.O.Box 223
Beaufort, NC 28516

Walker, Michele

From: Chris <blishbell@bellsouth.net>

Sent: Tuesday, August 19, 2014 1:07 PM
To: Walker, Michele
Subject: Seismic testing

Dear Michele ,
Did someone forget to inform you and your group , that it is turtle season , and the hatchlings will be out in the ocean !
Along with numerous other sea creatures !
Who is actually behind all this ?
Why are you people bound and determined to destroy our natural resources ?
I can't help but think the oil companies are behind this , anyone that cares about our oceans would not make a decision like this.
Please reconsider what you are doing !
Chris Blish
Kure bch NC
Sent from my iPad

Walker, Michele

From: Govoni, Daniel
Sent: Monday, August 18, 2014 9:55 AM
To: 'CHRIS'
Cc: Walker, Michele
Subject: RE: opposition to seismic testing

Dear Mr. Mason,

Thank you for your email dated 8/18/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: CHRIS [mailto:seamason1@msn.com]
Sent: Monday, August 18, 2014 8:41 AM
To: Govoni, Daniel
Subject: opposition to seismic testing

Dear Mr. Govoni,

I am writing to you to voice my opposition to the proposed seismic testing off of the NC coast. There is little doubt this testing is in conjunction with oil exploration which I also adamantly oppose.

The effect of this on the marine environment will only be realized when it is to late and there are dead dolphins washing up on our shores or the fish population vacates the area completely.

The North Carolina coast is continuously ranked as a #1 destination for Scuba diving due to the health of the marine environment, which contributes to a positive commercial / recreational impact for our state. The negative downstream effects of this testing would be far reaching in to many other areas as well.

Thank you for your consideration of this request.

Chris Mason
Newport, NC

Walker, Michele

From: Govoni, Daniel
Sent: Tuesday, September 02, 2014 9:57 AM
To: 'Christine Bullen'
Cc: Walker, Michele
Subject: RE: NSF Seismic Testing off NC Coast

Dear Christine Bullen,

Thank you for your email dated 8/30/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Christine Bullen [mailto:cvbullen@gmail.com]
Sent: Saturday, August 30, 2014 1:15 PM
To: Govoni, Daniel
Subject: NSF Seismic Testing off NC Coast

I am writing to express deep concern about the potential for loss of hearing for marine life due to the high dB levels proposed in the NSF testing. Dolphins and whales rely on sound for survival, and therefore mortality of the species is a potential outcome.

I think that the predominant factors that warrant a delay in the US NSF seismic testing are

- too many uncertainties relating to marine impacts

- lack of notice/information given to the public prior to the testing approval process

Please provide the residents of North Carolina more substantial information regarding impact, purpose, and testing location before allowing a federal entity to conduct a somewhat-experimental method of data collection off of our coast.

--
Christine V. Bullen, Ph.D.
931 Stately Pines Road
New Bern, NC 28560
Cell: 914-645-0605
Home: 252-288-6103
cvbullen@gmail.com
christine.bullen@gscouncil.org
Twitter | Facebook | LinkedIn | YouTube

Walker, Michele

From: Douglass, Claire <cdouglass@oceana.org>
Sent: Friday, August 22, 2014 5:06 PM
To: Walker, Michele
Subject: Oceana Comments Concerning the Marine Geophysical Survey Offshore North
Attachments: Comment Letter to North Carolina.pdf

Dear Mr. Davis:

Oceana is concerned about the National Science Foundation's proposal to use seismic airguns to study the Atlantic Ridge off the coast of Cape Hatteras this fall. Although scientific research is incredibly important to understand the world we live in, the timing of this study raises concern because it could affect Fall Fishing.

There has been little time to review this proposal and there is little scientific research on the effects of seismic airguns blasting on fish populations. The fall months are some of the most important times of the year for fishermen in North Carolina. Many fish species, including the spotted sea trout and striped bass, migrate south to the warmer waters off North Carolina in the fall. In addition, the king mackerel and spot fish are in a period of high activity to prepare for winter. The increased presence of fish in the waters is what drives Fall Fishing. North Carolina supports 8,800 commercial fishing jobs, in addition to 18,202 recreational fishing jobs. These industries combine to contribute some $1.4 billion to the North Carolina economy.

We will be sending more detailed public comments to the Bureau of Ocean Energy Management before its September 2nd deadline and will send you a copy for reference.

Sincerely,

Claire Douglass

Claire Douglass | Campaign Director, Climate and Energy
OCEANA | Protecting the World's Oceans
1350 Connecticut Ave. NW, 5th Floor | Washington, DC 20036 USA
T +1.202.467.1948 | **F** +1.202.833.2070
E cdouglass@oceana.org | **W** www.oceana.org

OCEANA | Protecting the World's Oceans

MEMORANDUM

1350 Connecticut Ave. NW, 5th Floor
Washington, DC 20036 USA
Toll free +1.877.7.OCEANA
P| +1.202.833.3900
F| +1.202.833.2070
oceana.org

August 22, 2014

Via E-mail

Braxton Davis
Director
c/o Michele Walker
North Carolina Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557
Michele.Walker@ncdenr.gov

Re: Oceana Comments Concerning the Marine Geophysical Survey Offshore North Carolina, 79 Fed. Reg. 44550 (July 31, 2014)

Dear Mr. Davis:

Oceana is concerned about the National Science Foundation's proposal to use seismic airguns to study the Atlantic Ridge off the coast of Cape Hatteras this fall. Although scientific research is incredibly important to understand the world we live in, the timing of this study raises concern because it could affect Fall Fishing.

There has been little time to review this proposal and there is little scientific research on the effects of seismic airguns blasting on fish populations. The fall months are some of the most important times of the year for fishermen in North Carolina. Many fish species, including the spotted sea trout and striped bass, migrate south to the warmer waters off North Carolina in the fall. In addition, the king mackerel and spot fish are in a period of high activity to prepare for winter. The increased presence of fish in the waters is what drives Fall Fishing. North Carolina supports 8,800 commercial fishing jobs, in addition to 18,202 recreational fishing jobs. These industries combine to contribute some $1.4 billion to the North Carolina economy.

We will be sending more detailed public comments to the Bureau of Ocean Energy Management before its September 2nd deadline and will send you a copy for reference.

Sincerely,

Claire Douglass
Campaign Director

Walker, Michele

From: Michael Murdoch <memurdoch@gmail.com>
Sent: Sunday, August 17, 2014 3:29 PM
To: Walker, Michele
Cc: 'Paul Getty'; Penny Hooper; Matt Graham ; Courtney Mehurg; Robert Scull; Deede Miller; Zachary Keith; Cassie Gavin; Jessica Lewis; John Fussell; Don & Carolyn Hoss
Subject: Croatan Group of the Sierra Club Opposes Marine Geographical Survey proposed by the National Science Foundation
Attachments: Croatan Group Sierra Club Opposes Marine Survey.JPG

Dear Ms. Walker: The Croatan Group of the Sierra Club opposes the National Science Foundation's proposal to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast, Sept. 15-Oct. 22, 2014. Please see attached letter that is also being sent to Mr. Braxton Davis, NC Division of Coastal Management Director.

Croatan Group Sierra Club

Serving Carteret, Craven, Jones, Onslow, and Pamlico Counties

Mr. Braxton Davis, Division of Coastal Management Director
400 Commerce Avenue
Morehead City, NC 28557

August 15, 2014

Dear Mr. Davis:

The Croatan Group of the Sierra Club comprising over 500 members from Carteret, Craven, Onslow, Jones, and Pamlico counties strongly opposes the plan by the National Science Foundation to conduct seismic testing in the Atlantic Ocean off of the North Carolina coast, Sept. 15-Oct. 22, 2014.

The damaging effects of seismic blasting using 18-36 air guns is not understood and not worth the risk to the rich and fragile marine life off of our coast. Seismic guns create sound blasts in the area of 250 decibels - around double the amount one would experience at a loud rock concert. The potential impact to the fishing and tourism industry in our region could be substantial.

The use of ecosounders in conjunction with the seismic blasting has also been a problem with marine life. These devices produce high frequency sounds that have been proven to cause the death of whales.

Now is not the time to experiment off the coast of North Carolina where a rich diversity of marine life is at risk.

We urge you to deny the request and at the very least require a full environmental impact statement where public input is solicited.

Sincerely,

Michael E. Murdoch

Michael E. Murdoch, Chair
Croatan Group of the Sierra Club
415 Wildwood Road
Newport, NC 28570

Note: Please provide us a decision regarding this matter.

Walker, Michele

From: Dain Eomar Nielsen <denielse@live.unc.edu>
Sent: Sunday, August 24, 2014 2:45 PM
To: Walker, Michele
Subject: Seismic Testing

Dear Ms Walker;

I am opposed to seismic testing. Clearly the research indicates there will be irreparable harm to much sea life.
Thank You;
Dain Nielsen

614 Robert E Lee Dr. Wilmington, NC 28412

Walker, Michele

From: Govoni, Daniel
Sent: Monday, August 18, 2014 11:43 AM
To: 'dive@discoverydiving.com'
Cc: Walker, Michele
Subject: RE: NSF Survey comments

Dear Debby Boyce,

Thank you for your email dated 8/18/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: dive@discoverydiving.com [mailto:dive@discoverydiving.com]
Sent: Monday, August 18, 2014 11:38 AM
To: Govoni, Daniel
Cc: Discovery Diving
Subject: NSF Survey comments

Good Morning Daniel

We have looked at the Draft Environmental Assessment and have some major concerns.

1. The timing of the survey is potentially devastating due to the timing in the middle of the last two productive months of our seasons these being the Dive Charter, Fishing Charter, Fishing Tournament, Diving and Fishing tourism and recreational boating industries.

2. It states they are avoiding the winter months of Jan thru March to avoid the whale migrations and potential negative affects; however they make no such efforts for the huge biomasses on each of the wrecks and hard bottom outcroppings in this area. With the abundance of these fish/biomass congregations in the planned survey path there is the potential of great animal distruction; this is very disturbing.

Although the information gleened from this survey may very interesteing the potential distruction and economic impact is not justified by the potentiael benefit.

Thank you Debby Boyce
Pres.

Discovery Diving Co., Inc.
& Beaufort Harbour Suites &
ACCET Accredited Discovery Diving Co., Inc School
Home of Eastern Carolina Artificial Reef Association
414 Orange St.
Beaufort, NC 28516
(p)252-728-2265 (252-scuba-ok)
(f)252-728-2581
www.DiscoveryDiving.com
www.DiscoveryDiving.edu
http://twitter.com/DiscoveryDiving
www.BeaufortHarbourSuites.com
stay@BeaufortHarbourSuites.com
www.CarolinaReefs.org

Walker, Michele

From: douglass swanson <wildagin@earthlink.net>
Sent: Tuesday, August 19, 2014 5:08 PM
To: Walker, Michele
Subject: seismic testing

Dear Ms. Walker,

I respectfully request that the seismic testing proposed by the National Science Foundation September 15 - October 22, 2014 be aborted. I cannot comprehend the reasoning of this at any time, because of our marine life. Whales, dolphins, turtles and others will be affected in a negative and harmful way. These blasts will disorient migration patterns and affect other behavior and habits. I vehemently oppose any further direction with this dangerous proposal.

Respectfully,

Douglass Swanson

115 Intracoastal Drive
Beaufort, NC 28516
252-728-2939

douglass swanson
wildagin@earthlink.net

Walker, Michele

From: Govoni, Daniel
Sent: Friday, September 05, 2014 12:35 PM
To: 'Ginger Taylor'
Cc: Walker, Michele
Subject: RE: Lamont Doherty proposal to conduct research using airguns off the coast of North Carolina

Dear Ms. Taylor,

Thank you for your email dated 9/5/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Ginger Taylor [mailto:gingertaylor1@gmail.com]
Sent: Friday, September 05, 2014 11:55 AM
To: Govoni, Daniel
Subject: Lamont Doherty proposal to conduct research using airguns off the coast of North Carolina

I petition the Division of Coastal Management to find this proposal inconsistent with coastal zone management for the region to be affected along the east coast especially off of North Carolina for the following reasons:

1. Due to the unique diversity of marine biota, the Outer Banks' economy is heavily impacted by the success of the fish stocks. Airguns have been shown to dramatically depress catch rates of various commercial species. (Engas, A. et al., 1996)

2. The Federal Register's Revised Take Table as of July 25, 2014 is not completely accurate. According to their list, North Atlantic right and fin whales have a 0% take risk (both of which are endangered species). Fin whales are reportedly seen year round off of Hatteras. Right whales migrate in the fall from Bay of Fundy to Florida to calve. Though aerial surveys report rare sightings, they are RARE as a species. We cannot assume because we don't see them, they are not in the Cape Hatteras vicinity. Right whales have been seen off the coast of Fort Fisher, NC in early November making it possible that they could be feeding in the nutrient rich water off of Cape Hatteras in October. Furthermore, right whales do not travel in families and are far less audible than other whales making the potential of them being in the region yet undetected much greater.(http://www.starnewsonline.com/article/20091112/articles/911129985?p=1&tc=pg&tc=ar)Butregardless, seismic testing has been reported to travel 100,000 miles which spans the distance from the Bay of Fundy to Florida. (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.)

3. Due to the steep slope off of Cape Hatteras that causes nutrient rich upwelling, the cold waters of the Labrador Current, and the warm waters of the Gulf Stream, this location is an unusually dynamic area for foraging unlike any other region on the entire east coast. "In the pelagic and mid-water depths there is high diversity of verte-brates, migratory birds, mammals, and turtles as well as fish. On the bottom there is also diversity of invertebrates." (Blake, J. A et al., Gooday, A. J. et al, Hecker, B, Milliman, J. D.and Rhodas, D. C, et al) This is a foraging hotbed for an unusually high density of species. The seismic testing that will occur there will create enough noise to disrupt eating, mating, and navigation for 33 days straight, "792 hours of continuous airgun operations" according to the Lamont-Doherty report. Because it is a feeding site to many endangered species such as fin and the North Atlantic right whales, hawksbill, Kemp's ridley, loggerhead, and leatherback sea turtles, by law this area should be protected by the Endangered Species Act and listed as a priority ocean area for protection in the Mid-Atlantic. (www.nmfs.voaa.gov/pr/speicis/esa/listed.htm)

4. Because beaked whales are deep divers, they are found in areas where there are canyons and are heavily impacted by these surveys due to sound bouncing off the canyon walls. (Sounding the Depths, pg. 11) Cuvier's beaked whales are seen in this coastal region year round, traveling north and south along Hatteras Canyon off Cape Hatteras, and could potentially be more at risk for this reason. "In general, the heads of canyons are known to be nursery areas for many fish and crustaceans, including commercially important ones. The sessile corals, sponges, and anemones found in the northern canyons have restricted distributions in that they must live attached to hard substrates. Hence populations within the canyons could represent crucial stock populations of sessile organisms." (http://www.nrdc.org/water/oceans/priority/recheck.asp)

5. The Lamont-Doherty report states the testing will be as high as 180 decibels. " . . . a 174-decibel rumble . . . . about as strong as a commercial jet at takeoff, measured about three feet away." (Sounding the Depths, pg. 4) Prolonged exposure to continuous loud noise is known to cause hearing loss to humans as well as marine mammals. This hearing impairment is known as "threshold shift." (Sound the Depths II, pg. 13) Though marine mammals have eyes and a sense of smell, the sense they rely on the most is sound to navigate, forage for food, mate, care for their offspring, and protect themselves from predators. To introduce sound that interferes with the most important sensory for 33 days straight is similar to blinding people with flood lights continuously for 24 hours,

for 33 days. How could people feed, care for their children, or stay out of harms way? It is our moral, scientific, and legislative duty to protect this region more so than other areas along the east coast.

6. The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in or an 18-airgun array with a total discharge of volume of ~3300. "A single airgun array can disrupt vital behavior in endangered whales over an area of at least 100,000 square nautical miles in size." (Boom, Baby, Boom: The Environmental Impacts of Seismic Surveys, pg. 3.) This underscores the harassment seismic testing will cause to the most endangered whale in the world – the North Atlantic right whale.

7. Other anthropogenic impacts that compromise the large whale populations are fishing gear entanglement and boat strikes. Right whales and fin whales are the most commonly reported species in the context of population size prone to vessel strikes. "Compared with the spatial extent of regulations, vessel-strike mortality continues to be highest in the mid-Atlantic coast." (Van Der Hoop, J. M. et al. 2012) Seismic testing will add yet another stressor on the already in periled species.

8. *Sargassum* is considered an essential fish habitat and is charged by law to minimize any adverse effects on such habitat. (Fishing North Carolina's Outer Banks: The complete Guide to Catching More, pg. 72). *Sargassum* found off North Carolina's coast is home to 81 fish species. Most of these fishes are juveniles that meander from the Gulf Stream. Commercially important dolphin fish, amberjacks, and tuna have also been documented to use this unique habitat as well as marine mammals (dolphins) and juvenile loggerhead sea turtles many of which are endangered. (http://oceanexplorer.noaa.gov/explorations/03edge/background/sargassum/sargassum.html) Influenced by the currents, large windrows of Sargassum mats consistently form just off of Cape Hatteras. The airgun blasts are not limited to just reaching the bottom but are also reported to be heard by mariners; thus, the *Sargassum* ecosystem stands to be impacted by the airgun operations. The NC Outer Banks fishing industry relies heavily on the Sargassum habitat. Communication with members from Pirates Cove Marina, the fishermen fear the negative impacts on fishing especially in hunting marlin.

Please consider this very unique aquatic region as a priority ocean area for protection in the Mid-Atlantic both for marine life and the fishing community, and not allow seismic testing incidental harassment to ever occur in this region.

Thank you for your consideration.

Ginger Taylor
6205 Mallard Drive
Wilmington, NC 28403

Walker, Michele

From: Govoni, Daniel
Sent: Tuesday, September 02, 2014 9:58 AM
To: 'Helen Livingston'
Cc: Walker, Michele
Subject: RE: Seismic Testing off of NC Coast

Dear Ms. Livingston,

Thank you for your email dated 8/30/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Helen Livingston [mailto:livingston.helen@gmail.com]
Sent: Saturday, August 30, 2014 3:59 PM
To: Govoni, Daniel
Subject: Seismic Testing off of NC Coast

Daniel M. Govoni, Asst. Major Permits Coordinator
NC Division of Coastal Management

Dear Mr. Govoni,

I write regarding the request from the National Science Foundation's request for a permit to do seismic testing off of the NC Coast. I respectfully request that this permit be denied, on the basis of the information below:

There should not be a rush, nor a secretiveness regarding this endeavor. Why are we, the people, being asked to pay for something that, not only could bring devastating harm to marine life, our ocean and our land; but that chiefly benefits Big Oil? Precious few jobs or money from drilling would make it's way beyond the Big Corporations in the first place.

Why is there so little information available to citizens, and so little time for us to respond, in the face of an issue that involves our fishing industry, our tourism industry, and such a potentially heavy cost for remediation? This is the perfect opportunity to stand against Corporatism.

There is not enough information about the effect of testing (at up to 250 decibels) on marine biology. We do know that whales and dolphins navigate by sound, and it seems reasonable to assume that there could be serious impacts on these, and other marine animals.

Having been closely associated with the BP spill in the Gulf, and the miserable response to the people by BP and the government, I do not want the same thing to happen to our coast. Drilling off the Atlantic Coast holds more potential for disastrous problems than does drilling in the Gulf of Mexico. We know from the BP spill that there is no amount of money that will protect our coast from the effects of the inevitable spills from oil drilling in such treacherous waters.

Please stand with NC's people, not Big Oil, and deny this permit for seismic testing. Financing Big Oil is a step back into the past, while NC is in the forefront of Renewable Energy, our future, through investment in wind and solar.

With appreciation for your consideration,

Helen Livingston
311 Montrose Lane
Laurinburg, NC 28352
910-276-1797

Walker, Michele

From: Jade Walker <jadewalker@mindspring.com>
Sent: Tuesday, August 26, 2014 8:23 PM
To: Walker, Michele
Subject: Public Comment concerning survey of the ocean near the Outer Banks

Dear Ms. Walker,

I have recently heard about the survey planned to be conducted off the coast of North Carolina in September and October. While my livelihood does not depend on access to the ocean, my recreation, as well as the disposable income that goes with it, does. Those who will be denied income for a month can speak far more eloquently about the hardship this will cause than I can, so I will leave that task for them. However, I am concerned about the safety to both residents and tourists, when a far-reaching survey such as this occurs during the two months most prone to hurricanes along the North Carolina coast.

I assume that the survey crew has established guidelines and procedures for handling the inclement and dangerous weather that can be encountered at that time for its own operation and equipment. I admit to only a cursory perusal of the online proposal, but it revealed nothing in terms of guidelines and procedures on how the residents and tourists are to operate in an evacuation scenario if access to certain areas of the coastline and ocean are restricted. What does the populace do in this situation?

There is also the issue of safeguarding property of residents and business owners if a serious storm approaches. Boats must be taken to a place of safety, and almost all boat owners have arrangements with a particular location to house or shelter their boats during a storm. What if the survey equipment blocks access to that pre-arranged place? It would be a shame for a fishing company who has already been blocked from their source of income by this survey to lose such a major asset as well for the same reason.

I believe there are better times during the year for this survey to take place, when fewer businesses are affected, and the weather conditions are more conducive to smooth and constant operation of the survey. Please consider rescheduling this survey for a more opportune time.

Yours,

Jade L. Walker

215 Lakewater Drive
Cary, NC 27511
jadewalker@mindspring.com

Walker, Michele

From: Govoni, Daniel
Sent: Wednesday, September 03, 2014 9:51 AM
To: 'James Barton'
Cc: Walker, Michele
Subject: RE: Seismic testing over ordnance disposal sites

Dear Mr. Barton,

Thank you for your email dated 9/3/14 and attached letters concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: James Barton [mailto:jamesbarton@uwuxo.com]
Sent: Wednesday, September 03, 2014 5:00 AM
To: Govoni, Daniel
Subject: Seismic testing over ordnance disposal sites

Nice talking with you earlier! Thank you for looking at this.

Jim

P.S. I never was able to locate a public comment access point on your website, but I found one at the National Science Foundation website and a few others to share my concerns with.

Walker, Michele

From: Jenna Nielsen <jennanielsen6@gmail.com>
Sent: Saturday, August 23, 2014 11:22 AM
To: Walker, Michele
Subject: Oppose Seismic Testing

Dear Officer Walker,

I am opposed to seismic testing. Clearly the research indicates there will be irreparable harm to sea life.

Thank You.
Jenna Nielsen
Wilmington, NC

Walker, Michele

From: jerryschill <jerryschill@ncfish.org>
Sent: Friday, August 22, 2014 10:10 AM
To: Walker, Michele
Subject: NSF Project

Mr. Braxton Davis, Director
NC Division of Coastal Management

Dear Mr. Davis:

It was only early this morning when I stumbled across an article in the Jacksonville Daily News about your Division asking for comments on the NSF seismic testing project. As a 61 year old trade association representing commercial fishermen in our state, one would think communications would be a little more open, especially when our folks have more interest in a project like this than most.

Since today is the deadline for comments, it is very difficult for me to circulate this information to our members in time so they can also comment.

I only became aware of this project when Louis Daniel sent me an e-mail a few days ago. (I was aware of the proposed testing, not your request for comments.) Upon my inquiry to the state of New Jersey, I found that many in that state opposed the same testing off their coast, including commercial fishermen and their organizations.

I certainly don't know enough about it, but cannot in the least concur with any effort to allow this testing to go on as scheduled. Commercial fishing is tough enough as it is and we certainly cannot risk any other obstacles for fishermen to make a living and providing food for consumers.

At the very least, one would expect a public meeting where the NSF can explain to the general public and the stakeholders about this proposal. However, that has not happened and most of us are in the dark about it.

Due to all the uncertainty about the project and how it would affect many aspects of our coastal life including but not limited to commercial and recreational fishing, the North Carolina Fisheries Association urges you to reject the NSF's consistency determination for this project.

Yours truly,

Jerry Schill, President
North Carolina Fisheries Association, Inc.
PO Box 335
Bayboro, NC 28515
Cell: (252) 361-3015
www.ncfish.org
jerryschill@ncfish.org

Walker, Michele

From: beach@mdurham.net
Sent: Tuesday, August 19, 2014 12:34 PM
To: Walker, Michele
Subject: Public Comment - No to seismic testing by NSF on Carolina Coast

Dear Ms. Walker,

I read with concern in the Star News that the National Science Foundation is requesting to conduct seismic testing next month on our coastline. As you are probably well aware, over 300 people came out in Kure Beach, NC several months ago to protest seismic testing for oil exploration. We were made aware of the dangers to our marine animals from the testing, regardless of its ultimate purpose. The whales and dolphins will be put at risk no matter who does this testing! I am amazed that a scientific foundation would request to violate the very laws of nature that cause such concern about our environment. Our ocean ecosystem is delicately balanced, and we do not need sonic booms adding to the many other disturbances that threaten that balance.

Please do not allow this testing to occur. We need to stand up against all types of seismic testing and threats to the coastal environment. One small step in this direction will only open the door to many more.

Thank you for your consideration.

Joanne and Mylie Durham
PO Box 452
Kure Beach, NC 28449

Walker, Michele

From: Judy Larrick <judylarrick@hotmail.com>
Sent: Tuesday, August 19, 2014 2:01 PM
To: Walker, Michele
Subject: NO TO SEISMIC TESTING

TO: Michele Walker, NC Division of Coastal Management

I read with horror today that the NC Division of Coastal Management is considering approval for a request by the National Science Foundation and Columbia University to conduct seismic testing off the coast of NC Sept 15 to Oct 22. This so-called Marine Geophysical Survey is another ploy by the Koch Brothers and financed by them to circumvent the seismic testing procedures for oil and gas exploration. I am also dismayed that the comment period ends Aug 22??? The public was given NO TIME to respond as well!

Sept and Oct are prime time for endangered sea turtle nest hatchings along the NC Coast, and thousands of hatchlings will be making their frenzied trek to the Gulf for survival. With only one in 1,000 survival rate today, this seismic testing is another nail in their coffin. Also, the Federal Government has designated the coast of North Carolina as a Critical Habitat for Sea Turtles and this certainly seems like a conflict of interest. It is also well documented that these seismic testing blasts will kill, maim and injure thousands of fish, dolphins, endangered whales, as well as sea turtles.

PLEASE, please, do not approve this testing. Do not allow "big Money" to destroy our natural resources and harm our wildlife and endangered sea turtles. As a child said in a public meeting on seismic testing in Kure Beach recently, "SOME THINGS JUST SHOULDN'T BE FOR SALE".

Judy F. Larrick
645 Settlers Lane
Kure Beach, NC 28449
910-458-3574

Walker, Michele

From: Govoni, Daniel
Sent: Friday, August 29, 2014 2:18 PM
To: 'Justin LeBlanc'
Cc: Walker, Michele
Subject: RE: Comments of Ocracoke Working Watermen's Association RE: Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off Cape Hatteras, September–October 2014

Dear Mr. LeBlanc,

Thank you for your email dated 8/29/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Justin LeBlanc [mailto:justin@capitolstrategies.com]
Sent: Friday, August 29, 2014 12:05 PM
To: Govoni, Daniel; Huggett, Doug; Daniel, Louis; hesmith@nsf.gov
Cc: laura.engleby@noaa.gov; beth.lowell@noaa.gov; rseagraves@mafmc.org; palmettobooks@bellsouth.net; mpaine@asmfc.org; dhiltoncfc@embarqmail.com; jerryschill@ncfish.org
Subject: Comments of Ocracoke Working Watermen's Association RE: Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off Cape Hatteras, September–October 2014

Dear Mrs. Govoni, Huggett, Daniel & Ms. Smith:

I am writing on behalf of the Ocracoke Working Watermen's Association (OWWA) to express our concern with the proposal of the National Science Foundation (NSF) 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 ~6600in^3 or 18 airguns with a total discharge volume of ~3300in^3 and could have an adverse impact on fisheries resources, protected species, and fishing operations.

As reported in the Draft Environmental Assessment for the proposal; "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."

As an industry severely regulated with regard to our interactions with these endangered species, we are greatly considered about the potential impacts of the seismic survey on their behaviors and movements. It is our understanding that acoustic impacts of the volume being proposed can cause confusion, disorientation, and panic among certain marine mammals. We are concerned that such impacts could result in increased interactions of such animals with lawfully placed and managed fishing gear. If such were to occur, we believe the interactions would be blamed on fishing activities instead of appropriately on the seismic survey. We have and continue to work very hard to minimize and mitigate any interactions of protected species with our fishing gear and do not want to be unfairly blamed for incidental takes for which the seismic survey is the real cause. We therefore request that, at a minimum, the seismic survey be scheduled for a time of year when fishing gear is not being actively worked in and around the proposed survey area.

We are also concerned that the seismic survey will change the behavior of our target species, including black drum, bluefish, flounder, and Spanish mackerel and could result in decreased landings or increased fishing effort to reach our catch limits. Furthermore, we understand that the survey could displace our fishing activities with its requirements for non-survey participants to remain a certain distance from the "blast zone". To address these potential impacts, we again request that the timing of the survey be changed.

While we would prefer that no seismic survey be conducted at all particularly if it leads to additional such surveys in search of oil and gas resources, we strongly urge the North Carolina Division of Marine Fisheries & Division of Coastal Management, the National Marine Fisheries Service, and the National Science Foundation ensure that impacts on fishery resources, protected species, and fishing operations be minimized the greatest extent possible.

Thank you for the opportunity to express these concerns.

Sincerely Yours,

Justin LeBlanc for the Ocracoke Working Watermen's Association
Senior Executive Consultant
202-213-4131
CAPITOL
STRATEGIES

From: Kathy <katatcb@yahoo.com>
Sent: Friday, August 22, 2014 12:13 PM
To: Walker, Michele
Subject: Seismic Testing

Dear Ms Walker,

Like many who live at the coast, I volunteer with the local sea turtle organization and am concerned about the use of seismic testing. The problem is compounded for endangered and threatened sea turtles if it is to be used during the nesting or hatching season. This includes the months of September and October.

From a 2012 study published by the BOEM...

"Leatherback hearing sensitivity overlaps with the frequencies and source levels produced by many anthropogenic sources, including seismic airgun arrays, drilling , low-frequency sonar, shipping, pile driving, and operating wind turbines, suggesting that leatherbacks are able to detect the sounds produced by these activities, and highlighting the need to investigate their potential physiological and behavioral impacts...

CONCLUSIONS & RECOMMENDATION

In this study, we made the first measurements of underwater and aerial hearing sensitivity of leatherback sea turtles. Leatherback sea turtle hatchlings are able to detect sounds underwater and in air, responding to stimuli between 50 and 1200 Hz in water and 50 and 1600 Hz in air with maximum sensitivity between 100 and 400 Hz in water (84 dB re: 1 μPa-rms at 300 Hz) and 50 and 400 Hz in air (62 dB re: 20 μPa-rms at 300 Hz). When the hearing sensitivity of leatherback sea turtles and are compared with the source level and frequency range many of the high intensity, low frequency marine anthropogenic sources of sound commonly considered when evaluating about effects of noise on marine life, it is clear that leatherbacks (and all other sea turtle species for which hearing has been tested) are able to detect many of these sources. Now that we have evidence that leatherback sea turtles can detect sources of low-frequency anthropogenic sound, we recommend future studies investigate the potential physiological (critical ratios and temporary and permanent threshold shifts) and behavioral effects of exposure to these sound sources."

http://www.cbd.int/doc/meetings/mar/mcbem-2014-01/other/mcbem-2014-01-submission-boem-05-en.pdf

Please do not allow this activity.
Thank you,
Kathy Martin

1603 South Lake Park Blvd. Apt 3
Carolina Beach, NC 28428
910-336-0246

Walker, Michele

From: Govoni, Daniel
Sent: Tuesday, September 02, 2014 10:02 AM
To: Walker, Michele
Subject: FW: 0648-XD394 Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina
Attachments: Seismic Testing .Letter to HARRISON.8.29.2014.pdf; Seismic Testing.Letter to DAVIS.8.29.2014.pdf

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

-----Original Message-----
From: Davis, Braxton C
Sent: Monday, September 01, 2014 9:49 AM
To: Govoni, Daniel
Subject: FW: 0648-XD394 Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina

****

Braxton Davis
Director, Division of Coastal Management NC Department of Environment and Natural Resources 400 Commerce Avenue Morehead City, NC 28557
(252) 808-2808 x202

____

From: Quidley, Mary [MARY@kdhnc.com]
Sent: Friday, August 29, 2014 5:52 PM
To: ITP.Cody@noaa.gov; Davis, Braxton C
Cc: Davies, Sheila F.; Debbie Diaz
Subject: 0648-XD394 Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina

Friday, August 29, 2014

Dear Ms. Harrison and Mr. Davis –

The attached comments related to the above-referenced project are submitted by the Town of Kill Devil Hills (NC). We anticipate adoption of a resolution, which will also express the Town's opposition, at the Board's September 8th meeting. In the event the resolution is adopted it will be forwarded to each of your offices with the respectful request that our comments be appended to include the resolution.

Original documents have been mailed to your respective offices.

Thank you.

On behalf of the Kill Devil Hills Board of Commissioners,

Mary E. Quidley
KDH Town Clerk
mary@kdhnc.com<mailto:mary@kdhnc.com>
252.449.5302

TOWN OF KILL DEVIL HILLS

Post Office Box 1719, 102 Town Hall Drive
Kill Devil Hills, North Carolina 27948
252-449-5300
www.kdhnc.com

August 29, 2014

Ms. Jolie Harrison
Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

RE: 0648-XD394, Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014

Dear Ms. Harrison:

On behalf of the Town of Kill Devil Hills Board of Commissioners, I am writing to comment on the application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation, for an Incidental Harassment Authorization to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the northwest Atlantic Ocean off the North Carolina coast from September through October, 2014. According to the NOAA July 31, 2014 notice, the seismic survey will take place in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles [mi]) off the coast of Cape Hatteras, North Carolina.

We were stunned and disappointed to hear about this application to use air guns to relentlessly blast the marine life off Dare County's coast in the name of science. With little public notice and a comment period only open until September 2, we consider ourselves lucky to know about this application at all. It appears to us that this application has been accelerated, without full disclosure to the public.

As a municipality located on a barrier island, we must be a good steward of our fragile and pristine environment. Whether it is monitoring Kill Devil Hills' water quality or protecting the turtles that nest on our

beautiful beach, we take great pride in doing everything we can to ensure that future generations will also be able to experience the magnificence of the Outer Banks.

Our area is home to many wildlife species, including the endangered right whale. Are these surveys so important that your organization is willing to ignore the major impacts to our ecosystem that will occur? Though the application states that the testing is not related to oil and natural gas exploration, we have a hard time believing that.

We strongly believe that more research should be completed to understand fully the impacts of seismic testing and how we can mitigate those impacts. Further information about the impacts of manmade sound on the underwater environment and its inhabitants and the nature and effects of seismic testing is needed before blasting should be conducted. How do we know if the impacts are immediate and dramatic or subtle and delayed?

We understand that alternative technologies to seismic airgun testing exist, which may be more costly, but less harmful to marine life. We would like to see these alternatives be given more consideration during the application process.

In closing, please deny this application. Seismic airgun testing causes catastrophic impacts to the marine ecosystem, including injury or death whales and dolphins. This, in turn, will set the stage for even more negative impacts to our area.

Thank you for your consideration.

Sincerely,

Sheila F. Davies

Sheila F. Davies
Mayor

cc: Dare County Board of Commissioners
Director, NC Department of Environment and Natural Resources, Division of Coastal Management
File

TOWN OF KILL DEVIL HILLS

Post Office Box 1719, 102 Town Hall Drive
Kill Devil Hills, North Carolina 27948
252-449-5300
www.kdhnc.com

August 29, 2014

Mr. Braxton Davis
Director
NC Department of Environment and Natural Resources
Division of Coastal Management
400 Commerce Avenue
Morehead City, NC 28557

RE: 0648-XD394, Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014

Dear Director Davis:

On behalf of the Town of Kill Devil Hills Board of Commissioners, I am writing to comment on the application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation, for an Incidental Harassment Authorization to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the northwest Atlantic Ocean off the North Carolina coast from September through October, 2014. According to the NOAA July 31, 2014 notice, the seismic survey will take place in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, North Carolina.

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beautiful beach, we take great pride in doing everything we can to ensure that future generations will also be able to experience the magnificence of the Outer Banks.

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We strongly believe that more research should be completed to understand fully the impacts of seismic testing and how we can mitigate those impacts. Further information about the impacts of manmade sound on the underwater environment and its inhabitants and the nature and effects of seismic testing is needed before blasting should be conducted. How do we know if the impacts are immediate and dramatic or subtle and delayed?

We understand that alternative technologies to seismic airgun testing exist, which may be more costly, but less harmful to marine life. We would like to see these alternatives be given more consideration during the application process.

In closing, please deny this application. Seismic airgun testing causes catastrophic impacts to the marine ecosystem, including injury or death whales and dolphins. This, in turn, will set the stage for even more negative impacts to our area.

Thank you for your consideration.

Sincerely,

Sheila F. Davies

Sheila F. Davies
Mayor

cc: Dare County local governments
Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service
File

Walker, Michele

From: Lacy Jenkins <lacyj@ec.rr.com>
Sent: Monday, August 18, 2014 3:10 PM
To: Walker, Michele
Subject: Seismic Testing

Hi Michele,

My husband and I are very much opposed to the seismic testing off the coast of NC. Our marine life is very precious to us and we do not need anything that would result in their leaving or avoiding the area. We already have enough interruption in the peaceful surroundings in this area with the training exercises aboard Camp Lejeune. Please do all in your power to avoid seismic testing in North Carolina coastal waters.

Thank you very much,

Lacy and Tom Jenkins
Swansboro, NC

Walker, Michele

From: Linda Cheshire <beachpropertync@gmail.com>
Sent: Wednesday, August 20, 2014 2:33 PM
To: Walker, Michele
Subject: National Science Foundation Seismic Testing

Hi Michele,
As a resident of Kure Beach and a real estate agent selling properties on this island anything that could disturb or damage our ocean resources and marine life is of great concern to me. Please do not let the National Science Foundation to this to our coast.
Sincerely,
Linda Cheshire

Linda Cheshire Broker, REALTOR
BLUE WATER REALTY
1000 S. Lake Park Blvd.
Carolina Beach, NC 28428
cell: 910-617-5945
office: 910-458-3001
fax: 910-458-3055

Click here to view Working With Real Estate Agents Brochure

Walker, Michele

From: lleblanc922 <lleblanc922@gmail.com>
Sent: Thursday, August 21, 2014 5:19 PM
To: Walker, Michele
Subject: Coastal seismic testing

This is absurd. We know so little about our oceans, but yet we are going to try to proceed with such abusive testing. Studies show these test have grave consequences on the ocean environments. No testing off of our coast or any other, due to lack of knowledge for consequential consequences to our oceans. No specific reasons show positive outcomes to such actions.

Luanne LeBlanc
nautwheeler34@yahoo.com

Sent from my Verizon Wireless 4G LTE smartphone

Walker, Michele

From: Govoni, Daniel
Sent: Tuesday, September 02, 2014 9:56 AM
To: 'Lynn bensy'
Cc: Walker, Michele
Subject: RE: Seismic testing

Dear Ms. Bensy,

Thank you for your email dated 8/30/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Lynn bensy [mailto:lynnbensy@gmail.com]
Sent: Saturday, August 30, 2014 10:18 AM
To: Govoni, Daniel
Subject: Seismic testing

NO seismic testing off our coast!

Lynn Bensy
Geeensboro, Nc

Please excuse any typos. This was sent from my iPad, and it has a mind of its own.

Walker, Michele

From: M Youngbluth <myoungbluth@hotmail.com>
Sent: Wednesday, August 20, 2014 8:58 PM
To: Walker, Michele
Subject: Seismic testing

Are we all going nuts? This state has such amazing features from mountains to sea...how are we willing to kill the whales, dolphins, sea turtles, etc. that the folks who live on the coast fight so hard to preserve? Please reconsider this terrible activity. There is no proof that it is not harmless to humans. We love our ocean!

M. Youngbluth
Kure Beach, NC

Sent from my iPad

Walker, Michele

From: Magen Eller <mageneller34@gmail.com>
Sent: Thursday, August 21, 2014 1:29 AM
To: Walker, Michele
Subject: Public Comments

Please reject the proposed seismic study off of the NC coast. Our wildlife and fisheries should be respected, especially during fishing season.

Now, Im not a scientist. I'm sure this proposed testing has some sort of deep and meaningful reason behind it. I'm just a simple mom, born and bred in NC, that loves our coast and the diversity of wild life. If the tests are unnecessary, and could harm or divert migrations, they should not be performed. Our economy has suffered enough without making it harder on those who earn their living on the coast, either with eco tourism or fishing.

Regards,
Magen Eller
2605 Deer Pl
Greensboro NC 27407

Walker, Michele

From: Mark Leblanc <bontonrouley@yahoo.com>
Sent: Wednesday, August 20, 2014 5:35 AM
To: Walker, Michele
Subject: Seismic Testing in My Back Yard

We respectfully ask that you not let Seismic Testing occur in our back yard. Is the Greed of a few so important that Marine Life has to Suffer. What have they done to you. Nothing! If this is allowed, what will our children see, the floating of dead carcasses on our beaches of once beautiful dolphins and whales. What will their children see when we kill everything that is harmless to us and beautiful to all. Nothing! But a polluted, Toxic, Dead Sea!! But you and who ever allows this to happen will have your money. We Beg Of You to Please Don't Let It Happen. Have we Humans not Destroyed enough of this Beautiful Planet we were made Stewards Of...

Thanks for Listening,
And Shame On You If Seismic Testing is Allowed off the North Carolina Coast.

Mark Le'Blanc
910-279-7474
mleblanc347@yahoo.com

Walker, Michele

From: Govoni, Daniel
Sent: Friday, September 05, 2014 10:28 AM
To: 'Meira Warshauer'
Cc: Walker, Michele
Subject: RE: comments re Lamont-Doherty application for airgun research of NC coast

Dear Ms. Warshauer,

Thank you for your email dated 9/4/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Meira Warshauer [mailto:meira.warshauer@gmail.com]
Sent: Thursday, September 04, 2014 9:35 PM
To: Govoni, Daniel
Subject: comments re Lamont-Doherty application for airgun research of NC coast

to: North Carolina Division of Coastal Management
re: Lamont Doherty proposal to conduct research using airguns off the coast of North Carolina

I request the request the Division of Coastal Management find this proposal inconsistent with coastal zone management for the region to be affected.

1. Cape Hatteras is home to an unusually large number of species of marine life, because of the convergence of currents from cold waters, the Labrador Current, and warms waters of the Gulf Stream, as well as the upwelling from deep canyons near the continental shelf. The airguns will disrupt their feeding patterns, communication channels, and in the case of certain cetaceans, their diving and breathing patterns as well. Carried out continuously over the span of 33 days, the airguns will cause long term disruption of survival activities for fish, turtles, and cetaceans.

2. Cetaceans are especially sensitive to sound stimuli. The pulses will invade their primary feeding area and cause significant harassment. It is being presented as though the noise will be a short-term inconvenience, but for many species of cetaceans, there is no research on how the noise will affect them. (Federal Register vol. 79, no. 147, p. 44558) Disruption of survival patterns can hardly be viewed as a mere inconvenience.

3. The Cape Hatteras area includes deep canyons where beaked whales may be diving. The noise can trigger a panic response causing them to surface too quickly, and suffer the bends, which can lead to fatality. While the Lamont Doherty claims to have a track record of no associated fatalities, we would not like Cape Hatteras to be the exception to that record.

The over 30 stranded mammals on Cape Hatteras from Naval sonar operation in 2005 is a troublesome precedent. While the Navy’s techniques may differ from the L.D. operation, the sensitivity of the cetacean population in the area remains a concern. The airguns will bring unnecessary stress to already declining populations of identified cetaceans in the area. Cuvier’s beaked whales, for example, have been sighted year round. Right whales were sighted as far south as Fort Fisher in early Novmeber, 2009.

(http://www.starnewsonline.com/article/20091112/articles/911129985?p=2&tc=pg)

Fin whales are also seen in the area, as are others.

4. The proposed mitigation of stopping the airguns if cetaceans are observed is inadequate, since the animals could be far from any visual sighting area, but still harmed by the airgun due to the greater range of sound in the acoustically efficient sea and canyons.

5. I don't see the urgent need to conduct this research with the current airgun technology, which will cause harm, to an unknown degree, to the marine life up and down this coast. I recommend postponing the research project in this sensitive and exceptional area until a completely safe technology is developed.

6. The NC coast relies on fishing and tourism as primary economic engines. This project threatens to harm both.

7. The hurricane season is becoming more active. Lamont Doherty wants to conduct the project during a period of historic storm activity. It is not an auspicious time for this. I would hate to see the project begin, and then have to be discontinued and restarted at a later time, thus causing even more harassment to the marine life in the area.

Sincerely,
Meira Warshauer
16 Palmetto Drive
Wrightsville Beach, NC 28480

(Mailing address below)

--
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Walker, Michele

From: Govoni, Daniel
Sent: Friday, September 05, 2014 11:48 AM
To: 'michael@kdhnc.com'
Cc: Davis, Braxton C; Walker, Michele
Subject: Federal Consistency Determination submitted by the National Science Foundation
Attachments: resolution (5).jpg; Attachment 1 Draft EA.pdf; CZMA Consistency Determination.pdf

Dear Commissioner Midgette,

Thank you for your email dated 9/4/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management (DCM) is coordinating a state review. Please see below clarification on the points requested:

#1 There are two separate tests currently requested - the first from NSF and the second from BOEM, is this correct? Are the two tests interrelated or are they independent from one another and being conducted for two separate purposes? If the study methods and the data collected are similar in nature, has the possibility been proposed for one joint seismic testing session rather than two separate sessions? Please clarify the purpose of the seismic tests requested, the proposed dates for the testing, and the areas that will be impacted as well as the extent of impact (fisheries closures?, etc.). The NSF and BOEM proposed geological and geophysical surveys via seismic testing are two separate studies and are independent of each other. The NSF proposes to fund several universities to conduct one seismic survey off the coast of North Carolina in order to analyze data along the mid-Atlantic coast of the East North American Margin to investigate how the continental crust stretched and separated during continental breakup. This activity is proposed to be conducted from September 15th to October 22 of 2014. BOEM is coordinating possible approvals for 9 applicants to conduct geological and geophysical exploration via seismic testing for possible offshore energy sources. DCM is not aware of when BOEM applicants propose to conduct these seismic surveys, the applicants are still in the preliminary stages of the permitting process. In summary, the NSF and BOEM seismic surveys will use similar technology, including the use of air guns, however the purpose and intent of the surveys differ. Both proposed surveys are located off the entire North Carolina coast. Please see attached draft EA and map (Figure 1) indicating the NSF proposed transects.

#2 It has been stated that the NC DMF requested the GPS coordinates of the seismic testing in order to perform their own observation of the study's impacts. Has the requested location information been provided to date? If so, please explain any plan currently in place for impact observation. DCM did receive the NSF proposed transects which can be viewed in the attached draft EA (see page 46 and 73). Regarding possible impact observation, DCM is still reviewing comments and coordinating within the Department of Environment and Natural Resources. DCM will have the final consistency determination concluded on 9/8/14 and you will be informed of this final decision.

#3 What are the environmental concerns related to seismic testing; has research been conducted that has substantiated or debunked the concerns? Please provide any specific case studies you may reference relating to marine life impacts from seismic testing. There has been several research papers published concerning this topic of which most have been cited in the NSF's draft EA, see attached (pages 78-98). Extensive compilations of research on impacts to marine life are also included in the NSF/USGS PEIS (http://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf) and the BOEM PEIS (http://www.boem.gov/Atlantic-G-G-PEIS/).

#4 How often are 250dB seismic tests performed off of the coast of the United States? Is this a relatively common practice, or would NC be something of an experiment in evaluating the impacts of the seismic testing at 250 dB? Seismic testing via air guns has been conducted in the past off the coast of the United States, however, DCM is unaware of the total number of seismic activities that have been conducted.

The Division appreciates your concerns on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
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-----Original Message-----
From: Midgette, Michael [mailto:michael@kdhnc.com]
Sent: Thursday, September 04, 2014 6:39 PM
To: Govoni, Daniel
Subject:

I am seeking information pertaining to a resolution that will be coming before the Kill Devil Hills Town Board on Monday, September 8, 2014. I am writing to ask that you review the attached resolution and provide any professional feedback that you have to offer relating to the resolution's content as well as review and provide clarification on the points below:

#1 There are two separate tests currently requested - the first from NSF and the second from BOEM, is this correct? Are the two tests interrelated or are they independent from one another and being conducted for two separate purposes? If the study methods and the data collected are similar in nature, has the possibility been proposed for one joint seismic testing session rather than two separate sessions? Please clarify the purpose of the seismic tests requested, the proposed dates for the testing, and the areas that will be impacted as well as the extent of impact (fisheries closures?, etc.).

#2 It has been stated that the NC DMF requested the GPS coordinates of the seismic testing in order to perform their own observation of the study's impacts. Has the requested location information been provided to date? If so, please explain any plan currently in place for impact observation.

#3 What are the environmental concerns related to seismic testing; has research been conducted that has substantiated or debunked the concerns? Please provide any specific case studies you may reference relating to marine life impacts from seismic testing.

#4 How often are 250dB seismic tests performed off of the coast of the United States? Is this a relatively common practice, or would NC be something of an experiment in evaluating the impacts of the seismic testing at 250 dB?

I appreciate your assistance in this matter,

Michael Midgette Town Commissioner Kill Devil Hills, North Carolina

Resolution No. 14-04-007
Town of Nags Head
Opposition to seismic testing
BOC Meeting April 2, 2014

A Resolution of the Board of Commissioners of the Town of Nags Head, North Carolina
Expressing opposition to seismic testing as proposed in the
Bureau of Ocean Energy Management (BOEM)
Programmatic Environmental Impact Statement (PEIS) - Option A and Option B

WHEREAS, seismic testing as proposed in the Bureau of Ocean Energy Management ("BOEM") Programmatic Environmental Impact Statement alternative A and alternative B has the potential to harm marine life; and

WHEREAS, seismic testing as proposed in BOEM Programmatic Environmental Impact Statement alternative A and alternative B has the potential to impact recreational and commercial fishing; and

WHEREAS, the Town of Nags Head is a municipality in Dare County where a major economic force is tourism related to the coastal environment; and

WHEREAS, the Town of Nags Head endeavors to be a good steward of the coastal environment and its resources; and

WHEREAS, the full impacts of seismic testing as proposed in BOEM Programmatic Environmental Impact Statement alternative A and alternative B are not yet fully understood by scientists, the Oil & Gas industry, or BOEM, and

WHEREAS, the Town of Nags Head believes that more research should be done to fully understand all impacts of seismic testing and options for mitigation those impacts; and

WHEREAS, the Town of Nags Head does not believe seismic testing as currently proposed in alternative A or alternative B of BOEM's Programmatic Environmental Impact Statement is the safest way to map oil & gas deposits in the mid-Atlantic region.

NOW, THEREFORE, BE IT RESOLVED, the Board of Commissioners of the Town of Nags Head, North Carolina, is opposed to seismic testing as proposed in in alternative A or alternative B of BOEM's Programmatic Environmental Impact Statement until such time as all testing options are evaluated and proper assurances for the protection of marine life are established.

This resolution adopted the 2nd of April 2014.

Robert C. Edwards, Mayor
Town of Nags Head

ATTEST

Carolyn F. Morris, Town Clerk

Walker, Michele

From: Govoni, Daniel
Sent: Tuesday, September 02, 2014 9:55 AM
To: 'Nichole Midgett'
Cc: Walker, Michele
Subject: RE: NO SEISMIC TESTING!

Dear Mr. Midgett,

Thank you for your email dated 8/29/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
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From: Nichole Midgett [mailto:pipsypeach@hotmail.com]
Sent: Friday, August 29, 2014 4:59 PM
To: Govoni, Daniel
Subject: NO SEISMIC TESTING!

I am writing in response to the proposed seismic testing the state is proposing to do off the coast of North Carolina this Fall. PLEASE DO NOT DO THIS TESTING! We need to be investing in renewable resources!!!! NOT OIL AND NATURAL GAS!!!!!!!!!!!! Please do all you can to deter the government from doing this testing!!! There is no telling what irreparable damages will be done.

Walker, Michele

From: Gray, Alex <AGray@oceana.org>
Sent: Friday, August 22, 2014 4:01 PM
To: Walker, Michele
Subject: Comments submitted by Oceana on behalf of citizens concerned about proposed seismic blasting
Attachments: Comments on proposed seismic blasting collected by Oceana - 20140822.csv; Oceana_NC NSF Study Fall 2014_Draft-Comment.pdf

Good afternoon Ms. Walker,

I would like to submit comments collected by Oceana concerning the National Science Foundation's request to use seismic airguns to study the Atlantic Ridge off the North Carolina coast this September through October.

I have attached these comments and the submitting persons' information as an Excel document. I have also attached the initial draft letter, which many of these persons used to guide the writing of their comments.

Thank you for your time,

Alex Gray | Digital Campaigner
____

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Dear N.C. Division of Coastal Management Director Braxton Davis and Public Information Officer Michele Walker:

I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to study the Atlantic Ridge off the coast of Cape Hatteras this fall. Although we believe that scientific research is incredibly important to understand the world we live in, the timing of this could hardly be worse for those fisherman and other businesses that depend on fall fishing.

Seismic airguns have been shown to decrease catch rates for certain fisheries, and at short distances can kill fish eggs and larvae. There has been little time to review this proposal and little scientific research on the effects of seismic airguns blasting on fish populations.

Moreover, "Fall Fishing" is a critical period for fisherman and fisheries because it is the same time many important species are highly active, including spotted sea trout, flounder, striped bass, king mackerel and spot. Commercial and recreational fishing are far too important to our state's economy and way of life to be put at risk.

Please consider our deep concern over seismic airgun blasting during the time period of the proposed study.

Sincerely,

SIGNER

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erb11light@yahoo.com	Ellen	Boyd	90 Welder'sLn.	Sylva	NC	28779
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Gallegoskaren@comcast.net	Karen	Gallegos	795 Crown Point circle	Corolla	NC	27927
obxnc3@gmail.com	Sarah	Midgett-Balaba	3114 S Memorial Ave	Nags Head	NC	27959
Hazel@Poolos.com	Hazel	Poolos	42717 Caudle Rd	Richfield	NC	28137
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gama49@embarqmail.com	Gary	McClure	PO Box 1029	Rutherford College	NC	28671
Lwilwerth60@hotmail.com	Maria	da Cunha	1470 NE 123 Street Apt 5(	North Miami	FL	33161
heynpc@yahoo.com	Pia	Heyn	1101 A Kensington Place	Asheville!	NC	28803
twohorsesforlinda@yahoo.com	Linda	Lentz	2839 owens community r(	vernon	FL	32462
bbrossman1@juno.com	charles	Brossman	205 crestline blvd	Greenville	NC	27834
darbydolittle6@hotmail.com	DARLENE	FALK	118 #2 Paul Carlton Rd.	Blowing Rock	NC	28605
janaobx@gmail.com	Jana	Murray	P.O. Box 261	Rodanthe	NC	27968
misswindy@aol.com	Windy	Champlin	PO Box 6	Nags Head	NC	27959
tctcme@gmail.com	Tania	Corbi	185 Sound View Drive	Wilmington	NC	28409
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jodie@joelambjr.com	Jodie	Herman	P.O. Box 1030	Kitty Hawk	NC	27949
btemp09@yahoo.com	Brooke	Templeton	631 Gannet Court	Corolla	NC	27927
teresa.clontz@yahoo.com	Ron & Teresa	Clontz	806 Cape Fear Blvd	Carolina Beach	NC	28428
edtupps@gmail.com	Edward	Tupper	310 W. Lookout Rd.	Nags Head	NC	27959
peaches@owensrestaurant.com	Peaches	Woodard	109 Bradford Lane	Manteo	NC	27954
angelbye1@yahoo.com	Susanne	Smith	208 w carolinian ct	nags head	NC	27959
dougturner1@verizon.net	Doug	Turner	16301 Midlothian Turnpik	Midlothian	VA	23113
haljerjen@aol.com	Ann	Cardew	2141 Maizefield Ln	Fuquay-Varina	NC	27526
info@wonriverkeeper.org	Douglas	Toltzman	120 Oak St	Hubert	NC	28539
Chaseascari@gmail.com	Chase	Ascari	510 St. Albans way	Richmond	VA	23229
shasha8676@hotmail.com	Shannon	Fussell	609 Carolina Sands Drive	Carolina Beach	NC	28428
roy.edlund@gmail.com	Roy	Edlund	PO Box 7232	Kill Devil Hills	NC	27948
webbdnc@aol.com	Charles	Webb	201 NC-54	Carrboro	NC	27510
bsbergst@gmail.com	Brittney	Bergstrom	6312 oakbrook cir	raleigh	NC	27609
bartonpmurray@gmail.com	Bart	Murray	PO Box 261	Rodanthe	NC	27968
hutchisongail61@gmail.com	Gail	Hutchison	6113	Manns Harbor	NC	27953
scottmbowl@yahoo.com	Scott	Bowling	220 Finley Forest Dr.	Chapel Hill	NC	27517
olv415@aol.com	Della	Oliver		Charlotte	NC	28269
beaverfalls1@yahoo.com	Lucy	Tyndall	3977 Flannery Ln	High Point	NC	27265
Scneas@aol.com	Kristen		Pond road	Wanchese	NC	27981
donhutson@yahoo.com	Don	Hutson	Sunrise Vw	Kitty Hawk	NC	27949
ptubilleja@gmail.com	Patrick	Tubilleja	4700 Winterlochen Rd	Raleigh	NC	27603
ppavlak001@gmail.com	Patrick	Pavlak		greensboro	NC	27455
obxhoney@aol.com	Michele	Desgain	1700 Seminole Street	Kill Devil Hill	NC	27948

marx_scott@msn.com	Christopher	Marx	7A OCEANIC ST	Wrightsville Beach	NC	28480
pixel_grrl@yahoo.com	Laura	Mitchell	2124 Rozzelles Ferry Rd	Charlotte	NC	28208
dinocolao@yahoo.com	Dino	Colao	1521 N. Croatan Hwy.	Kill Devil Hills	NC	27948
kchdavidson@gmail.com	Kym	Davidson	3 COLONIAL DR	wilmington	NC	28403
translatrice@gmail.com	Maria	Espina		Durham	NC	27701
rachael.hyde@gmail.com	Rachael	Hyde		Manteo	NC	27954
pntbtrandjelli@gmail.com	Angelica	Regueiro		Charlotte	NC	28214
amyhuggins@mac.com	Amy	Gaw	PO Box 1890	Kitty Hawk	NC	27949

Country	Phone	Comment
United States	8.29E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-967-56	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-493-77	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919 481671	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919.358.75	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-395-42	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-864-42	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.05E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704-299-19	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-488-44	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704-555-81	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	3.37E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	7.05E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.05E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(704) 814-8	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	3.37E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828 724 42	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919 244-46	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(231) 352-5	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	614-205-64	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	2.53E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919/424-61	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-489-49	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	980-333-45	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	252 269 92	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-484-92	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-419-16	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	704-367-00	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704-453-64	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	4.08E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	919-966-10	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	(910) 333-8	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.29E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	252.444.99	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	3.37E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.04E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States	704-588-49	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	919.807.13	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-328-09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	312-343-05	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-789-90	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	5.41E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	919-932-74	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	252-489-93	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	704-536-43	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	910-713-82	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	617-283-47	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	602 881 81	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	7.05E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	336-201-41	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.05E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.28E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	5.7E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-255-77	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704-545-65	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.04E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(828) 712-7	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-528-73	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336-491-16	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	910-458-35	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.1E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	800-533-20	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910 845 22	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States	(919) 389-6	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.05E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(704) 207-7	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704 633 30	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	9.11E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.04E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336-548-56	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336 259 60	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(336) 847-8	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	910-238-42	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	856-889-29	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	805 481 02	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.19E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns AT
United States	(910) 799-9	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.28E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910 619-31	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.29E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-891-25	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704 757 23	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336-578-30	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	252-491-84	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.05E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	252-753-63	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.28E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-795-38	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.1E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-942-49	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-475-63	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.19E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(919) 414-6	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(203) 273-2	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-803-73	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	2.53E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-216-07	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-791-45	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336-595-51	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.1E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-640-09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-402-94	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	202-486-64	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919 834-39	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	2.53E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-858-06	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-998-33	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(336)-407-8	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-238-09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	252-335-75	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-665-92	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-457-55	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	305-271-08	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(417) 722-9	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	3.37E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-8818-6	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	252-975-59	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	910-762-62	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	915-526-81	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-968-04	Seismic airguns are NOT a good idea! No, no,no.
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704 553845	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-844-76	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.28E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	916-834-05	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United Kingdom		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336-323-11	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.28E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

France		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
Ukraine		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	2.81E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.11E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.19E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-885-26	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(336) 561-3	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(336)29296	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.19E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	3.37E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336 629-22	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-554-98	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(910) 962-3	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919 460-97	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.28E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am extremely disturbed by the National Science Foundation's proposal to use seismic airguns to study the
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336-655-60	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704-202-60	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336---270+	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	336-333-38	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.29E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.17E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-968-42	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704-753-51	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-622-84	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828-664-01	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-682-56	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-416-98	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	1.34E+10	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-619-15	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	7.04E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919 835-47	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(828) 357-8	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	704-236-04	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(910) 262-2	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919-553-41	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	(828) 648-3	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	8.29E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	704-274-58	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(910) 352-9	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	919 942328	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	843-424-35	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to

United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		No to the National Science Foundation's proposal to use seismic airguns to study the Atlantic Ridge off the
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	9.2E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	336-686-25	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(919) 596-9	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	(910) 616-6	Did you know the diversity of marine mammal species alone that visit the region to feed? 15 different
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	828 280-77	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	226-632-06	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	407-637-54	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		As homeowners on Ocracoke island we are EXTREMELY concerned about the National Science
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United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
United States	772 971-92	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	(919) 612-8	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	919-471-27	As a resident of North Carolina, I am EXTREMELY UPSET about the National Science Foundation's proposal
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	828-230-17	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States		I believe we should tolerate no further harm to marine mammals and other ocean inhabitants. I support
United States		I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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United States	7.18E+09	I am EXTREMELY concerned about the National Science Foundation's proposal to use seismic airguns to
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Walker, Michele

From: John, Trish, Jenna, Dain and Rebekah <TNIELSEN1@ec.rr.com>
Sent: Saturday, August 23, 2014 11:15 AM
To: Walker, Michele
Subject: No to seismic testing

Seismic testing is the equivalent of having no Noise limits set for music bands in public spaces. Actually it is worse- as you know this has great potential to gravely hurt much marine life!!!
Please act in a way that is consistent with your position- Protect the ocean- thus protecting humans from ourselves!
Thank You;
Patricia Nielsen
Family Nurse Practitioner- BC
Internal Medicine and OB/GYN
Home address
614 Robert E Lee Drive
Wilmington, NC 28412
home phone
910-793-9777

Walker, Michele

From: NC Wreckdiving <admin@nc-wreckdiving.com>
Sent: Thursday, August 28, 2014 8:18 AM
To: Walker, Michele
Cc: Bobby Edwards; Dave /Ann Sommers; BFDC BFDC
Subject: Comment on Draft Environmental Analysis L-DEO Geophysical Survey off of Cape Hatteras

Comment on Draft Environmental Analysis L-DEO Geophysical Survey off of Cape Hatteras September 2014:

Based on the track data in Figure 6 and and wreck sites listed in Table 8, the conclusion stated on page 70 section 5 of the draft EA is grossly incorrect:

"Only a small percentage of the recreational dive sites (wrecks in water depths <100 m) are within 25 km of the survey track lines."

In fact the survey track will cover the vast majority of the dive sites actually dived or visited on a given day off the Cape Hatteras and Cape Lookout regions of the NC coast. When these regions are analyzed separately, which they should be diving purposes due to the distances between them, the mistake is even more profound.

The wrecks listed within the Cape Lookout portion of the track are among the most frequent destinations for dive charters off that portion of the coast: U352, Aeolus, Schurz, Papoose, Spar, Indra, Suloide, Parker, Box wreck. These represent the destination of an estimated 80-90% of the dive charters out of the Morehead City area.

The wrecks listed off the Cape Hatteras portion of the track would exclude all wrecks on the Diamond Shoals region which are also very popular dive destinations. These include the British Splendour, Australia, Kassandra, Lancing, Empire Gem, etc. Given the location of the Splendour, these would almost also have to include the Proteus, Tarpon and Manuela, although those are not named on Table 8. This would represent an estimated 70 to 80% of the actual destinations of dive charters out of Cape Hatteras.

If prohibited from diving these destinations, the economic impact, both direct to the local area dive charter fleet and dive shops and indirect to the related tourism industry, would be significant and could reach the level of millions of dollars lost over the course of the scheduled surveys.

Thank you

Paul Hudy

www.nc-wreckdiving.com

Walker, Michele

From: Paulette Playce <pplayce@aol.com>
Sent: Thursday, August 21, 2014 11:11 AM
To: Walker, Michele
Subject: SEISMIC TESTING

MS. Walker

Please let our governor and legislature know that I AM OPPOSED TO SEISMIC TESTING. As a recent transplant to this beautiful state, I wish it to remain as wild, pure and beautiful as possible . The NC Coast is a treasure to protect for all of us now, and for the future generations. I live on Pleasure Island, which is heavily dependent on tourism related to the coastal life. One spill could destroy not only the sea life, but also many jobs.

I would rather pay more at the pump, than lose my homeland forever……

Thank you for your attention

“"Change is the law of life. And those who look only to the past or present are certain to miss the future."

- John F. Kennedy

Paulette Playce
314-406-4248

Walker, Michele

From: Govoni, Daniel
Sent: Monday, August 25, 2014 9:17 AM
To: 'Charles H Peterson'
Cc: Walker, Michele
Subject: RE: CRFL & BOEM site information -- for NSF study conflict resolution

Dear Charles H. Peterson,

Thank you for your email dated 8/25/14 with attachments concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Charles H Peterson [mailto:cpeters@email.unc.edu]
Sent: Monday, August 25, 2014 9:09 AM
To: Govoni, Daniel
Cc: Avery Paxton; Davis, Braxton C
Subject: Fwd: CRFL & BOEM site information -- for NSF study conflict resolution

Dear Mr. Govoni:

I am contacting you in your role with NC DCM as a permit reviewer in the matter of an NSF research project to be conducted during Sept and Oct 2014 in waters of Onslow and Raleigh Bay not far off the coast of North Carolina. Only last week were we made aware of this project. We extend a strong objection to this study on the grounds that it interferes directly with our (UNC IMS and NC DMF) ability to carry out research funded by the NC CRFL funds. We are supported to study the reef systems and the processes affecting dynamics of reef fishes in state and federal waters off Onslow Bay. We are evaluating how the reef habitat, especially epibiotic communities but also the degree of sedimentation, vary among natural, artificial, and wreck reefs seasonally as a function of location, depth, reef structure, and physical forcing. Sept and Oct are the most critical months for our dive-based research and we use virtually every day calm enough to dive safely in those two months. Exclusion from our research sites by the Columbia-based and NSF-funded study is incompatible with our need to fulfill the research contractual obligations.

Hence, we strongly oppose this NSF project - on grounds of inconsistency with the Coastal Area Management Act as it fosters state-funded research and study in state and federal waters of these key Essential Fish Habitats. We also challenge the legal right of another funded project to drive us off a dive site at which we are operating. Any prior notice supposedly given by posting on a federal NSF web site is totally inadequate and inconsistent with State of North Carolina commitments to public notice for any proposed substantive disruption to existing uses on our waters and the seafloor below them. We also object to this NSF project on behalf of the dive industry, the commercial fishing industry, and the recreational fishing industry of North Carolina. These two months are perhaps the most important months of the year for these existing uses.

We appreciate the opportunity to make our comments to you.

Sincerely,

Charles H. "Pete" Peterson
Alumni Distinguished Professor
Marine Sciences, Biology, and Ecology
University of North Carolina at Chapel Hill

Addendum

Please find attached names, coordinates, and maps of our survey sites for the CRFL and BOEM research. Only the CRFL sites are affected by the proposed NSF geophysical surveys. The BOEM sites are outside of the 25km range.

The NSF draft EA explicitly identifies the following CRFL sites as within 25km of their proposed transects (Table 8, page 57 of NSF document):

- Titan Tug (AR-345)
- Indra Shipwreck
- Theodore Parker Shipwreck
- SCGC Spar (AR-305) Shipwreck

However, they failed to mention all the other artificial reefs that don't contain shipwrecks (e.g., our sites that contain concrete pipes and/or bridge rubble). Additionally, they didn't include any natural hard-bottom sites.

Likely, all 16 of our CRFL-supported research sites are affected. However, 3 sites (Keypost Rock, Station Rock, and Pipes 2007, may lie a bit outside of the 25km range (it's difficult to tell from their low resolution map (fig 6, p. 56 that has dive sites plotted with the proposed survey tracts). If this is the case, only 13 sites would be inaccessible. Either way, it is seriously in conflict with our state-funded research.

Walker, Michele

From: Govoni, Daniel
Sent: Monday, August 18, 2014 9:15 AM
To: 'Richard LaPalme'
Cc: Walker, Michele
Subject: RE: NSF Draft EA for Seismic Testing

Dear Mr. LaPalme:

Thank you for your email dated 8/15/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. I can assure you that your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

-----Original Message-----
From: Richard LaPalme [mailto:rlapalme@ec.rr.com]
Sent: Friday, August 15, 2014 9:43 PM
To: Govoni, Daniel
Subject: NSF Draft EA for Seismic Testing

Dear Mr. Govoni:

The Draft Environmental Assessment for a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocan off Cape Hatteras, September-October 2014 contains no cost-benefit analysis and no objective, scientifically based deterministic assessment of the level of damage and the number of marine organisms by damage level.

The Draft EA contains only subjective conclusions based upon the authors supposition of minimal to no lasting effects. Extensive scientific data is presented to discuss the mechanisms for damage to marine life, yet no actual assessment is performed with this data. The authors repeatedly state that they do not expect any serious, lasting harm to marine life. The authors do not actually provide verifiable evidence to substantiate there claims.

Based upon the lack of credible benefit to the citizens of North Carolina and to the communities of the Atlantic East Coast from the proposed seismic testing I must request that you object to the Consistency Determination in this case. I ask that you seek further details of the cost to the marine ecosystem resulting from this testing and a verifiable assessment of the associated benefits to the citizens of North Carolina.

Respectfully,
Richard LaPalme
USCG Master Mariner

Walker, Michele

From: Rick Allen - Nautilus Productions HD <nautilusvideo@earthlink.net>
Sent: Thursday, August 28, 2014 9:26 AM
To: Walker, Michele
Subject: Comment on Draft Environmental Analysis L-DEO Geophysical Survey off of Cape Hatteras September 2014:

Dear Ms. Walker,

I am writing in opposition to the proposed Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast from Sept. 15 to Oct. 22. I have two main concerns: A) Damage/adverse effects to marine mammals & fish in the survey area. B) Negative economic impact to coastal businesses.

A. While more study is needed the deleterious effects of seismic testing to marine mammals and auditory damage to fish specious are demonstrable. A study of beaked whales determined;
(1) gas-bubble disease induced in supersaturated tissue by a behavioural response to acoustic exposure, is a plausible pathologic mechanism for the morbidity and mortality seen in cetaceans associated with sonar exposure and merits further investigation; and (2) current monitoring and mitigation methods for beaked whales are ineffective for detecting these animals and protecting them from adverse sound exposure. In addition, four major research priorities, needed to address information gaps on the impacts of sound on beaked whales, are identified: (1) controlled exposure experiments to assess beaked whale responses to known sound stimuli; (2) investigation of physiology, anatomy, pathobiology and behaviour of beaked whales; (3) assessment of baseline diving behaviour and physiology of beaked whales; and (4) a retrospective review of beaked whale strandings.
(*http://scholar.google.com/scholar_url?hl=en&q=http://www.dtic.mil/cgi-bin/GetTRDoc%3FAD%3DADA593622&sa=X&scisig=AAGBfm1e3Ccl4yB5xhQ83pELrToLzSfGHQ&oi=scholarr*). Using this study as a basis it is incredibly easy to correlate similar damage to other marine mammals. Further a study entitled "High intensity anthropogenic sound damages fish ears" (*http://scitation.aip.org/content/asa/journal/jasa/113/1/10.1121/1.1527962*) determined that "the ears of fish exposed to an operating air-gun sustained extensive damage to their sensory epithelia that was apparent as ablated hair cells. The damage was regionally severe, with no evidence of repair or replacement of damaged sensory cells up to 58 days after air-gun exposure." How does this benefit an incredibly important fishery?

B. Based on the track data in Figure 6 and and wreck sites listed in Table 8, the conclusion stated on page 70 section 5 of the draft EA is grossly incorrect:

"Only a small percentage of the recreational dive sites (wrecks in water depths <100 m) are within 25 km of the survey track lines."

In fact the survey track will cover the vast majority of the dive sites actually dived or visited on a given day off the Cape Hatteras and Cape Lookout regions of the NC coast. When these regions are analyzed separately, which they should be due to the distances between them, the mistake is even more profound.

The wrecks listed within the Cape Lookout portion of the track are among the most frequent destinations for dive charters off that portion of the coast: U352, Aeolus, Schurz, Papoose, Spar, Indra, Suloide, Parker, Box wreck. These represent the destination of an estimated 80-90% of the dive charters out of the Morehead City area.

The wrecks listed off the Cape Hatteras portion of the track would exclude all wrecks on the Diamond Shoals region which are also very popular dive destinations. These include the British Splendour, Australia, Kassandra, Lancing, Empire Gem, etc. Given the location of the Splendour, these would almost also have to include the Proteus, Tarpon and Manuela, although those are not named on Table 8. This would represent an estimated 70 to 80% of the actual destinations of dive charters out of Cape Hatteras.

If prohibited from diving these destinations, the economic impact, both direct to the local area dive charter fleet and dive shops and indirect to the related tourism industry, would be significant and could reach the level of millions of dollars lost over the course of the scheduled surveys. (Paul Hudy, *http://www.nc-wreckdiving.com/*)

I hope you will consider the negative environmental & economic impacts of the survey in your assessment of the project.

Sincerely,
Rick Allen

--
Rick Allen
Nautilus Productions LLC
P.O. Box 53269
Fayetteville, NC 28305

910-826-9961 Office
910-624-7488 Mobile

nautilusvideo@earthlink.net
www.nautilusproductions.com

Nautilus Productions is the exclusive licensor of footage from Blackbeard the Pirate's flagship – the Queen Anne's Revenge. The Nautilus Productions staff has been the official video crew for the study and recovery of the infamous pirate Blackbeard's ship since the project's inception.

Walker, Michele

From: Skillman, Roger <RogerSkillman@anderson5.net>
Sent: Thursday, September 04, 2014 10:23 PM
To: Walker, Michele
Subject: Seismic Testing Project Questions

Michele,

If the seismic testing project offshore proceeds as planned for September/October 2014, will there be compensation for lost business and crew pay during this period?

I work for a scuba diving charter boat, and we have numerous charters scheduled for this time frame.

Thanks,
Roger Skillman

Walker, Michele

From: Sara Smith <sara.ml.smith@gmail.com>
Sent: Tuesday, August 19, 2014 5:22 PM
To: Walker, Michele
Subject: Seismic Testing off of the NC Coast

I am opposed to the seismic testing in the Atlantic Ocean. Input was requested; please stop before it starts.

Sara Smith
665 Settlers Lane
Kure Beach, NC

Sent from my iPhone

Walker, Michele

From: scott.hughes18@frontier.com
Sent: Wednesday, August 20, 2014 10:22 PM
To: Walker, Michele
Subject: subj: Comments on article in Star news 08/19 Ref: NC Seismic tests this fall-NSF request

Michele, just saw 08/19 article in Star News article on NC Seismic tests this fall. Just want to make several points on the NSF request to dfo seismic testing off the Carolina coast from Sept 15 to Oct 22:

Point 1. NSF Timing. NSF request coming on heels of US Government ok'ing seismic tests for private companies doing profile for potential oil deposits. Coincidental?? Yeah, Right.

Point 2. Purpose. Proposed NSF activities are unrelated to activities for energy resources. However, survey is very similar in methodology and location/timing. Coincidental? Yeah, Right.

Point 3. Injurious Impacts. NSF says that injurious impacts to marine mammals, sea turtles, seabirds have not been proven to occur near seismic airgun arrays. What size rocks have the NSF official's heads been under?? NSF's own EA says that 'potential impacts of their survey on the environment would primarily be a result of the operation of the airgun array. The result would be increased underwater moise, which could result in avoidance behavior by marine mammals,sea turtles, and seabirds/fish. Is NSF for REAL??

Point 4. Mitigation Efforts. As I understand it, the only mitigation efforts NSF is contemplating is to have someone look out for whales, dolphins, and other fish "on the surface'. If they spot something on the surface, they will then do their mitigation plan. Forget the thousands of fish and other ocean life under water. Just react if they see ocean life on the surface. Again, how big is the rock that NSF has its collective heads under??

I love NC. I am a native north carolinean. I live at Topsail Island. I love the beach areas-- and I am alarmed at the NSF's request to do their seismic testing-which to me, is the beginning of utter deteriation of our beaches and waters. Their profiling, baselining, whatever you want to call it- is the beginning of destruction of our beaches and oceans as we know them. All for money in some way....
Thank you
Henry S (Scott) Hughes Topsail Beach, NC

Walker, Michele

From: Govoni, Daniel
Sent: Monday, August 18, 2014 2:55 PM
To: 'Simon Campbell'
Cc: Walker, Michele
Subject: RE: Proposed seismic testing off the NC coast Sept-Oct

Dear Mr. Campbell,

Thank you for your email dated 8/18/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: Simon Campbell [mailto:simonmufc@gmail.com]
Sent: Monday, August 18, 2014 1:31 PM
To: Govoni, Daniel
Subject: Proposed seismic testing off the NC coast Sept-Oct

Daniel,
I would like to lodge my opposition to the proposed seismic testing that may occur between mid-September and mid-October. I do not think there has been sufficient time for full public review and comment regarding the merits of the study versus the impact to marine wildlife and economic activity. The proposal does not provide details regarding why the research vessel can only be in NC waters between September and October. The proposal seems like an added on activity just because of expedient timing for the people submitting the proposal. Specifically, the notice also has not been sufficient for SCUBA divers to plan appropriately for trips.

The economic disruption to the diver operators and other businesses will be severe as many divers plan trips months in advance.

I know of 5 divers that are planning to visit from Britain to dive the coast during the proposed period. If the proposed activity proceeds they will take their business to another state. Please contact if you have any questions or would like further comment.

Thank you for your attention.

Simon Campbell
Garner, NC
919-609-5696

Walker, Michele

From: Sophina <willthechange@hotmail.com>
Sent: Tuesday, August 19, 2014 4:54 PM
To: Walker, Michele
Subject: This is not what we want!

1. I vote!
2. Seismic testing from September 15 – October 22 off the North Carolina coast, for research purposes???
3. NOT COOL with this voter!!!!!
4. Sea item # 1. please

Have a super day,
Sophina White

Walker, Michele

From: Govoni, Daniel
Sent: Friday, September 05, 2014 10:34 AM
To: 'stanbozarth@gmail.com'
Cc: Walker, Michele
Subject: RE: Seismic Testing - Outer Banks

Dear Mr. Bozarth,

Thank you for your email dated 8/28/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

-------- Original Message --------
Subject: Seismic Testing - Outer Banks
From: Stan Bozarth <stanbozarth@gmail.com>
To: "Davis, Braxton C" <Braxton.Davis@NCDENR.Gov>
CC:

Dear Sir,
I cannot find any indication as to where I might make a formal comment on the proposed subject testing, so I am directing my comment to you in hopes it will be forwarded to the appropriate party.

I believe the proposed seismic testing is too intense and too prolonged. It will, if past experience counts for anything, likely result in extreme negative consequences to marine mammals and other vital parts of the important Outer Banks ecosystem.

I am hopeful the NC Coastal Commission will oppose this activity, or at least demand that it be conducted over a much longer period of time. I realize those doing the testing would oppose such demands because it would be more "economical" to do otherwise. Economics should not be the ruling measure of how such activity is to be conducted.

Thank you,
Stan Bozarth
Wilmington, NC 28411
Sent from my iPad

Walker, Michele

From: Govoni, Daniel
Sent: Monday, August 18, 2014 10:00 AM
To: 'terry@discoverydiving.com'
Cc: Walker, Michele
Subject: RE: NSF survey

Dear Terry Leonard,

Thank you for your email dated 8/18/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: terry@discoverydiving.com [mailto:terry@discoverydiving.com]
Sent: Monday, August 18, 2014 9:58 AM
To: Govoni, Daniel
Cc: terry@discoverydiving.com
Subject: NSF survey

Sir

I operate a dive charter vessel out of Beaufort, NC. I have looked at this proposed survey in regards to its impact on my business and am against it during this time frame . Sept and Oct are the last two months of the dive season in NC. Myself and the other dive operators have numerous trips scheduled during this time period. These trips are generally not able to be rescheduled and are the last income of the year for most of the boats .

Thanks

Terry Leonard
Owner Outrageous V
414 Orange Street
Beaufort,NC 28516

Walker, Michele

From: Govoni, Daniel
Sent: Tuesday, September 02, 2014 9:56 AM
To: 'TKERNHICKORY@aol.com'
Cc: Walker, Michele
Subject: RE: Offshore Seismic Testing

Dear Mr. Kern,

Thank you for your email dated 8/30/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: TKERNHICKORY@aol.com [mailto:TKERNHICKORY@aol.com]
Sent: Saturday, August 30, 2014 12:47 AM
To: Govoni, Daniel
Subject: Offshore Seismic Testing

Mr Govoni:

I am asking that you not issue the permits or allow the Seismic Testing of the shore of NC. No one understand the effects of Marine Life such as dolphins and whales that already under extreme environmental pressure and this could damage their ability to hear which they rely on for survival. What has been said this could do nothing to this marine life up to death .....kind of a large spread there. This was expressed by NC DMF Director Louis Daniel. The will also close commerical fishing during the fall run for 37 days. Their are too many unknow factors to allow a Federal enitity to conduct and experimental method of data off our coast. The lack of real notice and information to possible bad effects to the public is alarming. Lets all just look a little deeper into this. The lack of transparency really is apparent.

Repectfully,

Thomas S. Kern III

1650 20th Ave Ct NE
Hickory NC 28601

828-312-1127

President of Catawba Valley Tea Party.

Walker, Michele

From: Govoni, Daniel
Sent: Monday, August 18, 2014 9:43 AM
To: 'LINDA HARTLE'
Cc: Walker, Michele
Subject: RE: Opposed to Seismic Ocean Survey off NC Coast

Dear Ms. Hartle,

Thank you for your email dated 8/17/14 concerning the Federal Consistency Determination submitted by the National Science Foundation proposing to conduct a Marine Geophysical Survey via seismic testing in the Atlantic Ocean off of the North Carolina coast. As you may be aware, the Division of Coastal Management is coordinating a state review. Your comments will be examined and taken into consideration prior to the Division making a final Consistency Determination, you will be informed of this final decision.

The Division appreciates you taking the time to comment on this proposal, and your email will be added to the official file. Please feel free to contact me at (252) 808-2808 (ext. 215), if you should have any additional questions or concerns relating to this proposal.

Sincerely,
Daniel Govoni

Daniel M. Govoni
Asst. Major Permits Coordinator
NC Division of Coastal Management
400 Commerce Ave.
Morehead City, NC 28557

(252) 808-2808
(252) 247-3330 fax
daniel.govoni@ncdenr.gov

From: LINDA HARTLE [mailto:avatar3@yadtel.net]
Sent: Sunday, August 17, 2014 9:25 PM
To: Govoni, Daniel
Subject: Opposed to Seismic Ocean Survey off NC Coast

I was born and raised in NC and my wife has lived here with me for over 30 years. During that time we have not only enjoyed the nature and wildlife of our coast but are also frequent SCUBA divers and think that the proposed Seismic Survey will be both detrimental to our coastal economic development and devastating to marine life.

You obviously have not had the chance to enjoy our coast as we have if you support this measure.

--

Tony and Linda Hartle

Walker, Michele

From: Tonya Byrum <tonyalbyrum@gmail.com>
Sent: Monday, August 25, 2014 11:49 AM
To: Walker, Michele
Subject: Seismic tests

Anything that negatively effects our local community and our fishermen on the outer banks, is not o.k. with me.
This is my comment: NO!
Tonya L. Byrum
Nags Head, N.C.
Beach Waves Too
Salon By The Sea

Robert C. Edwards
Mayor

Susie Walters
Mayor Pro Tem

Cliff Ogburn
Town Manager

Town of Nags Head

Post Office Box 99
Nags Head, North Carolina 27959
Telephone 252-441-5508
Fax 252-441-0776
www.nagsheadnc.gov

M. Renée Cahoon
Commissioner

John Ratzenberger
Commissioner

Marvin Demers
Commissioner

August 19, 2014

Mr. Braxton Davis
Director
NC Department of Environment and Natural Resources
Division of Coastal Management
400 Commerce Ave.
Morehead City, 28557

RE: 0648-XD394, Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Northwest Atlantic Ocean Offshore North Carolina, September to October 2014

Dear Braxton:

On behalf of Nags Head's Board of Commissioners, I am writing to comment on the application from the Lamont-Doherty Earth Observatory (Lamont-Doherty) in collaboration with the National Science Foundation (Foundation), for an Incidental Harassment Authorization (Authorization) to take marine mammals, by harassment incidental to conducting a marine geophysical (seismic) survey in the northwest Atlantic Ocean off the North Carolina coast from September through October, 2014. According to the NOAA July 31, 2014 notice, the seismic survey will take place in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast of Cape Hatteras, North Carolina.

We were stunned and disappointed to hear about this application to use air guns to relentlessly blast the marine life off Dare County's coast in the name of science. With little public notice and a comment period only open until September 2, we consider ourselves lucky to know about this application at all. It appears to us that this application has been accelerated, without full disclosure to the public.

As a municipality located on a barrier island, we must be a good steward of our fragile and pristine environment. Whether it is monitoring Nags Head's water quality or protecting the turtles that nest on our beautiful beach, we take great pride in doing everything we can to ensure that future generations will also be able to experience the magnificence of the Outer Banks.

Our area is home to many wildlife species, including the endangered right whale. Are these surveys so important that the government is willing to ignore the major impacts to our ecosystem that will occur? Though the application states that the testing is not related to oil and natural gas exploration, we have a hard time believing that.

As you can see by the resolution our Board adopted April 2, 2014, we strongly believe that more research should be completed to fully understand the impacts of seismic testing and how we can mitigate those impacts. Further information about the impacts of manmade sound on the underwater environment and its inhabitants and the nature and effects of seismic testing is needed before blasting should be conducted. How do we know if the impacts are immediate and dramatic or subtle and delayed?

We understand that alternative technologies to seismic airgun testing exist, which may be more costly, but less harmful to marine life. We would like to see these alternatives be given more consideration during the application process.

In closing, we have asked Jolie Harrision at the National Marine Fisheries Service to deny this application. Seismic airgun testing causes catastrophic impacts to the marine ecosystem, including injury or death whales and dolphins. This, in turn, will set the stage for even more negative impacts to our area.

Sincerely,

Bob Edwards

Robert C. Edwards
Mayor

Enclosure

RCE/rlt

Walker, Michele

From: Victoria Driscoll <vmdriscoll@gmail.com>
Sent: Tuesday, August 19, 2014 2:07 PM
To: Walker, Michele
Subject: Seismic testing on eastern Atlantic coastal water

Please do not do this testing. there is so much evidence that it harms marine life to do this testing in the ocean please do not do this. I am an active volunteer with sea turtle project in the Fort Fisher aquarium in coastal North Carolina.
Please Do not do this seismic testing September 2014 or ever.

Sincerely
Victoria Driscoll
MBA accounting

Walker, Michele

From: McLellan, William <mclellanw@uncw.edu>
Sent: Tuesday, August 19, 2014 2:17 PM
To: Walker, Michele
Cc: McLellan, William; Pabst, D. Ann
Subject: Comments on Seismic Testing off the Outer Banks of North Carolina in Sept and Oct, 2014
Attachments: William McLellan NCDENR Comments on Seismic Testing off the Outer Banks of North Carolina.pdf

<u>Comments on Seismic Testing off the Outer Banks of North Carolina in Sept and Oct, 2014: 0648-XD394</u>

William McLellan
Biology and Marine Biology
UNC Wilmington
601 South College Road
Wilmington, NC 28403

This proposal to conduct seismic surveys off the Outer Banks of North Carolina greatly concerns me for two reasons.

The first concern is with the use of full scale industrial seismic exploration vessels in the exact habitat that we have found high beaked whale abundances. For the past three years, a joint program with Duke University and UNC Wilmington has been conducting monthly aerial surveys for seasonal distribution and vessel operations focused on tagging and identification of marine mammals. The aerial surveys track from the coastal shelf east over the first and second shelf breaks to pelagic waters. Sightings data have been uploaded to OBIS SEAMAP, presented at annual Navy meetings with NOAA staff present, and recently been forwarded to senior NOAA research staff from the NE Science Center. The proposed tracklines for seismic testing track directly over the highest density of beaked whale sightings, but the proposal barely mentions the potential for beaked whale interactions. In essence, beaked whales will be present within the seismic testing area for the entire sampling period. In my opinion, standard operating procedures to shut down seismic activity when marine mammals are sighted are not effective when mitigating interactions specifically with beaked whales. Beaked whale dive times have now been extended to over two hours for Cuvier's beaked whales (*Ziphius cavirostris*) (Schorr et al. 2014). Our Lab recently published myoglobin data for cetaceans collected from strandings from the exact locations associated with these seismic surveys. One of animals presented in the recent publication (Velten et. at 2013) was an adult female True's beaked whale (*Mesoplodon mirus*) testing out with the highest level of myoglobin EVER measured in a mammal. This extreme level of myoglobin implies this animal could dive on a breath hold for extended periods of time. The combined dive time lengths and potential for extended breath hold diving violate the ability for vessel based observers to shut down seismic operations based on visual sightings of animals surfacing near the operations vessel.

If seismic operations are not able to alter their testing as beaked whales are encountered in real time there is a likelihood that those beaked whales will be directly affected by the seismic energy inputs into the surrounding ocean. While the proposal states there will be little effect on local marine mammals, there have been many publications that link anthropogenic sound sources, both commercial and military, with morbidity and mortality of cetaceans, especially beaked whales. The location of beaked whales continuously in the same space and time as the proposed seismic surveys suggests there could be negative interactions between these two. As the Marine Mammal Stranding Coordinator for the State of North Carolina I am extremely troubled by the use of seismic testing off the coast of North Carolina and the possibility of cetacean strandings. We are still responding to the largest Unusual Mortality Event ever investigated on the east coast, which has involved over 1400 bottlenose dolphins (*Tursiops truncatus*) and nearly 300 in North Carolina. The North Carolina stranding network received NO Prescott stranding grant support in 2013. Yet, this seismic activity could increase beaked whales and other cetacean strandings that are known to inhabit these waters. Strandings of these species require vastly more time, effort and resources than is exerted for response to the more common bottlenose and other dolphins species. Beaked whales require a team to commit 2-3 days of stranding response, diagnostic testing and necropsy effort for each individual animal. I have personally spent one week per each beaked whale stranding that has occurred in the state over the past 3-4 years. Short-finned pilot whales (*Globicephala macrorhynchus*) also overlap the geographic region of the proposed seismic tests. In 2005, a mass stranding of 35 short-finned pilot whales occurred along the coast near the site of the proposed seismic tests. This mass stranding event was investigated by NOAA as it occurred coincident with Navy sonar exercises. NOAA's report (Hohn et al. 2006) stated that it could not be determined whether there was or was not a causal link between the exposure to anthropogenic sound source and the stranding event. It is frankly unacceptable that this seismic activity will be conducted with no plan to investigate strandings and no additional support provided to the state stranding network. Funded science cannot simply push responsible oversight off to unfunded scientists!

The second concern is simply the compressed timing for this public comment period. The proposal states seismic activity will begin off Cape Hatteras in the middle of September, 2014. The current comment period ends on Sept 2, 2014 which leaves less than two weeks to compile and act on suggestions proposed during the comment period. The proposed seismic activities should be postponed until all comments are received and acted upon. If that does not take place it brings in to question the validity of the entire comment process.

<u>Literature Cited</u>

Hohn, A. A., Rotstein, D. S., Harms, C. A., and Southall, B. L. (2006). Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whales (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005. NOAA Technical Memorandum NMFS-SEFSC-537

Schorr, G.S., Falcone, E.A., Moretti, D.J., and R.D. Andrews. 2014. First long-term behavioral records from Cuvier's beaked whales (*Ziphius cavirostris*) reveal record-breaking dives. PLOS One 9(3)e92633.

Velten, B.P., Dillaman, R. M., Kinsey, S. T., McLellan, W. A. and D. A. Pabst. 2013. Novel locomotor muscle design in extreme deep-diving whales. Journal of Experimental Biology. 216:1862-1871.

Comments on Seismic Testing off the Outer Banks of North Carolina in Sept and Oct, 2014: 0648-XD394

William McLellan
Biology and Marine Biology
UNC Wilmington
601 South College Road
Wilmington, NC 28403

This proposal to conduct seismic surveys off the Outer Banks of North Carolina greatly concerns me for two reasons.

The first concern is with the use of full scale industrial seismic exploration vessels in the exact habitat that we have found high beaked whale abundances. For the past three years, a joint program with Duke University and UNC Wilmington has been conducting monthly aerial surveys for seasonal distribution and vessel operations focused on tagging and identification of marine mammals. The aerial surveys track from the coastal shelf east over the first and second shelf breaks to pelagic waters. Sightings data have been uploaded to OBIS SEAMAP, presented at annual Navy meetings with NOAA staff present, and recently been forwarded to senior NOAA research staff from the NE Science Center. The proposed tracklines for seismic testing track directly over the highest density of beaked whale sightings, but the proposal barely mentions the potential for beaked whale interactions. In essence, beaked whales will be present within the seismic testing area for the entire sampling period. In my opinion, standard operating procedures to shut down seismic activity when marine mammals are sighted are not effective when mitigating interactions specifically with beaked whales. Beaked whale dive times have now been extended to over two hours for Cuvier's beaked whales (*Ziphius cavirostris*) (Schorr *et al.* 2014). Our Lab recently published myoglobin data for cetaceans collected from strandings from the exact locations associated with these seismic surveys. One of animals presented in the recent publication (Velten *et. at* 2013) was an adult female True's beaked whale (*Mesoplodon mirus*) testing out with the highest level of myoglobin EVER measured in a mammal. This extreme level of myoglobin implies this animal could dive on a breath hold for extended periods of time. The combined dive time lengths and potential for extended breath hold diving violate the ability for vessel based observers to shut down seismic operations based on visual sightings of animals surfacing near the operations vessel.

If seismic operations are not able to alter their testing as beaked whales are encountered in real time there is a likelihood that those beaked whales will be directly affected by the seismic energy inputs into the surrounding ocean. While the proposal states there will be little effect on local marine mammals, there have been many publications that link anthropogenic sound sources, both commercial and military, with morbidity and mortality of cetaceans, especially beaked whales. The location of beaked whales continuously in the same space and time as the proposed seismic surveys suggests there could be negative interactions between these two. As the Marine Mammal Stranding Coordinator for the State of North Carolina I am extremely troubled by the use of seismic testing off the coast of North Carolina and the possibility of cetacean strandings. We are still responding to the largest Unusual Mortality Event ever investigated on the east coast, which has involved over 1400 bottlenose dolphins (*Tursiops truncatus*) and nearly 300 in North Carolina. The North Carolina stranding network received NO Prescott stranding grant support in 2013. Yet, this seismic activity could increase beaked whales and other cetacean strandings that are known to inhabit these waters. Strandings of these species require vastly more time, effort and resources than is exerted for response to the more common bottlenose and other dolphins species. Beaked whales require a team to commit 2-3 days of stranding response, diagnostic testing and necropsy effort for each individual animal. I have personally spent one week per each beaked whale stranding that has occurred in the state over the past 3-4 years. Short-finned pilot whales (*Globicephala macrorhynchus*) also overlap the geographic region of the proposed seismic tests. In 2005, a mass stranding of 35 short-finned pilot whales occurred along the coast near the site of the proposed seismic tests. This mass stranding event was investigated by NOAA as it occurred coincident with Navy sonar exercises. NOAA's report (Hohn *et al.* 2006) stated that it could not be determined whether there was or was not a causal link between the exposure to anthropogenic sound source and the stranding event. It is frankly unacceptable that this seismic activity will be conducted with no plan to investigate strandings and no additional support provided to the state stranding network. Funded science cannot simply push responsible oversight off to unfunded scientists!

The second concern is simply the compressed timing for this public comment period. The proposal states seismic activity will begin off Cape Hatteras in the middle of September, 2014. The current comment period ends on Sept 2, 2014 which leaves less than two weeks to compile and act on suggestions proposed during the comment period. The proposed seismic activities should be postponed until all comments are received and acted upon. If that does not take place it brings in to question the validity of the entire comment process.

<u>Literature Cited</u>

Hohn, A. A., Rotstein, D. S., Harms, C. A., and Southall, B. L. (2006). Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whales (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005. NOAA Technical Memorandum NMFS-SEFSC-537

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NORTH CAROLINA WATERMEN UNITED

Protecting Your Freedom To Fish

www.ncwu.net

DCM Director Braxton Davis
400 Commerce Avenue
Morehead City NC 28557

August 27, 2014

Dear Director Davis,

In regard to the seismic testing by the Marine Geophysical Survey, the North Carolina Watermen United (NCWU) does not agree to any testing that will in any way cause a disturbance to our marine life, or the ways, means or times in which we work in various fisheries. Many of our fisheries are already greatly affected now because of the possibility of interacting with marine life, e.g., the Loggerhead sea turtle. We cannot agree to any testing that has such a high probability of potential harm.

We are especially opposed to the use of "sonic booms," which has proven in the past to cause avoidance, stunning and even FishKill for marine animals. We would like to request further research on the impacts of manmade sound on the underwater environment. We also understand that alternative technologies exist and hope they will be considered for the survey.

We are also concerned about the timing of the testing since it is currently scheduled to occur in productive fishing areas at a time when fishing is still going on. The winter months, December – February, would not cause nearly as many inconveniences - many changes in days or places for recreational, charter/headboat and commercial trips.

Yours truly,

Britton Shackelford

Britton Shackelford
President, NCWU
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252-473-8078

Table 1. List of annual coastal fishing tournaments off the coast of North Carolina and their homeport locations. Nearshore < 20 nm from shore and offshore > 20 nm from shore.

Month	Tournament	Location
April	Masonboro Sportfishing Tournament *Wrightsville Beach, NC*	Offshore
May	Reelin' for Research *Morehead City, NC*	Offshore
	Far Out Shoot Out *Ocean Isle Beach, NC*	Offshore
	Hatteras Village Offshore Open *Hatteras Village, NC*	Offshore
	Swansboro Rotary 2014 Memorial Day Blue Water Fishing Tournament Swansboro, NC	Offshore
	Cape Fear Blue Marlin Tournament *Wrightsville Beach, NC*	Offshore
	JWR Gaffer Dolphin Tournament *Morehead City, NC*	Offshore
	Boy Scout Gulf Stream Open *Wrightsville Beach, NC*	Offshore
June	Big rock Blue Marlin Tournament *Morehead City, NC*	Offshore
	Jolly Mon King Classic *Ocean Isle Beach, NC*	Nearshore/ Offshore
	Hatteras Marlin Club Blue Marlin Release Tournament *Hatteras Village, NC*	Offshore
July	Hatteras Grand Slam *Hatteras Village, NC*	Offshore
	The East Coast Got-Em-On Classic *Carolina Beach, NC*	Nearshore/ Offshore
	Barta Boys and Girls Club Billfish Tournament *Beaufort, NC*	Offshore
	Dare County Boatbuilders Tournament *Manteo, NC*	Offshore
	Ducks Unlimited "Band the Billfish" Tournament *Morehead City, NC*	Offshore
	CCCF Spanish Mackerel Challenge *Beaufort, NC*	Nearshore/ Offshore
	Raleigh Saltwater Sportfishing Club King Mackerel Tournament *Morehead City, NC*	Nearshore/ Offshore
	S.H.A.R.E. King Mackerel Tournament *Wrightsville Beach, NC*	Nearshore/ Offshore
	Capt. Eddy Haneman Sailfish Tournament *Wrightsville Beach, NC*	Offshore
August	Onslow Bay Open King Mackerel Tournament *Morehead City, NC*	Nearshore/ Offshore

	Pirate's Cove Billfish Tournament *Manteo, NC*	Offshore
	Rotary Club of Sneads Ferry King Mackerel Tournament *Sneads Ferry, NC*	Nearshore/ Offshore
September	Atlantic Beach King Mackerel Tournament *Atlantic Beach, NC*	Nearshore/ Offshore
	New Bridge Bank Wild King Classic *Wrightsville Beach, NC*	Nearshore/ Offshore
	King of the Cape Open King Mackerel Tournament *Beaufort, NC*	Nearshore/ Offshore
	Oregon Inlet Billfish Roundup *Manteo, NC*	Offshore
October	Brown Bag Wahoo Tournament *Morehead City, NC*	Offshore
	US Open King Mackerel Tournament *South Port, NC*	Nearshore/ Offshore
	Fall Brawl King Classic *Ocean Isle Beach, NC*	Nearshore/ Offshore
	Swansboro Rotary King Mackerel Tournament *Swansboro, NC*	Nearshore/ Offshore
	NC Troopers Association Offshore – Inshore Saltwater Challenge *Morehead City, NC*	Nearshore/ Offshore
	Martini's Fall Hook-A-Hoo Rodeo *Wrightsville Beach, NC*	Offshore
November	Cape Hatteras Anglers Club Team and Open Individual Invitational Tournament *Buxton, NC*	Nearshore

NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

June 18, 2014

Doug Huggett
Federal Consistency Coordinator
NC Division of Coastal Management
400 Commerce Avenue
Morehead City, NC 28557-3421

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

Dear Mr. Huggett:

NSF is considering support of a collaborative research project proposed to be conducted during the period September-October 2014 that would include a marine geophysical survey in the Atlantic Ocean off of Cape Hatteras and associated land-based activities in North Carolina and Virginia. The proposed seismic survey would be funded entirely by the National Science Foundation (NSF) and led by Drs. H. van Avendonk (University of Texas at Austin), M. Nedimovic (Dalhousie University); M. Long (Yale University); B. Dugan (Rice University); M. Hornback and B. Magnani (Southern Methodist University); P. Witta (The College of New Jersey); S. Harder (University of Texas at El Paso); D. Lizarralde (Woods Hole Oceanographic Institution); and D. Shillington, A. Becel, and J. Gaherty (L-DEO). The collaborative research efforts would collect and analyze data along the mid-Atlantic coast of the East North American Margin (ENAM) 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 proposed seismic survey would be conducted on the NSF-owned research vessel (R/V) *Marcus G. Langseth* (R/V *Langseth*), which is operated by Columbia University's Lamont-Doherty Earth Observatory (LDEO). The proposed activities are not related to energy resources or facilities, including oil and gas exploration, development, production, or lease sales, and therefore are not subject to Bureau of Ocean Energy Management regulatory jurisdiction pursuant to the Outer Continental Shelf Lands Act. The proposed activities are also not related to ocean mining.

Attached please find the NSF Consistency Determination for the proposed seismic survey. This determination is based on review of the proposed activities conformance with North Carolina's coastal program policies, which are primarily found in Chapter 7 of Title 15A of North Carolina's Administrative Code. Details of the determination are provided through submission of a Draft Environmental Assessment prepared pursuant to the National Environmental Policy Act of 1969, as amended, for the proposed activities (Attachment 1). The NC State Historic Preservation Office (SHPO) HPOWEB GIS service was used to evaluate whether there would be any historic resources within the area of proposed land shot sites (Attachment 2). The proposed activity is consistent (to the maximum extent practicable) with the enforceable policies of North Carolina's Coastal Management Program.

Pursuant to CFR 930.41, the North Carolina Coastal Management Program has 60 days from the receipt of this letter in which to concur with or object to this Consistency Determination, or to request an extension under 15 CFR Section 930.41(b). The NSF would be appreciative, however, if the North Carolina Coastal Management Program could inform us of their perspective on the consistency determination at their earliest possible convenience within this time period. The State's concurrence will be presumed if the States response is not received by the NSF on the 60th day from receipt of this Determination.

Should you have any questions about the information provided, please feel free to contact me at hesmith@nsf.gov or (703) 292-7713.

Sincerely,

Holly Smith

Holly Smith
Environmental Compliance Officer

Attachment 1: Draft Environmental Assessment for a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras

Attachment 2: Active Land Shot Sites - Historic Resources

NSF COASTAL ZONE MANAGEMENT ACT (CZMA)

CONSISTENCY DETERMINATION

This document provides the North Carolina (NC) Coastal Management Program (CMP) with the National Science Foundation's (NSF) Consistency Determination under CZMA Section 15 CFR Part 930, subpart C for a collaborative research project entitled, "Collaborative Research: A community seismic experiment targeting the pre-, syn-, and post-rift evolution of the Mid Atlantic US margin." The collaborative research proposal has been reviewed under the NSF merit review process and identified as an NSF program priority to meet NSF's critical need to foster a better understanding of Earth processes. The information in this Consistency Determination is provided pursuant to 15 CFR Part 930.39.

The collaborative research activities are proposed to be conducted during the period September - October 2014 and would include a marine geophysical survey in the Atlantic Ocean off Cape Hatteras and associated land-based activity in NC and Virginia. The proposed activities would be funded entirely by the National Science Foundation (NSF) and led by Drs. H. van Avendonk (University of Texas at Austin), M. Nedimovic (Dalhousie University); M. Long (Yale University); B. Dugan (Rice University); M. Hornback and B. Magnani (Southern Methodist University); P. Witta (The College of New Jersey); S. Harder (University of Texas at El Paso); D. Lizarralde (Woods Hole Oceanographic Institution); and D. Shillington, A. Becel, and J. Gaherty (L-DEO).

Pursuant to the National Environmental Policy Act, as amended, NSF has prepared a Draft Environmental Assessment (Draft EA) to evaluate the potential impacts on the human and natural environment associated with the proposed activities, including to endangered and threatened species listed under the Endangered Species Act. The Draft EA, entitled, "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", was prepared on our behalf by LGL Limited environmental research associates (LGL) (Attachment 1). The Draft EA tiers to a 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 (NSF/USGS PEIS) (Attachment 1, page 1). The conclusions from the Draft EA will be used to inform the Division of Ocean Sciences (OCE) management of potential environmental impacts of the proposed activities. OCE's review of the Draft EA concurs with the report's findings that implementation of the proposed activities would not have a significant impact on the environment. OCE will continue to review information between now and the time of the issuance of the Final EA and if any contrary conclusion is reached during this timeframe regarding environmental impacts, I will immediately notify you of such a conclusion.

The proposed marine seismic survey would take place within the Exclusive Economic Zones of the U.S. and outside of NC state waters. The proposed seismic survey would be conducted on the NSF-owned research vessel *Marcus G. Langseth* (R/V *Langseth*), which is operated by Columbia University's Lamont-Doherty Earth Observatory (LDEO). The proposed activities are not related to oil and gas exploration, development, production, or lease sales, and therefore are not subject to Bureau of Ocean Energy Management regulatory jurisdiction pursuant to the Outer Continental Shelf Lands Act (OCSLA).

The purpose of the proposed collaborative research activities 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 PIs 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.

Marine Activity

The proposed survey area is located between approximately (~) 32–37°N and ~71.5–77°W in the Atlantic Ocean ~6–430 km off the coast of Cape Hatteras (Attachment 1, Figure 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. Proposed activities would avoid the North Atlantic right whale migration period.

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; LDEO's operation of the *Langseth* is funded by NSF through a cooperative agreement entered into in 2012. The proposed energy source was considered by the PIs during planning efforts and tailored to use the least amount of energy to meet the research goals for this particular survey site. The *Langseth* would deploy an array of 36 airguns in 4 strings as an energy source with a total volume of ~6600 in^3 or an array of 18 airguns in 2 strings with a total discharge volume of ~3300 in^3. The airgun arrays are described in § 2.2.3.1 of the NSF/USGS 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 seismics and ~22 s (50 m) during MCS seismics. The receiving system would consist of an 8-km hydrophone streamer or 94 ocean bottom seis-mometers (OBSs) (for a description of OBSs, see Attachment 1, page 5). 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 (Attachment 1, Figure 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 (Attachment 1, page 64), 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.

Standard monitoring and mitigation measures would be implemented during the survey, including use of Protected Species Visual Observers, Passive Acoustic Monitoring, exclusion zones calculated for both source levels and tow depths, speed or course alterations, power or shut downs, and ramp-up procedures (Attachment 1, page 14).

Land-based Activity

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. The two land-based transects are between ~34.5–37°N and ~76–79.5°W (Attachment 1, Figure 1). 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. This work would involve drilling 20 cm diameter, 25 m deep holes. The drill rig would be a 30-tonne, tandem-axle truck ~10.5 m 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 as 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 (Attachment 1, § 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.

Consultations

NSF has initiated consultations with the National Marine Fisheries Service and U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act, and the ship operator of the R/V *Langseth* is seeking an Incidental Harassment Authorization under the Marine Mammal Protection Act (MMPA) for the survey. NSF will also consult on Essential Fish Habitat pursuant to the Magnuson Stevens Act. The proposed activities are not related to oil and gas exploration, development, production, or lease sales, and therefore are not subject to Bureau of Ocean Energy Management regulatory jurisdiction pursuant to the Outer Continental Shelf Lands Act.

Potential Effects to North Carolina Coastal Resources

During preparation of the Draft EA and in accordance with the Coastal Zone Management Act (CZMA) (16 USC §1451, *et seq*.), NSF considered whether the proposed activity would have any effect on coastal uses or resources of the state of North Carolina. Potential impacts of the seismic survey on the environment, if any, would be primarily a result of the operation of the airgun array. The increased underwater noise may result in avoidance behavior by marine mammals, sea turtles, seabirds, and fish, and other forms of disturbance. 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 anticipated on individual marine mammals, sea turtles, seabirds, fish, the populations to which they belong, or their habitats as a result of this proposed action. Mitigation measures proposed in the Draft EA for the survey would reduce potential risks to marine species (Attachment 1, pages 7-15). The marine seismic survey, which would be conducted outside of state waters, would not preclude fisheries from operating within or around the survey area. A safe distance, however, would need to be kept between the R/V Langseth and other vessels to avoid entanglement with the towed seismic equipment, and a chase boat would also be employed to assist the Langseth by identifying, location, and/or removing obstacles as required (Attachment 1, page 69). LDEO would use vessel based radio broadcasts to issue Notice to Mariners to alert mariners, including fishermen and scuba divers, of survey activities. During the proposed seismic survey, only a small fraction of the survey area would be ensonified at any given time (Attachment 1, page 70). Disturbance to fish species would be short-term, and fish would return to their pre-disturbance behavior once the seismic activity ceased (Attachment 1, page 70). Given the proposed activities, including the short duration of the survey, temporary nature of potential impacts to marine species, and distance from the survey to the coastal zone, impacts on marine species within state waters are possible but would not be anticipated to be significant. Access to North Carolina beaches and fisheries in state waters would not be impeded by the marine- or land-based proposed activities. The proposed marine geophysical survey would not interfere with commercial or recreational fisheries activities.

No significant impacts on dive sites, including shipwrecks, would be anticipated. Airgun sounds would have no effects on solid structures, and the R/V *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. (Attachment 1, page 70)

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. Further, although a space-use conflict could exist with divers at sites near the survey vessel, given the proposed survey time and short duration of time that the survey vessel would be in water depths <100m this would not be a significant conflict. (Attachment 1, page 70)

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. (Attachment 1, page 70)

No activities would occur in any protected lands, preserves, sanctuaries, or Critical Habitat for ESA-listed species. All required stated, county and local permits and licenses required for the activities would be obtained by the PIs. Many of the ESA-listed species that were identified using the USFWS's Information, Planning, and Conservation System (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 Attachment 1, § 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. (Attachment 1, page 70)

Coastal Management Program Objectives and Policies

Projects within Areas of Environmental concern

It is not anticipated that land based activities would be located within any Area of Environmental Concern (AEC). The marine based activities would occur entirely outside of any AEC, as the survey would take place outside of state waters. The project is consistent with North Carolina's coastal program policies and objectives regarding AECs as outlined below.

Pursuant to 15A NCAC 07H .0205, management objectives have been established for conservation of coastal wetlands for the purpose of preserving and perpetuating their biological, social, economic and aesthetic values. To fulfill these objectives uses which are not water dependent are not allowed in coastal wetlands pursuant to 15A NCAC 07H .0208(a)(1). The proposed land and marine based activities would not take place in any wetlands (coastal or noncoastal) nor would the activities have any impacts on wetlands; therefore, the proposed activities are consistent with the management objectives of 15A NCAC 07H .0205.

Pursuant to 15A NCAC 07H .0206, management objectives have been established for conservation of estuarine waters for the purpose of preserving and perpetuating their biological, social, economic and aesthetic values. To fulfill these objectives uses which are not water dependent are not allowed in estuarine waters pursuant to 15A NCAC 07H .0208(a)(1). The proposed land- and marine- based activities are not located within estuarine waters and impacts to estuarine waters from the proposed land based activities would not be anticipated; therefore the proposed activities are consistent with the management objectives of 15A NCAC 07H .0206.

Pursuant to 15A NCAC 07H .0207, management objectives have been established for development of public trust areas for the purpose of protecting public rights for navigation and recreation, and management of public trust areas for the purpose of saving and perpetuating their biological, economic and aesthetic values. To fulfill these objectives uses which are not water dependent are not allowed in public trust areas pursuant to 15A NCAC 07H .0208(a)(1). The proposed land and marine based activities would be conducted outside of public trust areas. Therefore, the proposed activities are consistent with management objectives of 15A NCAC 07H .0207.

Pursuant to 15A NCAC 07H .0209, management objectives have been established to ensure that shoreline development is compatible with the dynamic nature of the shoreline, and North Carolina's objectives for conserving and managing the important natural features of the estuarine and ocean systems. Proposed land and marine based activities would not involve development of the shoreline. Land-based activities would take place ~1 km from the nearest shoreline, (Attachment 1, Figure 1) and due to the nature of the activities would avoid any Outstanding Resource Waters (Attachment 1, pages 5-7). Furthermore, based on analysis contained in the Draft EA (Attachment 1, § III and IV), alteration of coastal wetlands, degradation of submerged aquatic vegetation or shellfish beds, or irreversible damage to historic resources were not identified as potential impacts of the proposed activities. Therefore, the proposed activities are consistent with the management objectives of 15A NCAC 07H .0209.

Pursuant to 15A NCAC 07H .0303, management objectives have been established to ensure that development in ocean hazard areas is compatible with the goals of eliminating unreasonable danger to life while achieving a balance between the financial, safety, and social factors involved in development of these areas. Ocean hazard areas include ocean erodible areas, where there exists a substantial possibility of excessive erosion and significant shoreline fluctuation; high hazard flood areas; inlet hazard areas; and unvegetated beach areas. The proposed activities are not located within any ocean hazard areas as defined at 15A NCAC 07H .034 (Attachment 1, Figure 1); therefore, no further analysis is required regarding the proposed project's consistency with the objective of 15A NCAC 07H .0303.

Pursuant to 15A NCAC 07H .0403 the CRC objective in regulating development within critical water supply areas is the protection and preservation of public water supply well fields and A-II streams and to coordinate and establish a management system capable of maintaining public water supplies so as to perpetuate their values to the public health, safety, and welfare. The proposed marine-based activities would be located outside of state waters and not located near public water supplies. Due to the nature of the activities, the proposed land-based activities would be sited to avoid public water supplies or any water resource or wetland (Attachment 1, pages 5-6). Therefore the proposed activities are consistent with the management objectives of 15A NCAC 07H .0403.

Pursuant to 15A NCAC 07H .0505, management objectives have been established to both protect habitats necessary for survival of threatened and endangered plants and animals, and minimize land use impacts that might jeopardize these habitats. As described in the Draft EA, no activities would occur in any protected lands, preserves, sanctuaries, or Critical Habitat for ESA-listed species (Attachment 1, § III). Some federally listed endangered and threatened species, or species currently proposed for listing under the Endangered Species Act of 1973, as amended, may be located in or near the proposed land-based research activity (Attachment 1, pages 45-53). Mitigation measures would be employed to avoid impacts to endangered and threatened species (Attachment 1, pages 70-72). Researchers would inspect sites in advance of activities and relocated activities to avoid any impacts to endangered and threatened species. Section 7 consultation with the US Fish and Wildlife Service (USFWS) has been initiated. Given that land-based activities would take place on previously disturbed lands (such as road sides), and mitigation measures would be implemented, the proposed activities would not be expected to have an adverse impact on protected habitats, animals, or plants. For these reasons, the proposed activities are consistent with the management objectives of 15A NCAC 07H .0505.

Pursuant to 15A NCAC 07H .0506, management objectives have been established to protect the features of designated coastal complex natural areas for the purpose of safeguarding these areas' biological relationships, and educational, scientific and aesthetic values. The Coastal Resources Commission has not specifically identified any coastal complex natural areas. As described in the Draft EA, no activities would occur in any protected lands, preserves, sanctuaries, or Critical Habitat for ESA-listed species (Attachment 1, § III). Some federally listed endangered and threatened species, or species currently proposed for listing under the Endangered Species Act of 1973, as amended, may be located in or near the proposed land based research activity (Attachment 1, pages 45-53). Mitigation measures would be employed to avoid impacts to endangered and threatened species (Attachment 1, pages 70-72). Researchers would inspect sites in advance of activities and relocate activities to avoid any impacts to endangered and threatened species or critical habitat. Section 7 consultation with the USFWS has been initiated. Given that land-based activities would take place on previously disturbed lands (such as road sides), and mitigation measures would be implemented, the proposed activities would not be expected to have an adverse impact on protected habitats, animals, or plants. Marine-based activities would occur outside of state waters, outside any AEC. For these reasons, the proposed activities are consistent with the management objectives of 15A NCAC 07H .0506.

Pursuant to 15A NCAC 07H .0507, management objectives have been established to protect unique coastal geologic formations for the purpose of preserving the formation's physical components that serve as important scientific and educational sites, or as valuable scenic resources. Presently, the only designated unique coastal geologic formation is Jockey's Ridge (15A NCAC 07H .0507[c][3]). Jockey's Ridge is located within the Town of Nags Head. The proposed activities would avoid Jockey's Ridge; therefore, the proposed activities would have no effect to this unique coastal geologic formation and it is consistent with the management objectives of 15A NCAC 07H .0507.

Pursuant to 15A NCAC 07H .0509, management objectives have been established to conserve significant coastal archeological resources for the purpose of preserving their value as scientific, educational, and aesthetic resources. Land-based activities would take place on pre-disturbed lands (Attachment 1, pages 5-6). Passive seismometers would be placed along roadsides, within ~20 feet of the roads. Three seismometers would be located at a 3 separate coastal community sites. Land shots would be conducted at 14 sites, 11 of which would occur in NC. The NC State Historic Preservation Office (SHPO) HPOWEB GIS service was used to evaluate whether there would be any historic resources within the area of the proposed NC land shot sites (Attachment 2). No historic resources were identified within ~.5 km of the land shot sites. Permuda Island has been designated as a significant coastal archaeological resource area of environmental concern. The proposed land-based activities would not take place on Permuda Island and would remain approximately 30 km away. Ship wrecks within 25 km of the marine-based activities in water depths less than 100 m have been identified in Attachment 1, figure 6. Marine-based activities would be conducted outside of state waters; deployment of OBSs outside of state waters would be conducted to avoid shipwrecks. The coordinates of any shipwrecks on survey track lines in water depths >100 m would be given to the crew conducting OBS deployment (Attachment 1, page 45). Shipwrecks within state waters would not be affected by marine-based activities (Attachment 1, page 70). Based on the review of historical resources, it appears that no historic resources would be near or affected by the proposed activities; therefore, the proposed activities are consistent with the management objectives of 15A NCAC 07H .0509.

Pursuant to 15A NCAC 07H .0510, management objectives have been established to conserve significant coastal historic architectural resources for the purpose of preserving their value as scientific, educational, and aesthetic resources. Land-based activities would avoid any structures or buildings (Attachment 1, page 6). Land shots would be conducted at 14 sites, 11 of which would occur in NC. The NC State Historic Preservation Office (SHPO) HPOWEB GIS service was used to evaluate whether there would be any historic resources within the area of the proposed NC land shot sites (Attachment 2). No historic resources were identified within ~.5 km of the land shot sites. No historic resources were identified near proposed land-based activities or would be affected by the proposed activities; therefore, the proposed activities are consistent with the management objectives of 15A NCAC 07H .0510.

Pursuant to 15A NCAC 07H .0600, management objectives have been established for all AECs for the purpose of preventing pollution of shellfish waters, maintaining aircraft safety, and preventing noise pollution resulting from airspace activity. The proposed activities would not affect any of these resources within AECs; therefore, the proposed activities are consistent with the management objectives of 15A NCAC 07H .0600.

Projects outside of Areas of Environmental concern

The proposed activities would occur outside of AECs. The proposed activities that would occur outside of AECs are consistent with the North Carolina coastal program policies as outlined below.

Pursuant to 15A NCAC 07M .0301, it is the policy of NC to foster, improve, enhance, and ensure optimum access to the public beaches and waters of the 20 coastal counties concurrent with needs of private property owners and protection of important coastal natural resources. Land based activities would not inhibit access to public beaches or waters. Because the proposed marine geophysical survey is ~6-430 km (4-270 mi) from the coast and is outside of state waters, the project activities would have no impact on access to public beaches and waters of the 20 coastal counties. Therefore, the proposed activities are consistent with the public access policy outlined at 15 NCAC 07M .030.

Pursuant to 15A NCAC 07M .0401, it is the policy of NC that development of energy resources and facilities shall avoid significant adverse impacts upon vital coastal resources or uses, and public trust or access areas. To foster compliance with this policy, Impact Assessments are required for Major Energy Facilities as defined at 15A NCAC 07M .0402(b). The proposed activities do not meet the definition of a Major Energy Facility. Furthermore, the proposed activities are not related to exploration or development of outer continental shelf resources and other relevant energy facilities. Therefore, no further action is required regarding the consistency of the proposed activities with the energy policy outlined at 15 NCAC 07M .0401.

Pursuant to 15A NCAC 07M .0501, it is the policy of NC that all state agencies coordinate activities in coastal areas for the purpose of reducing the damage from coastal disasters. In accordance with this policy, local governments must include disaster planning activities in their land use plans, temporary emergency housing must be located outside of hazardous areas, and building repair and reconstruction activities must comply with the standards of the Guidelines for Areas of Environmental Concern, North Carolina Building Code (including wind resistant standards), the National Flood Insurance Program, and local reconstruction plans. The proposed research activities would not involve construction or installation of permanent structures and would be of short duration, not requiring disaster planning efforts. Therefore, the proposed activities are consistent with the guidelines and policies of 15A NCAC 07M .0501.

Pursuant to 15A NCAC 07M .0601, it is the policy of NC that floating structures used for residential or commercial purposes not infringe upon public trust rights nor discharge into public trust waters. The proposed activities do not involve construction or use of a floating structure or discharge into public trust waters; therefore, no further action is required regarding the consistency of the proposed activities with the floating structure policy outlined at 15A NCAC 07M .0601.

Pursuant to 15A NCAC 07M .0701, it is the policy of NC that adverse impacts to coastal lands and waters will be mitigated through proper planning, site selection, compliance with development standards, and creation or restoration of coastal resources. For a project requiring mitigation to be approved, pursuant to 15A NCAC 07M .0703 the following conditions must be met: there must be no reasonable and prudent alternatives to the project design or site; the entire project must be dependent upon close proximity to public trust waters and coastal wetlands; the public benefits must clearly outweigh the long range adverse effects to the environment; and all reasonable means and measures to lessen the impacts of the project are incorporated into the project design. The proposed activities are intended specifically to investigate geologic features of the ENAM located off of the coast of North Carolina. 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 (Attachment 1, page 6). The proposed marine geophysical survey may have minor, temporary effects on marine species, such as marine mammals in the waters surrounding the survey, and potentially within state waters. Potential impacts from the proposed marine geophysical survey on the marine environment are described in detail in the Draft EA (Attachment 1, pages 53-75). The proposed marine geophysical survey includes a monitoring and mitigation plan that would reduce any potential impacts on the marine environment, such as on marine mammals, to a level of insignificance (Attachment 1, pages 7-15). Therefore, the proposed activities are consistent with the mitigation guidelines and policies outlined at 15 NCAC 07M .0701 and no further action is required.

Pursuant to 15A NCAC 07M .0801, it is the policy of NC that no land or water use shall cause the degradation of water quality so as to impair traditional uses of coastal water such as fishing, swimming, hunting, boating, and commerce. All of the waters of the state within the coastal area have a potential for uses which require optimal water quality. Therefore, at every possible opportunity, existing development adjacent to these waters shall be upgraded to reduce discharge of pollutants. Basinwide management to control sources of pollution both within and outside of the coastal area which will impact waters flowing into the rivers and sounds of the coastal area is necessary to preserve the quality of coastal waters. The adoption of methods to control development so as to eliminate harmful runoff which may impact the sounds and rivers of the coastal area and the adoption of best management practices to control runoff from undeveloped lands is necessary to prevent the deterioration of coastal waters. Land-based activities would avoid areas with wetlands or water (Attachment 1, page 6) and would not be anticipated to affect water quality. The proposed marine geophysical survey would occur outside of state waters and would follow all international and federal regulatory requirements for vessel discharges. The proposed marine geophysical survey would not be anticipated to effect water quality (NSF/USGS PEIS, page 3-1). The proposed activities would not degrade water quality and are therefore consistent with 15A NCAC 07M .0801.

Pursuant to 15A NCAC 07M .0901, it is the policy of North Carolina that use of aircraft for the purpose of managing and protecting coastal resources, detecting violations of environmental rules and laws, and performing public health, safety and welfare services is of vital public interest. To insure access to airspace, pursuant to 15A NCAC 07M .0902, access corridors free of special use airspace designations shall be preserved along the length of the barrier island and laterally at intervals not to exceed 25 miles for the purpose of providing unobstructed access to the coastline, and development of aviation-related projects shall to the maximum extent practicable facilitate use of aircraft by local, state, and federal government agencies. The proposed activities are not aviation related, nor would they impact aircraft access corridors; therefore, the proposed activities are consistent with the aircraft usage policy outlined at 15 NCAC 07M .0901.

Pursuant to 15A NCAC 07M .1001 the use of water and wetland-based target areas for military training purposes may result in adverse impacts on coastal resources and on the exercise of public trust rights. The public interest requires that, to the maximum extent practicable, use of such targets not infringe on public trust rights, cause damage to public trust resources, violate existing water quality standards or result in public safety hazards. The proposed activities are not related to military activities; therefore, no further action is required regarding the consistency of the proposed activities with the policies on water and wetland-based target areas for military training activities outlined at 15A NCAC 07M .1001.

Pursuant to 15A NCAC 07M .1101, it is the policy of the State of North Carolina that material resulting from the excavation or maintenance of navigation channels be used in a beneficial way wherever practicable. The proposed activities would not involve the excavation or maintenance of navigation channels; therefore, no further action is required regarding the consistency of the proposed activities with the policies on beneficial use and availability of materials resulting from the excavation or maintenance of navigational channels outlined at 15A NCAC 07M .1101.

Pursuant to 15A NCAC 07M .1201, mining activities impacting the federal jurisdiction ocean and its resources can, and probably would, also impact the state jurisdictional ocean and estuarine systems and vice-versa. Therefore, it is state policy that every avenue and opportunity to protect the physical ocean environment and its resources as an integrated and interrelated system will be utilized. The usefulness, productivity, scenic, historic and cultural values of the state's ocean waters will receive the greatest practical degree of protection and restoration. No ocean mining shall be conducted unless plans for such mining include reasonable provisions for protection of the physical environment, its resources, and appropriate reclamation or mitigation of the affected area as set forth and implemented under authority of the Mining Act (G.S. 74-48) and Coastal Area Management Act (G.S. 113A-100). Mining activities in state waters, or in federal waters insofar as the activities affect any land, water use or natural or historic resource of the state waters, shall be done in a manner that provides for protection of those resources and uses. The siting and timing of such activities shall be consistent with established state standards and regulations and shall comply with applicable local land use plan policies, and AEC use standards. The proposed activities are a collaborative research effort which includes a marine geophysical survey. These activities, however, are not related to ocean mining. The proposed activities do not involve ocean mining; therefore, no further action is required regarding the consistency of the proposed project with the ocean mining policies outlined at 15A NCAC 07M .1201.

North Carolina Dredge and Fill Law (NCGS 113-229)
The proposed project would not result in any excavation or filling within any estuarine waters, tidelands, or State-owned lakes; therefore, no further action is required regarding compliance with NCGS 113-229.

Required State and Local Permits
All necessary state, county, and local permits for land-based activities would be obtained by the PIs for the proposed activities.

Conclusion
The proposed activities are situated outside of AECs. Proposed activities would not have any significant impacts to coastal resources. Therefore, the proposed activities are consistent, to the maximum extent practicable with the enforceable policies of North Carolina's federally approved coastal management program.

Pursuant to CFR 930.41, the North Carolina Coastal Management Program has 60 days from the receipt of this letter in which to concur with or object to this Consistency Determination, or to request an extension under 15 CFR Section 930.41(b). NSF would be appreciative however if the North Carolina Coastal Management Program could inform us of their perspective on the consistency determination at the earliest possible convenience within this time period. The State’s concurrence will be presumed if the States response is not received by NSF on the 60th day from receipt of this Determination.

The States's response should be sent via email to:

Holly Smith
National Science Foundation
Division of Ocean Sciences
4201 Wilson Blvd.
Room 725
Arlington, VA 22230
Email: hesmith@nsf.gov

Attachment 1: Draft Environmental Assessment for a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras

Attachment 2: Active Land Shot Sites - Historic Resources

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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and

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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

~	approximately
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.

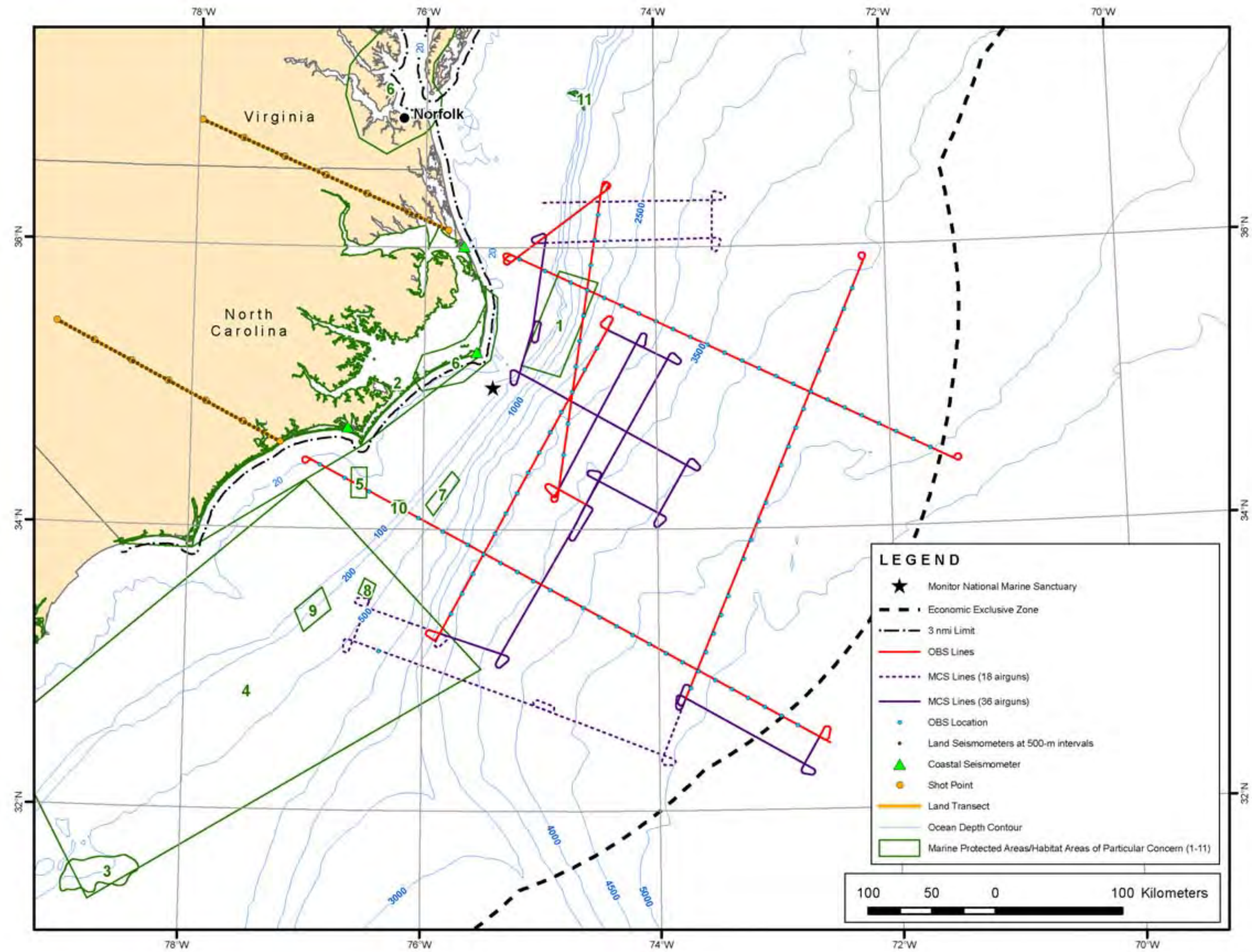

Figure 1. Location of the proposed seismic survey at the proposed survey site in the Atlantic Ocean off Cape Hatteras during September–October 2014. Also shown are a National Marine Sanctuary, one marine protected area, and 10 habitat areas of particular concern (see text).

(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

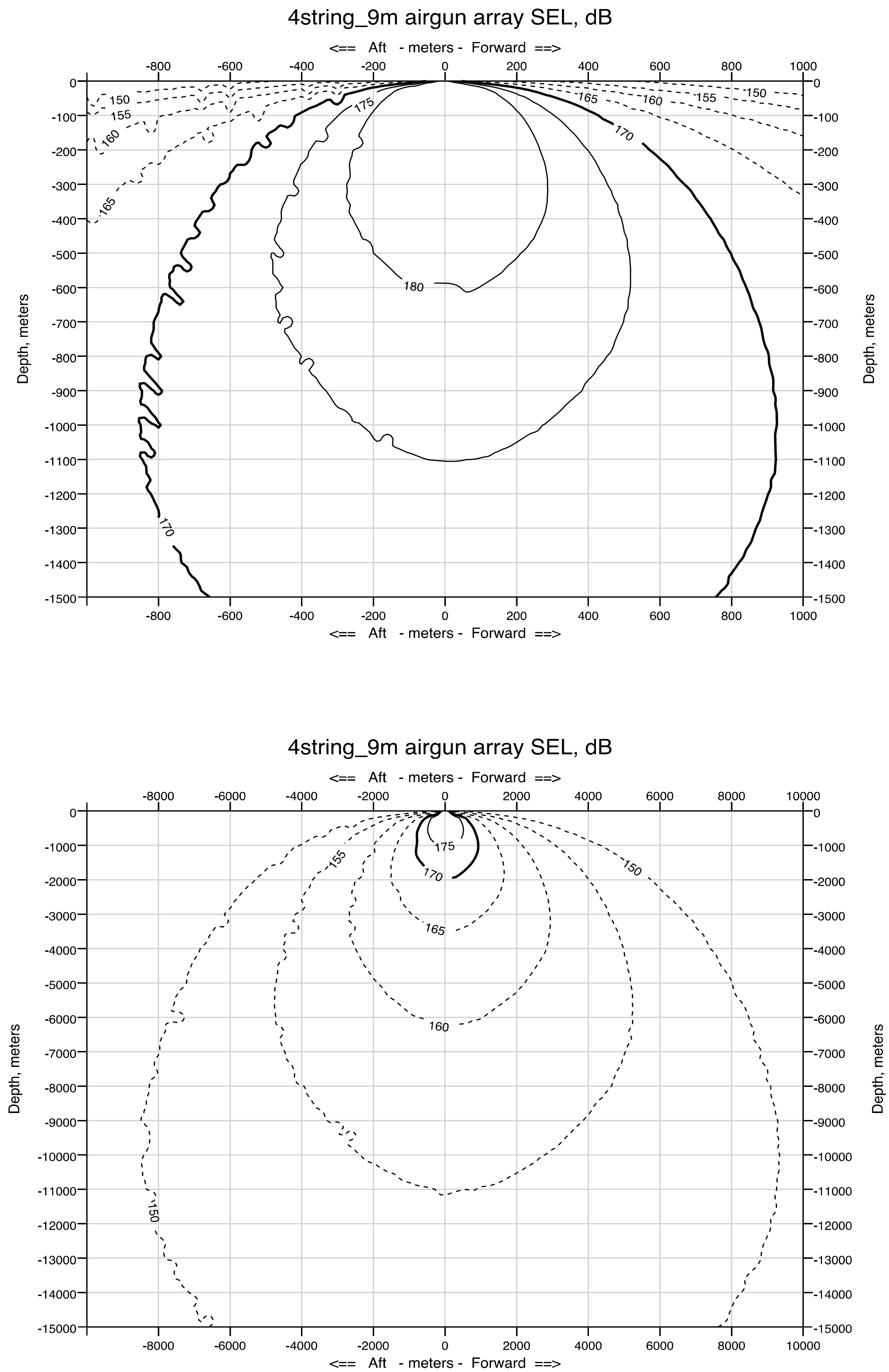

FIGURE 2. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the survey off Cape Hatteras, at a 9-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the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

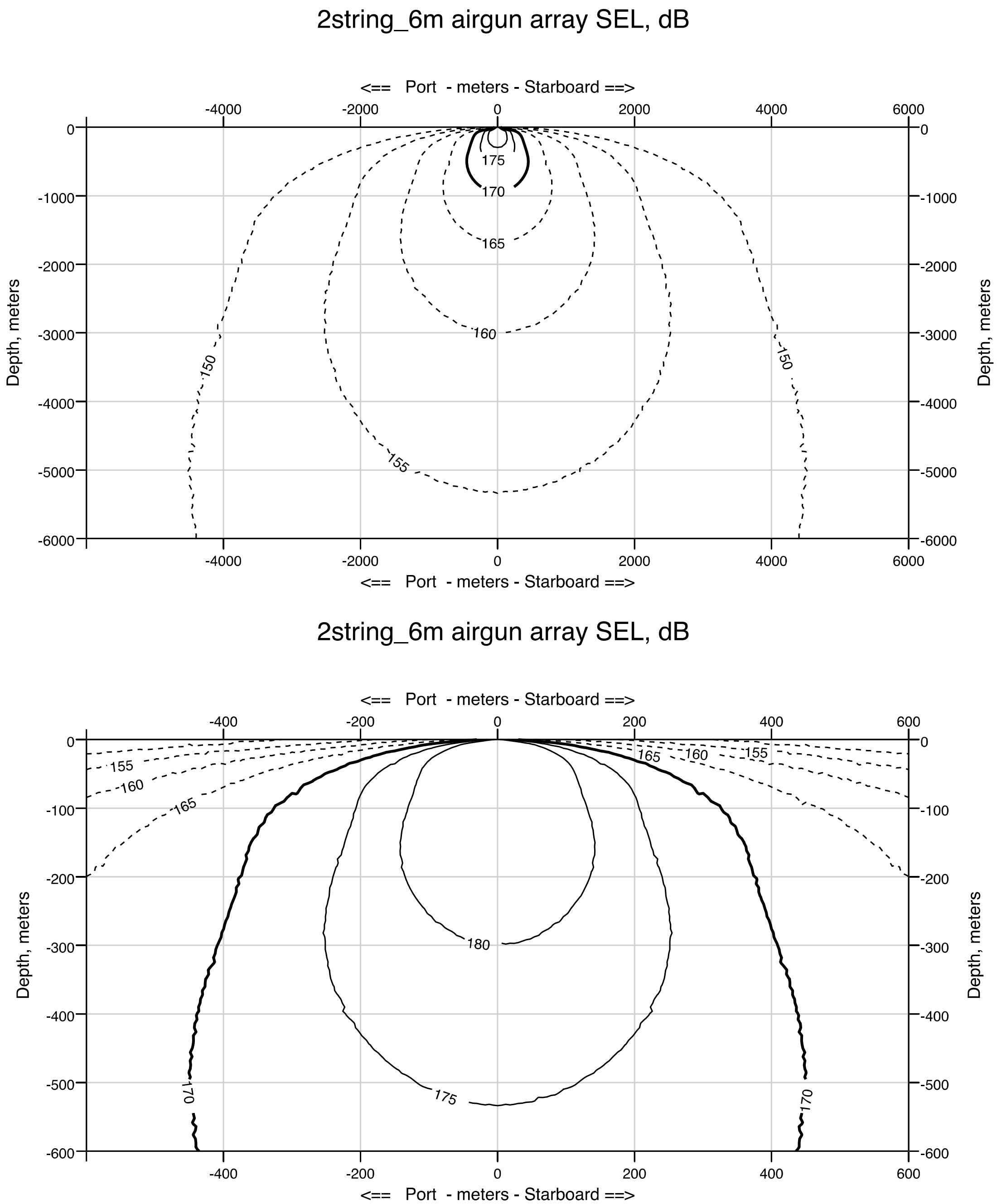

FIGURE 3. Modeled deep-water received sound levels (SELs) from the 18-airgun array planned for use during the survey off Cape Hatteras, at a 6-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 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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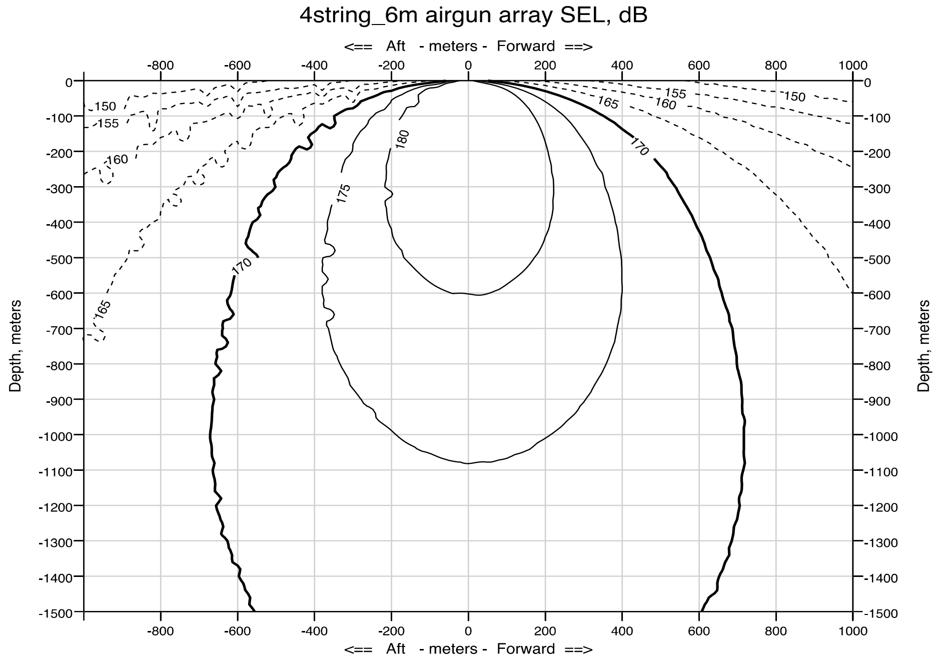
[1] SEL (measured in dB re 1 µ$Pa^2 \cdot s$) is a measure of the received energy in the pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period. Because actual seismic pulses are less than 1 s in duration in most situations, this means that the 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.



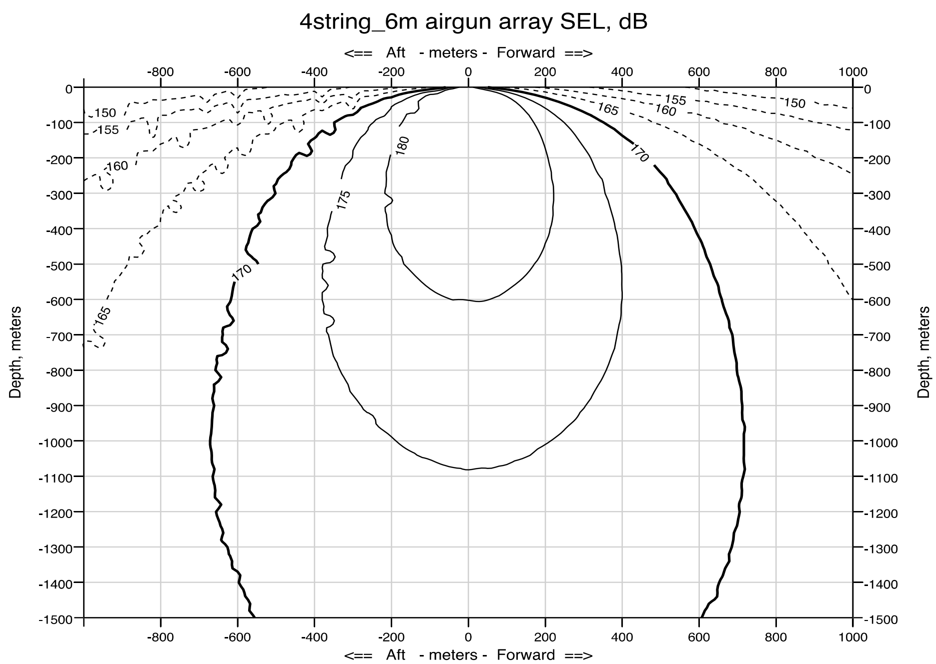
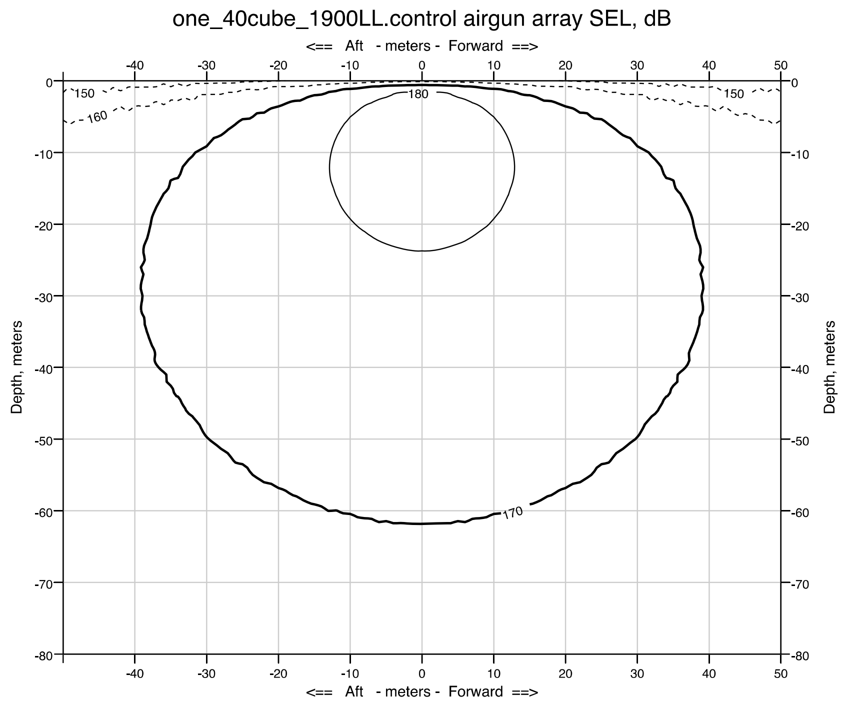


FIGURE 4. Modeled deep-water received sound levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB rms isopleth,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



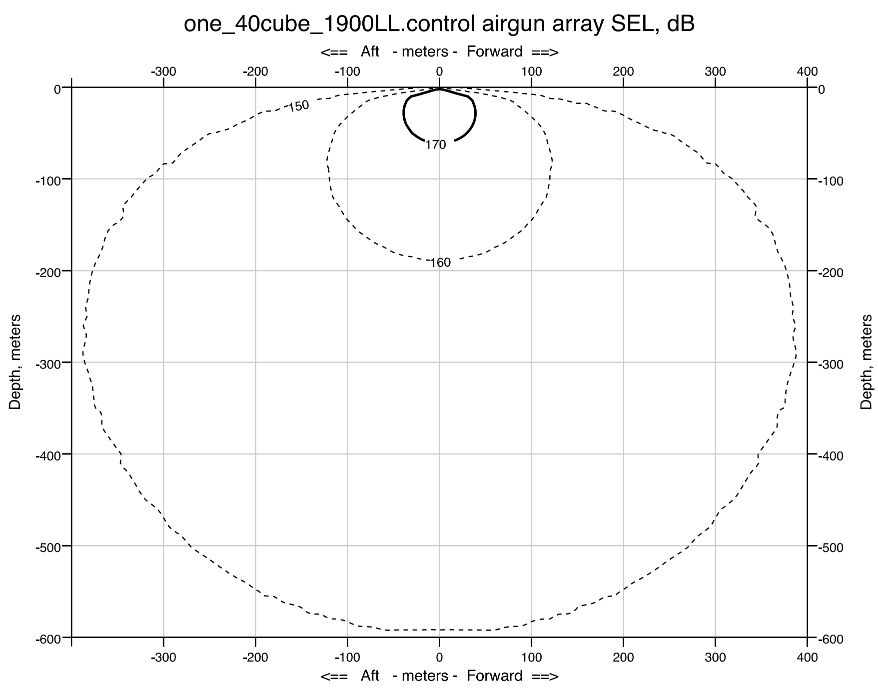


FIGURE 5. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9 m depth, which is planned for use as a mitigation gun during the proposed survey off Cape Hatteras. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to 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 in^3	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 in^3	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 in^3	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 northeastern U.S. during early spring and summer. The highest abundance in Cape Cod Bay is in February and April (Winn et al. 1986; Hamilton and Mayo 1990) and from April to June in the Great South Channel east of Cape Cod (Winn et al. 1986; Kenney et al. 1995). Throughout the remainder of summer and into fall (June–November), they are most commonly seen farther north on feeding grounds in Canadian waters, with a peak abundance during August, September, and early October (Gaskin 1987). Morano et al. (2012) and Mussoline et al. (2012) indicated that right whales are present in the southern Gulf of Maine year-round and that they occur there over longer periods than previously thought.

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

Knowlton et al. (2002) provided an extensive and detailed analysis of survey data, satellite tag data, whale strandings, and opportunistic sightings along State waters of the mid-Atlantic migratory 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	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	Gear Type: 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	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

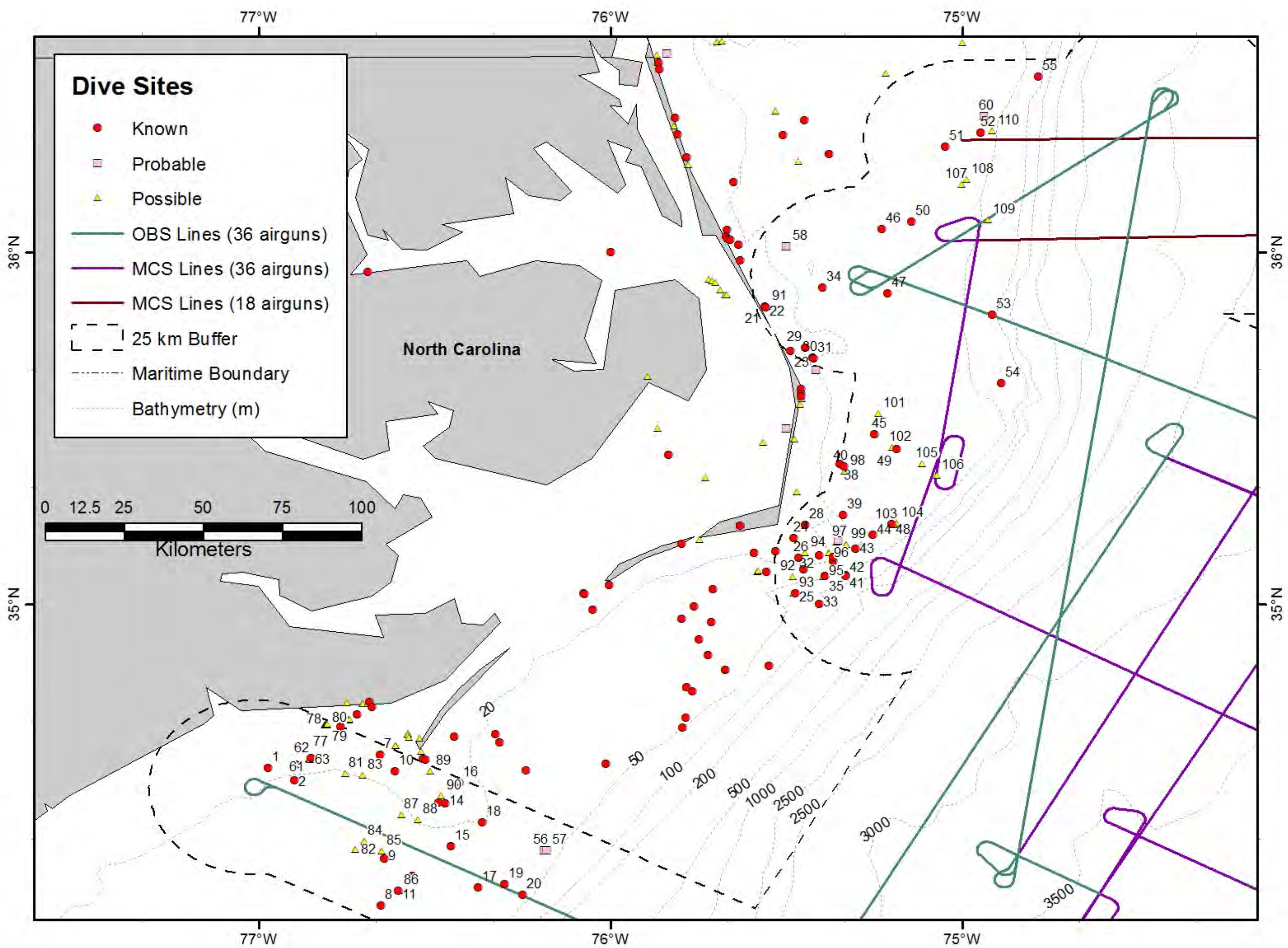

Figure 6. Recreational dive sites in water depths <100 m.

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.

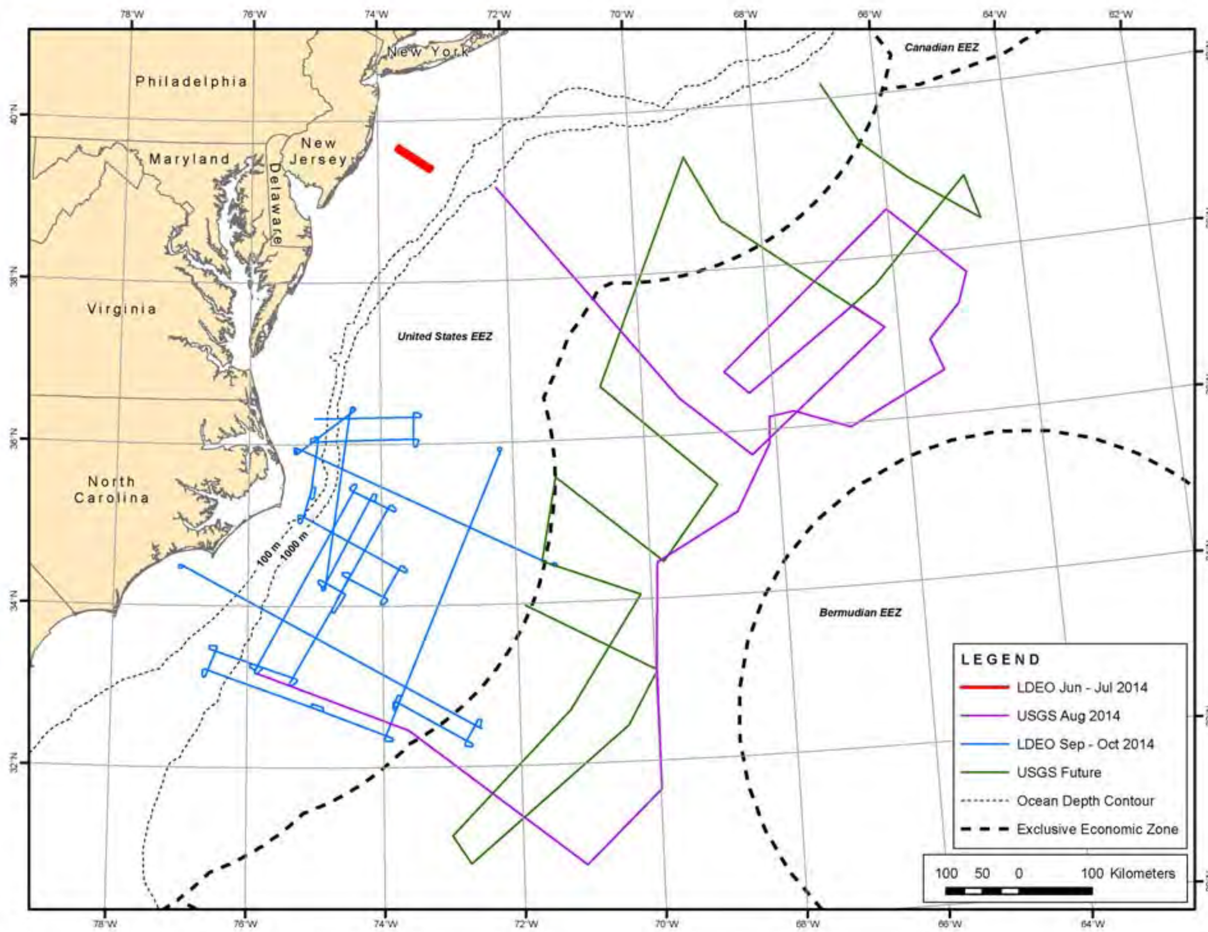

FIGURE 7. Locations of known proposed research activities off the U.S. east coast.

(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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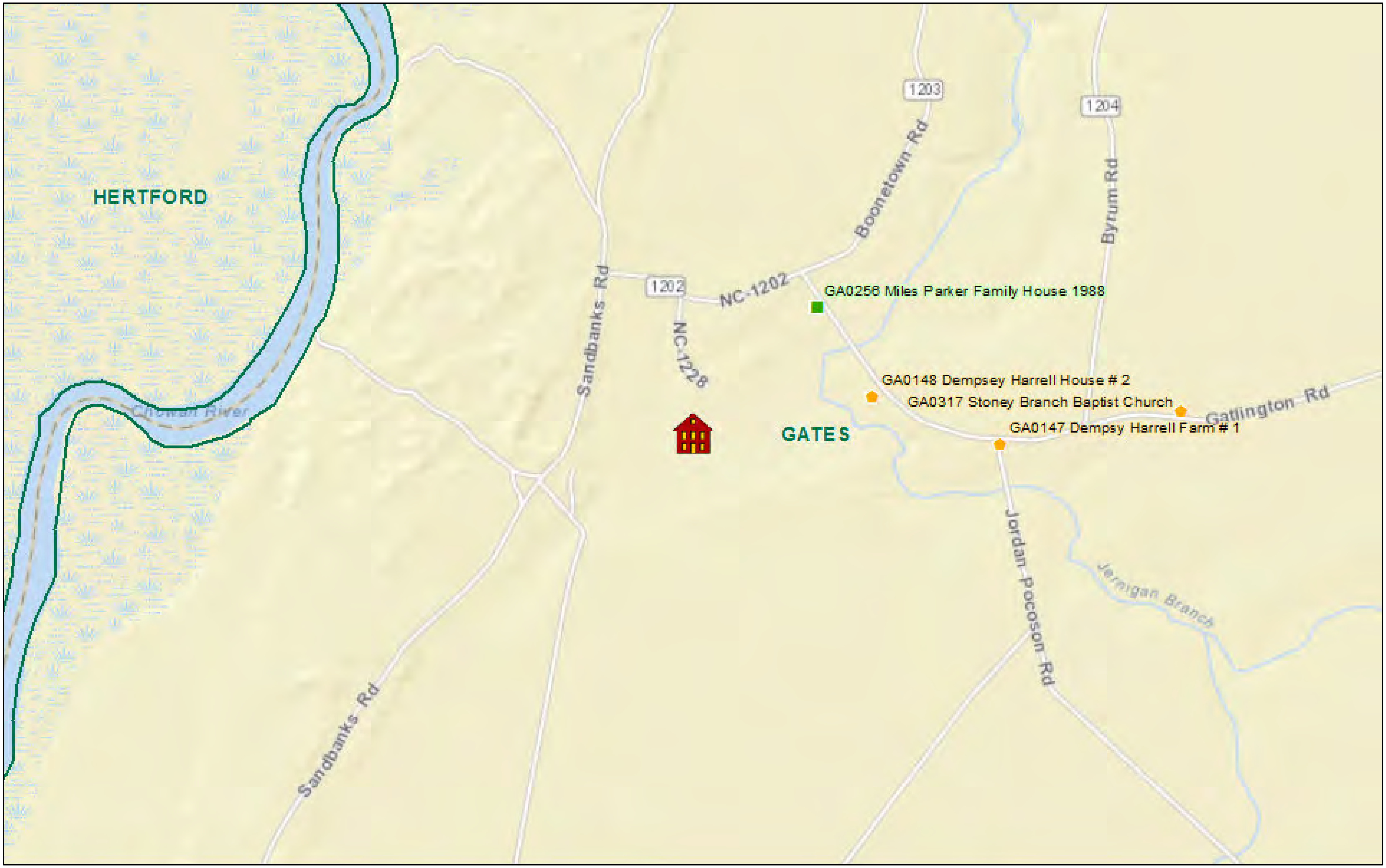
Active Land Shot Sites - Historic Resources

The NC State Historic Preservation Office (SHPO) HPOWEB GIS service was used to evaluate whether there would be any historic resources within the area of the proposed land shot sites. The proposed land shot sites are included in the following maps. Alternative siting options for some locations are also included in case individual proposed sites are determined to not be viable operationally.

Shot Point 14



June 18, 2014

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

1:31,598

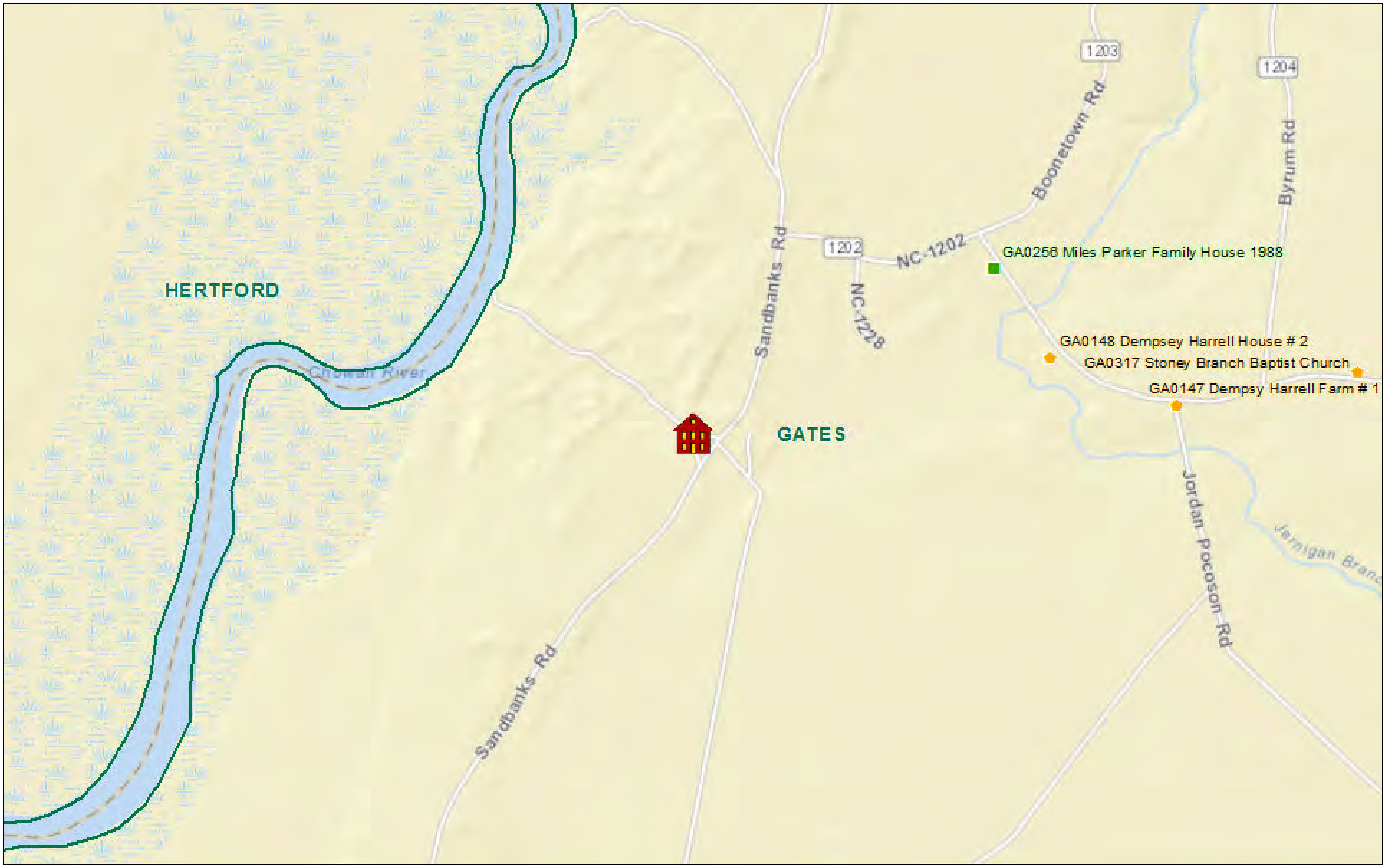
0 0.25 0.5 1 mi

0 0.425 0.85 1.7 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Shot Point 14A

Attachment 2



June 18, 2014

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- NR Listing, Gone
- NRHD Center Point

1:31,598

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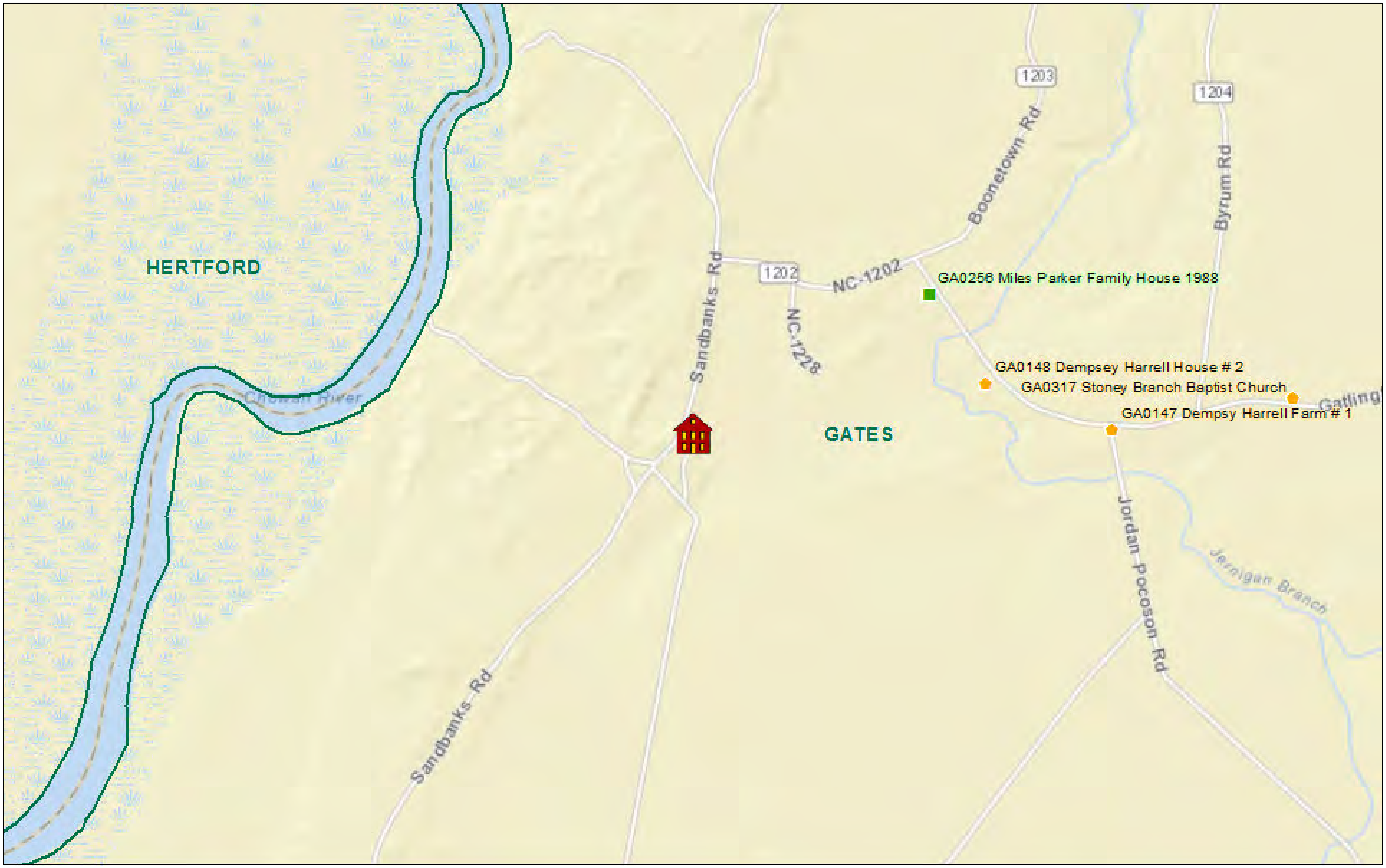
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Shot Point 14B



June 18, 2014

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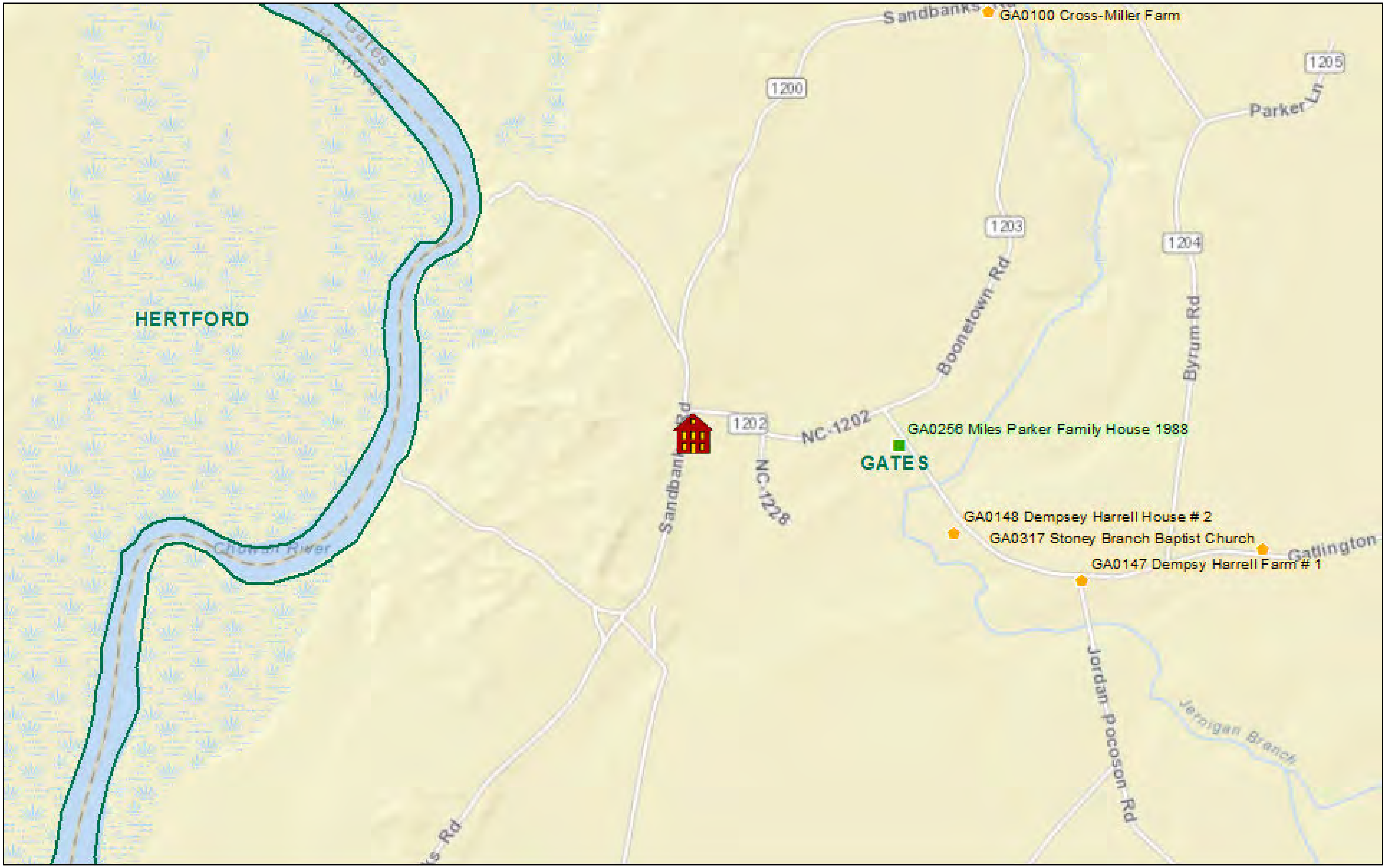
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Shot Point 14C



June 18, 2014

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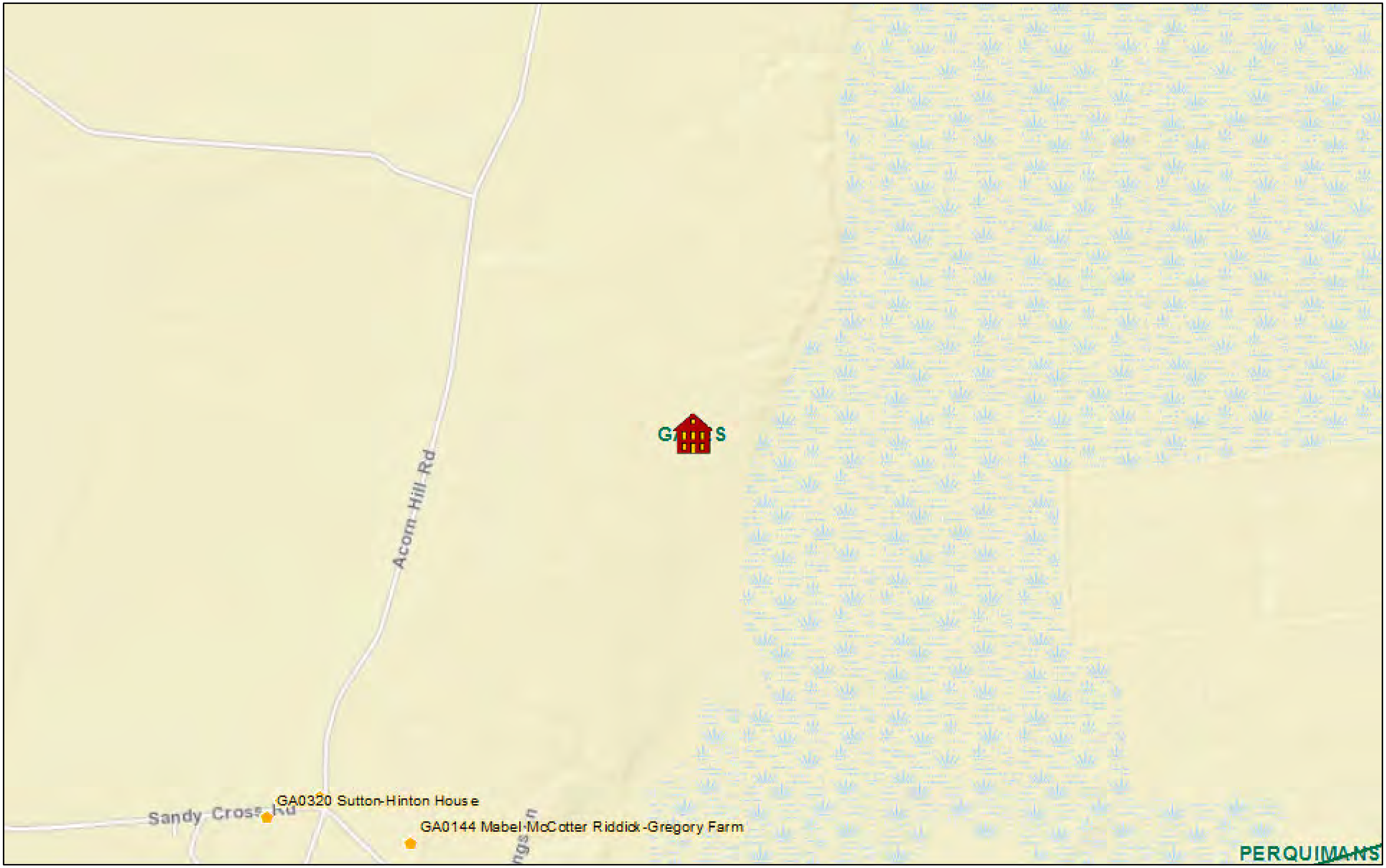
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Shot Point 15A

Attachment 2



June 18, 2014

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0 0.25 0.5 1 mi

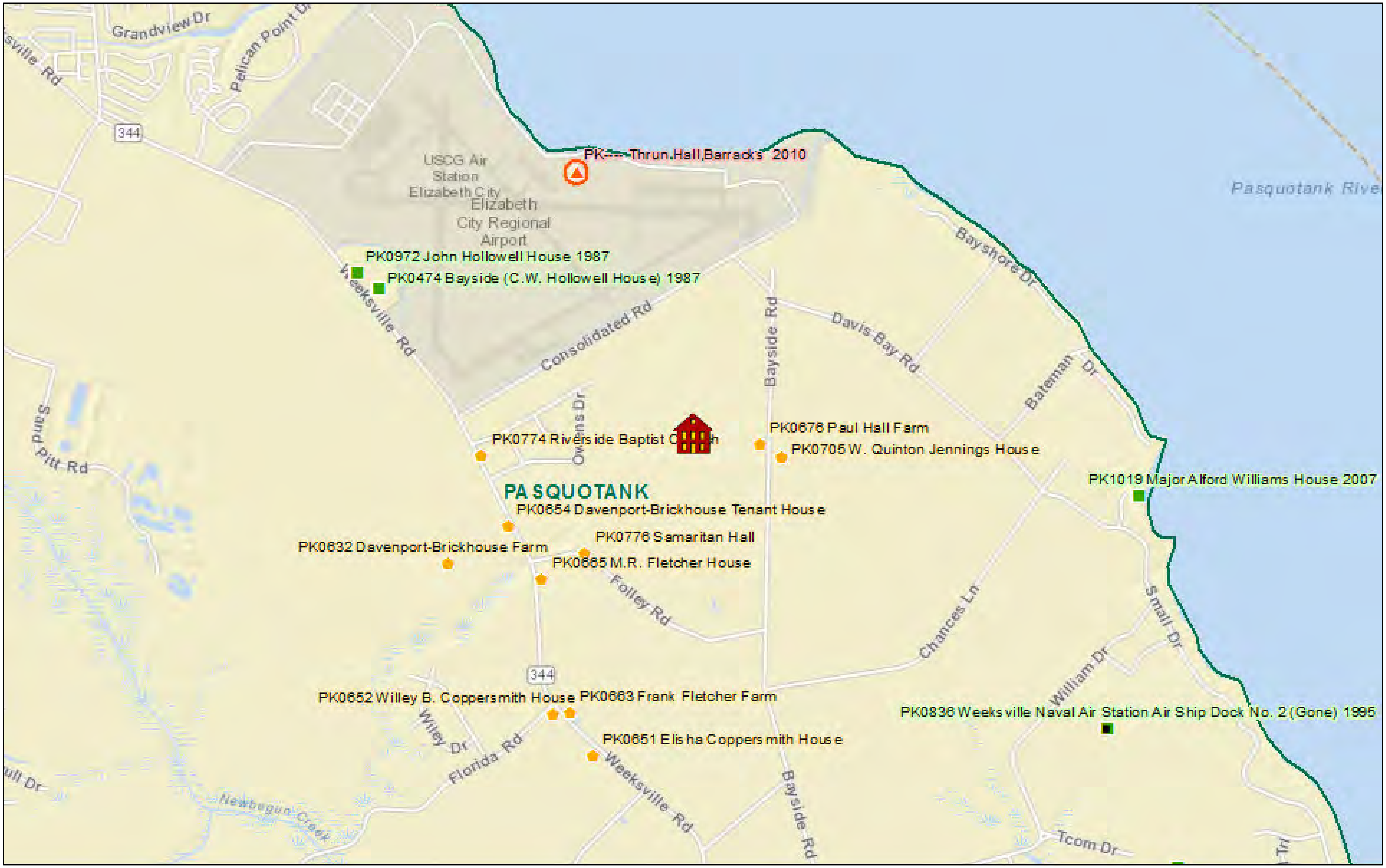
0 0.425 0.85 1.7 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Point 16

Attachment 2



June 12, 2014

1:36,112

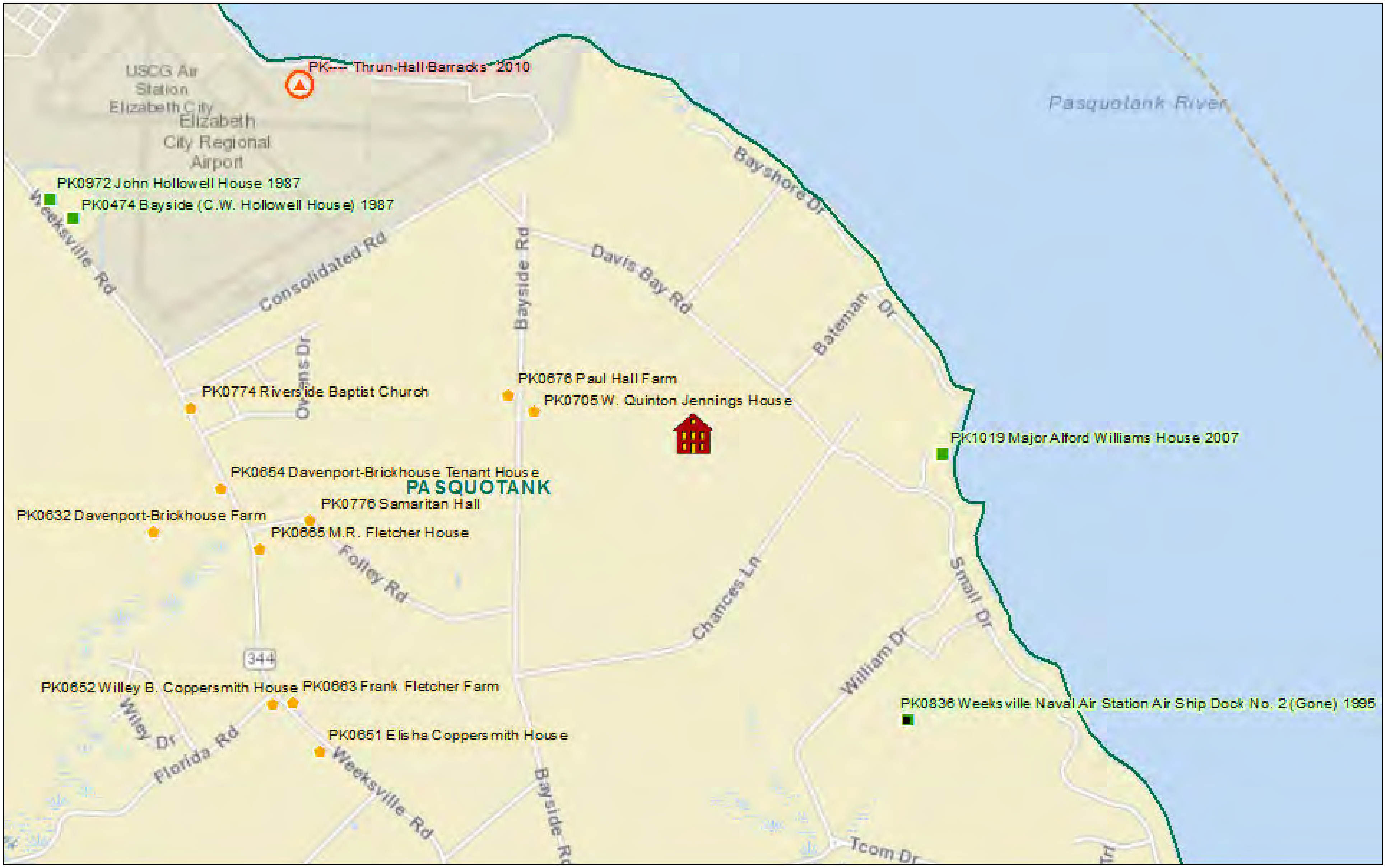
0 0.3 0.6 1.2 mi

0 0.5 1 2 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Shot Point 16A



June 18, 2014

1:31,598

0 0.25 0.5 1 mi

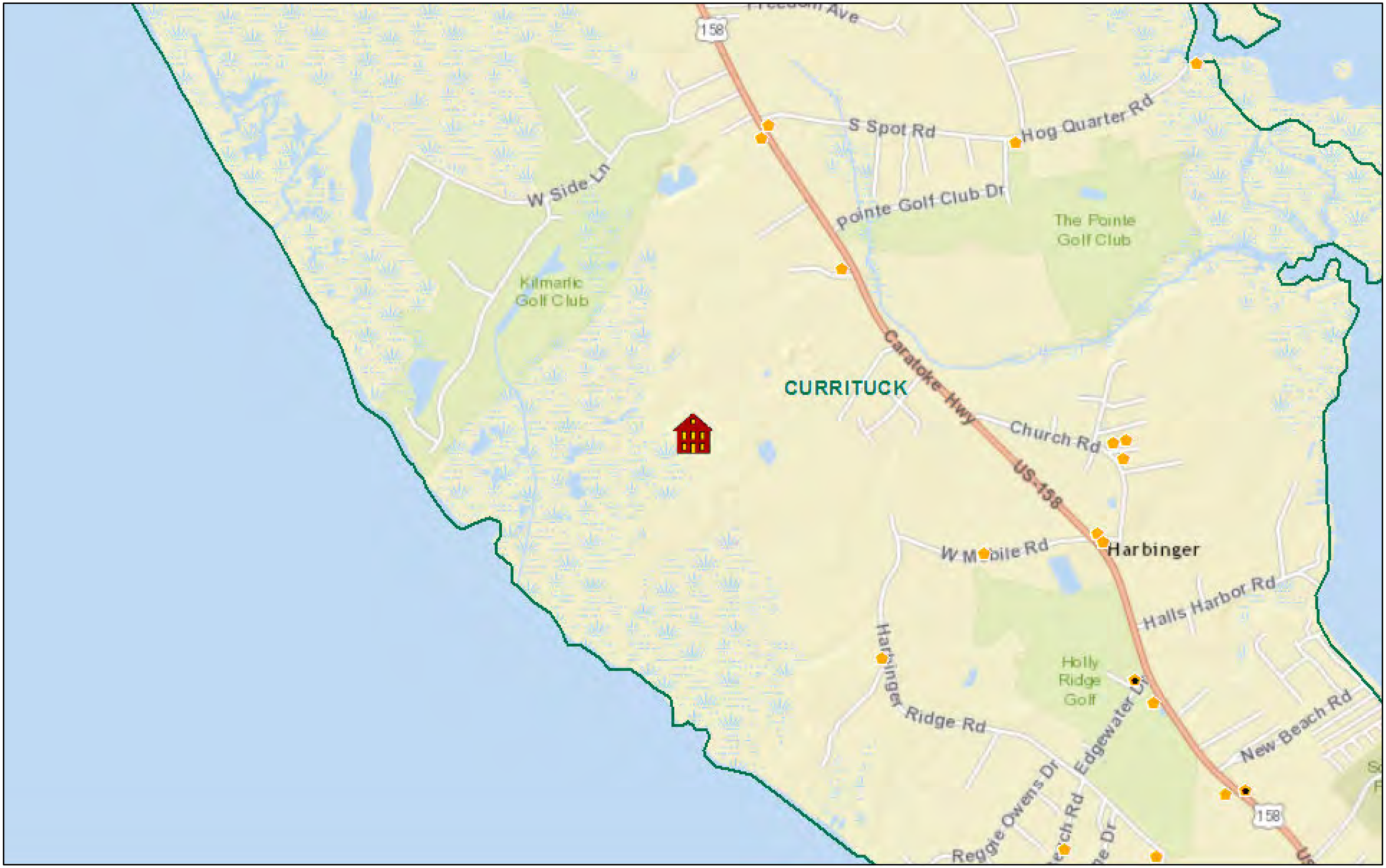
0 0.425 0.85 1.7 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Shot Point 17A

Attachment 2



June 18, 2014

1:31,598

0 0.25 0.5 1 mi

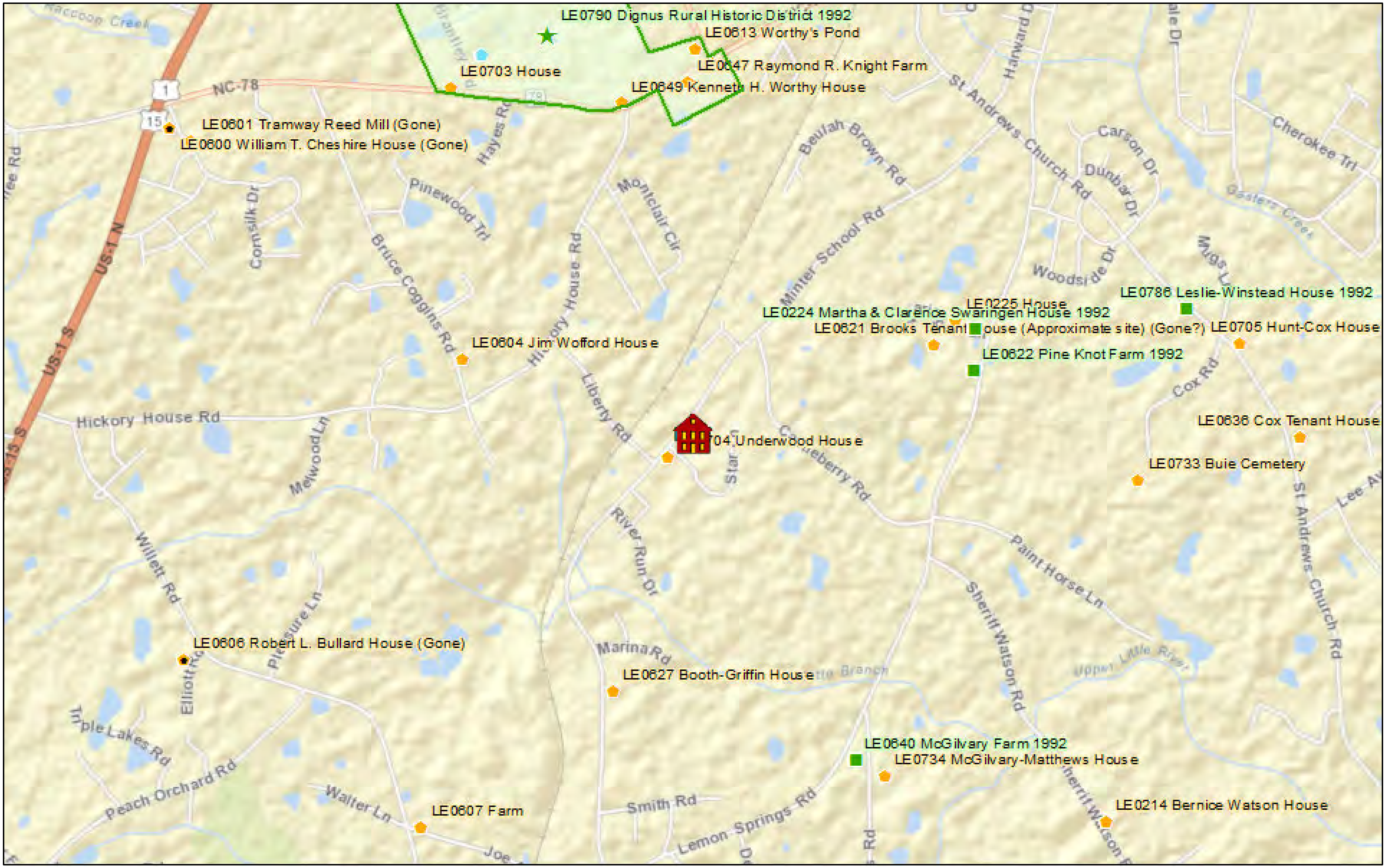
0 0.425 0.85 1.7 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Point 21

Attachment 2



June 12, 2014

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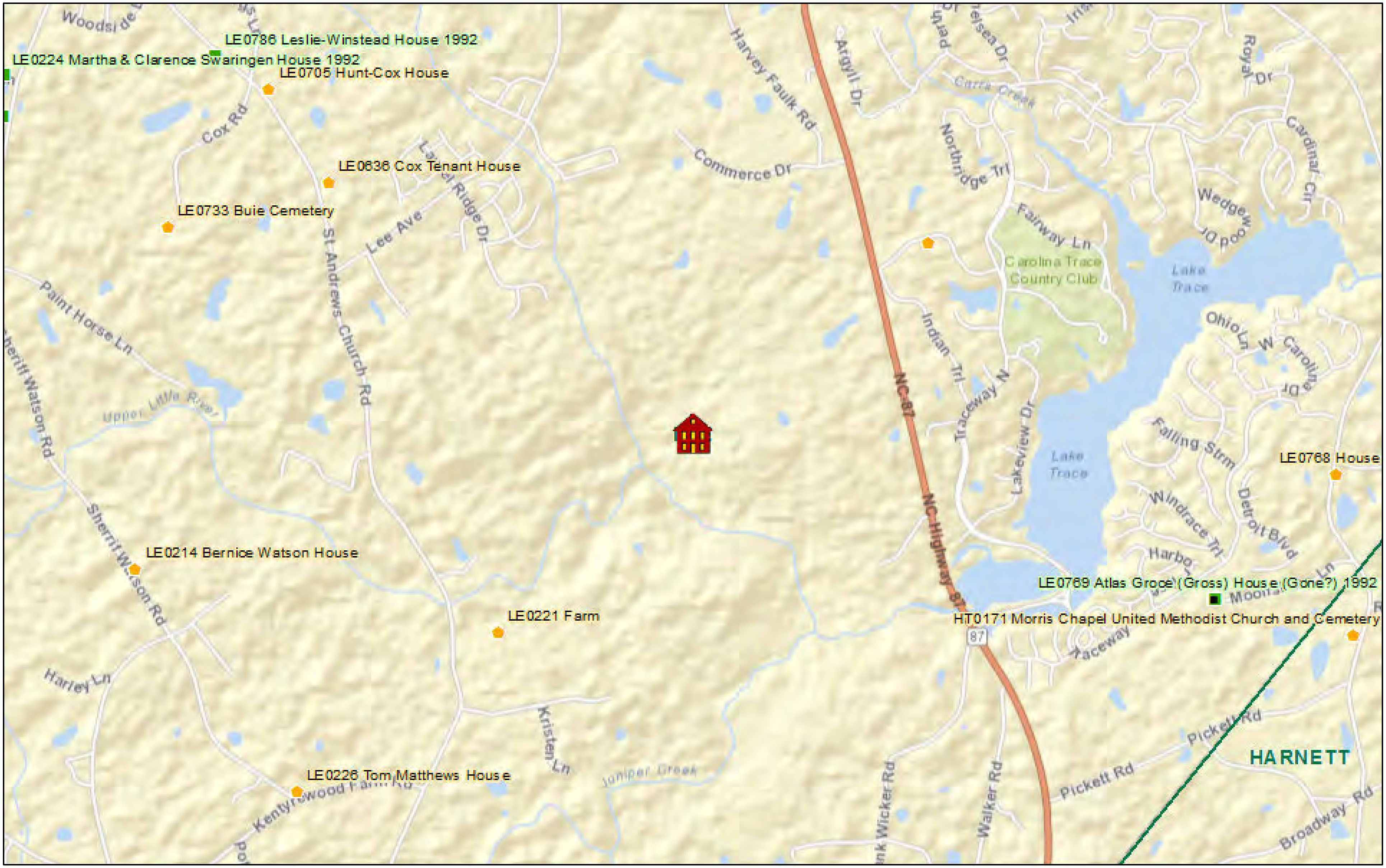
0 0.5 1 2 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Point 21A

Attachment 2



June 12, 2014

1:36,112

0 0.3 0.6 1.2 mi

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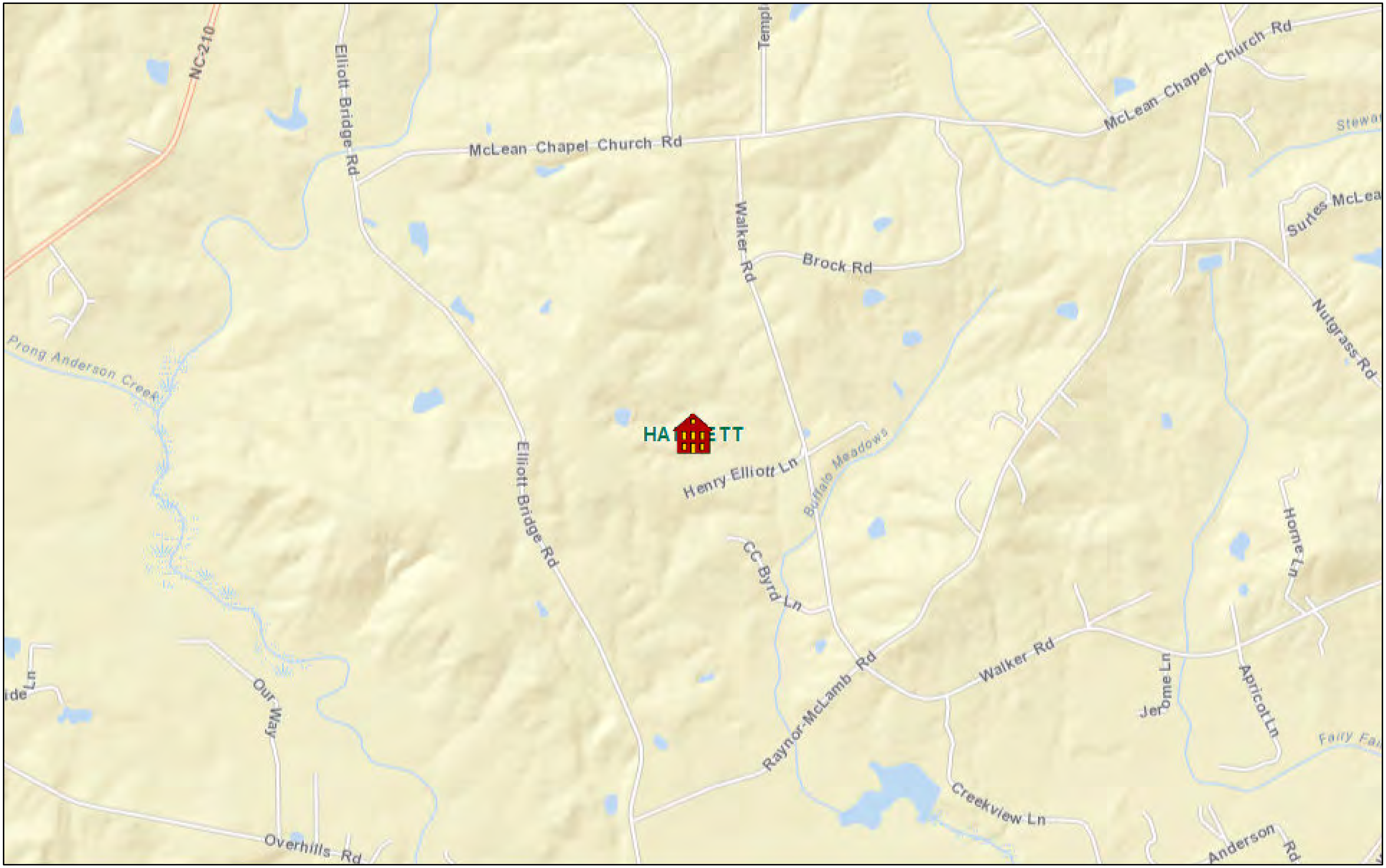
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Point 22

Attachment 2



June 12, 2014

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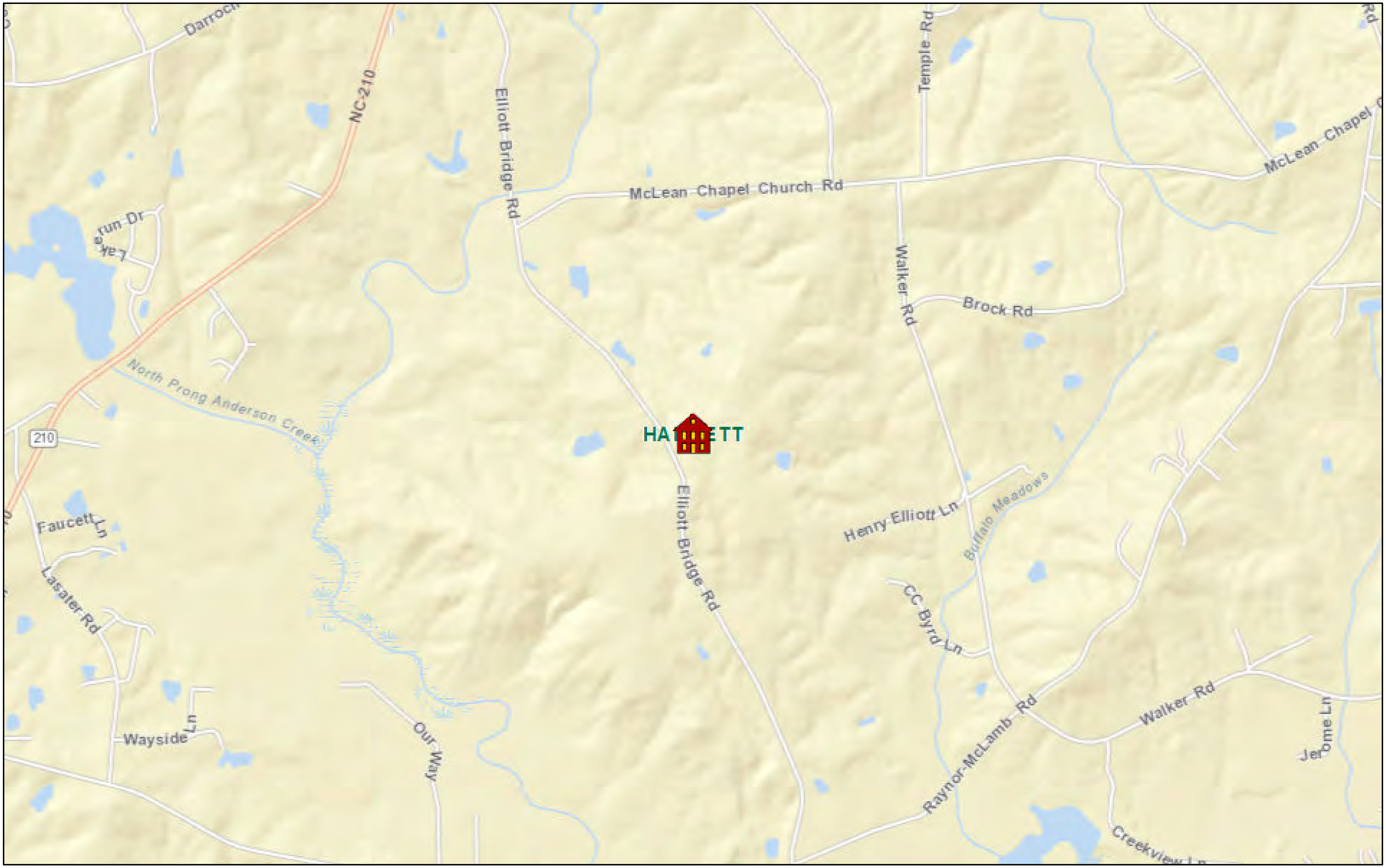
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Point 22A

Attachment 2



June 12, 2014

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- NR Individual Listing
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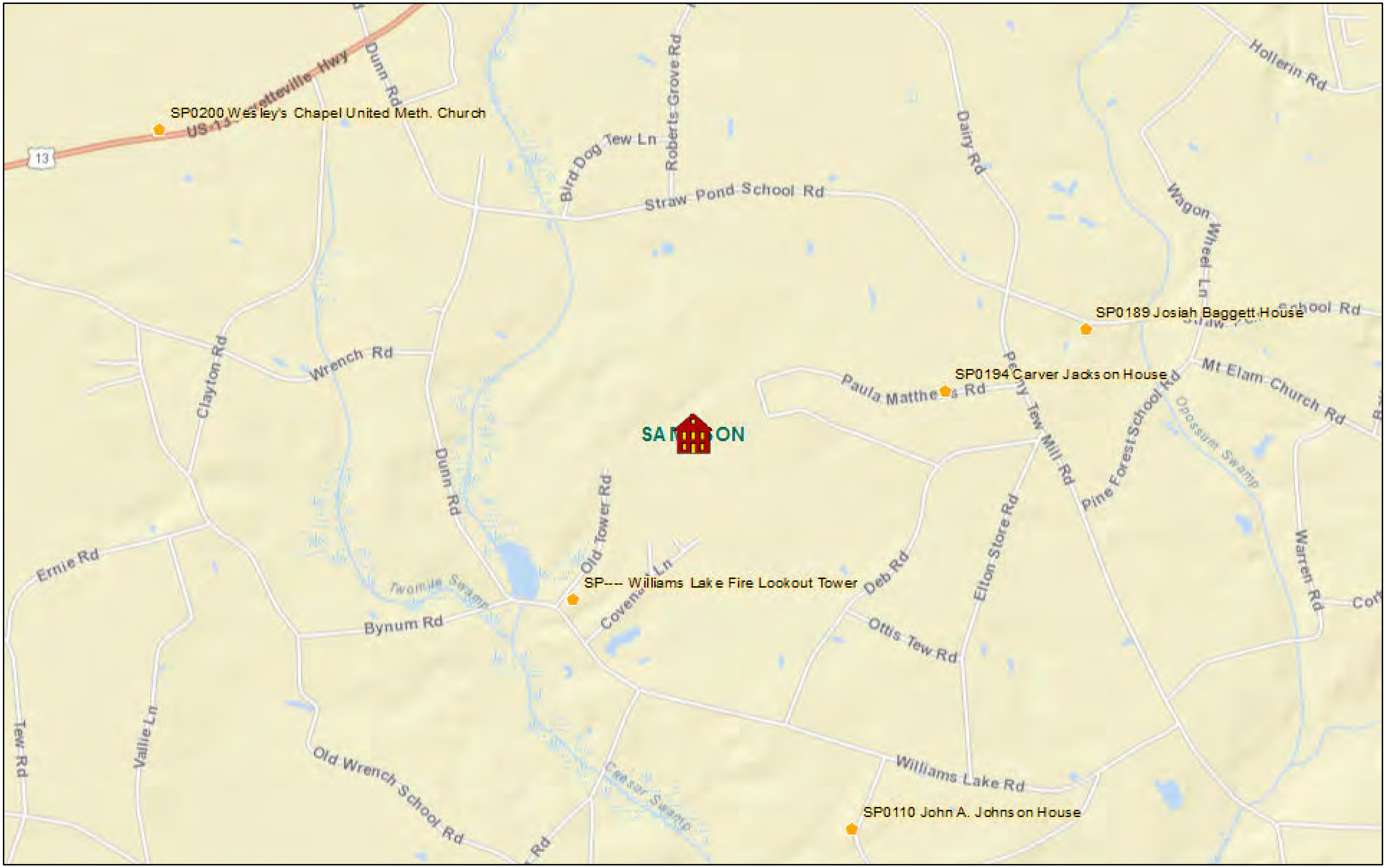
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Point 23

Attachment 2



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- NR Individual Listing
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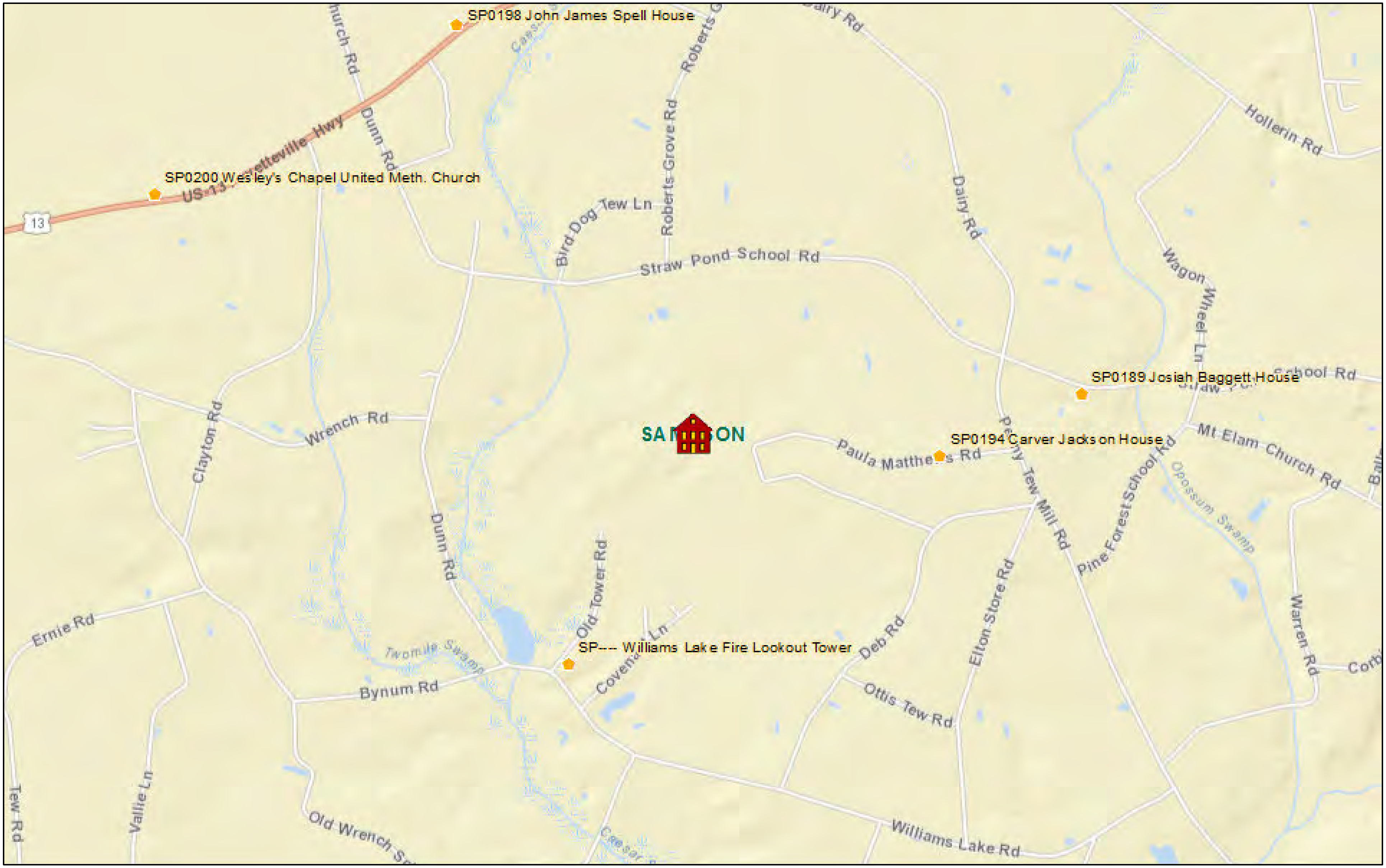
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Point 23C

Attachment 2



June 12, 2014

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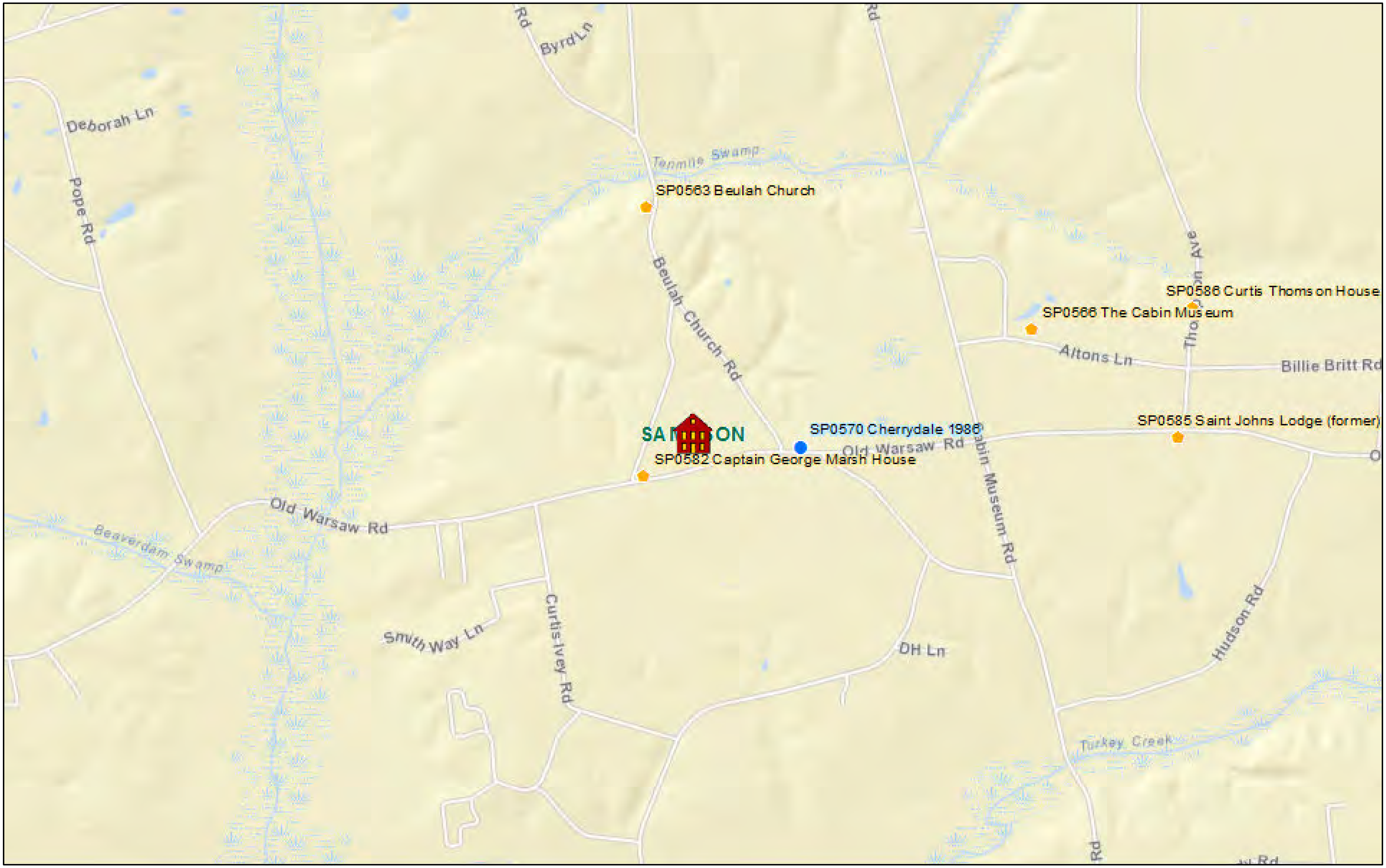
- NRHD Center Point

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Point 24

Attachment 2



June 12, 2014

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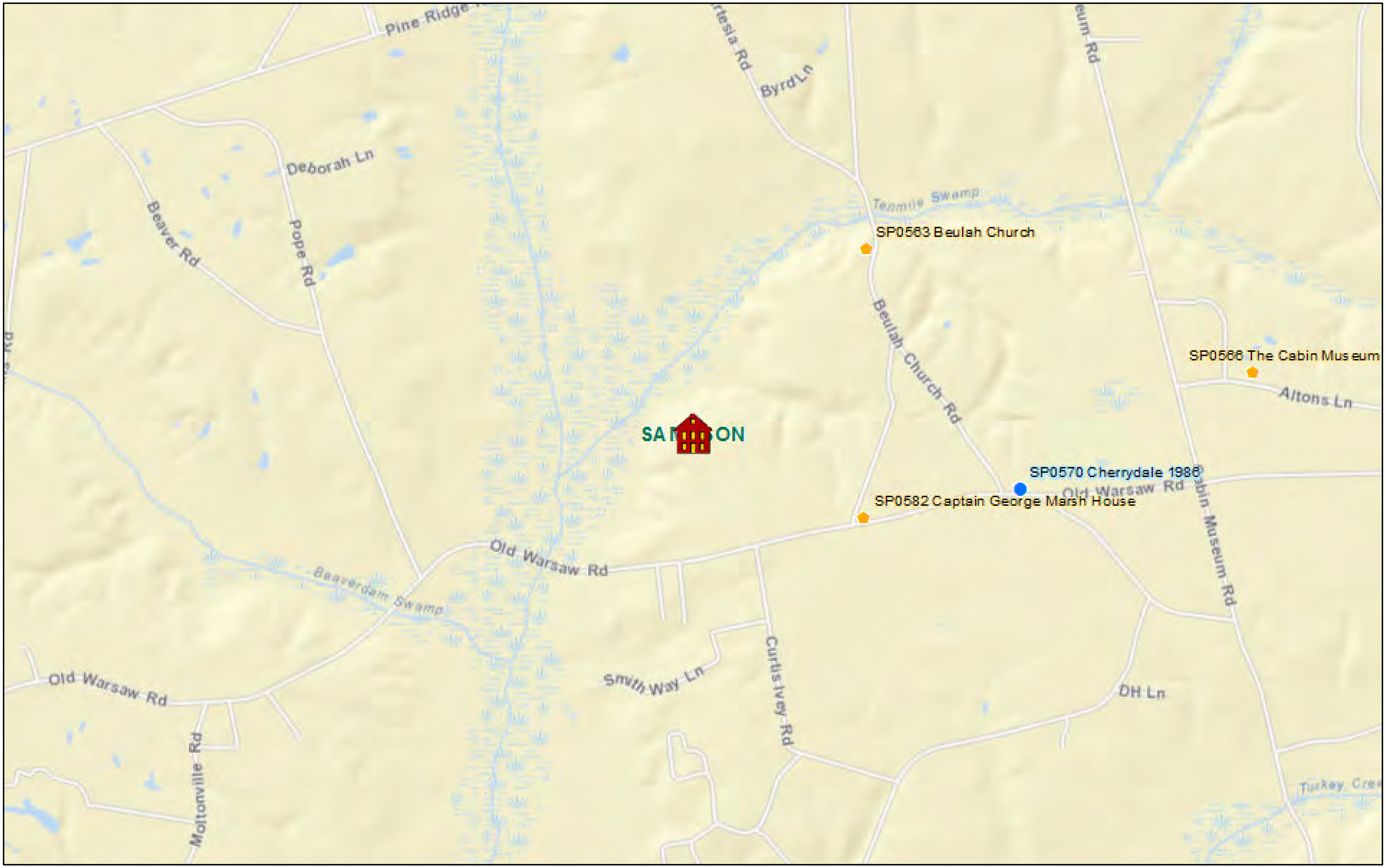
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

Point 24A

Attachment 2



June 12, 2014

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

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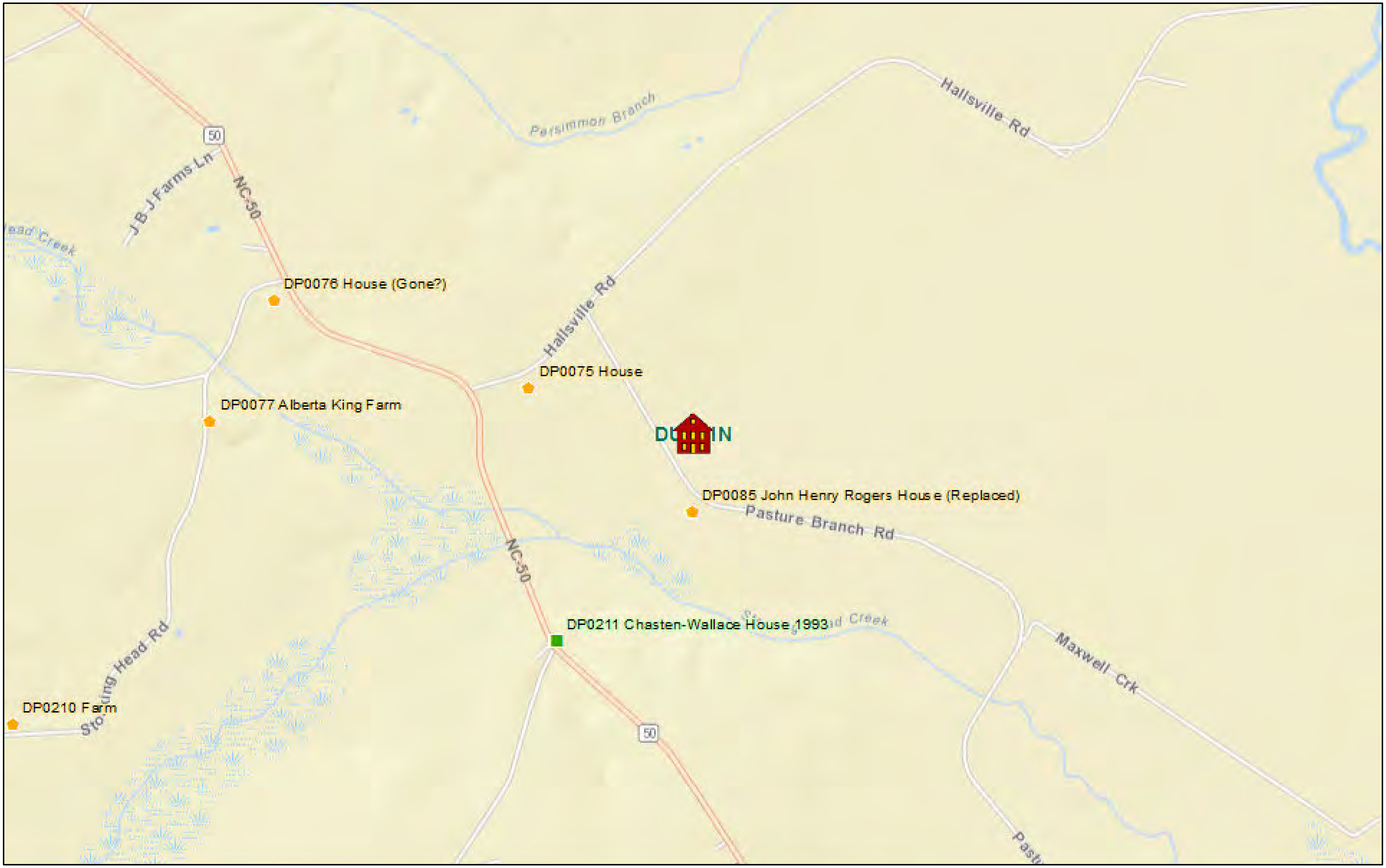
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Point 25

Attachment 2



June 12, 2014

- NR Individual Listing
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- NRHD Center Point

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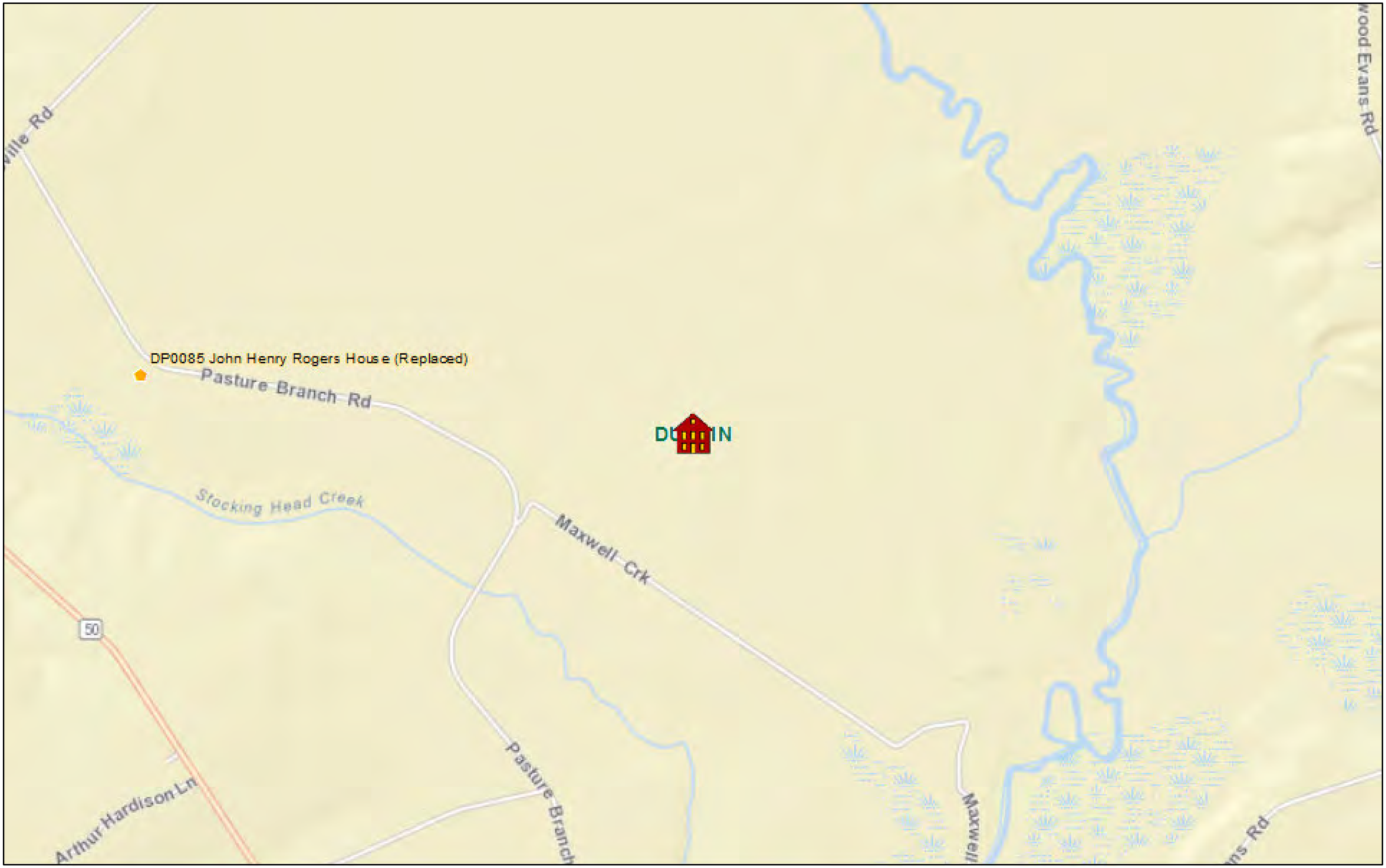
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Shot Point 25A



June 18, 2014

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Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

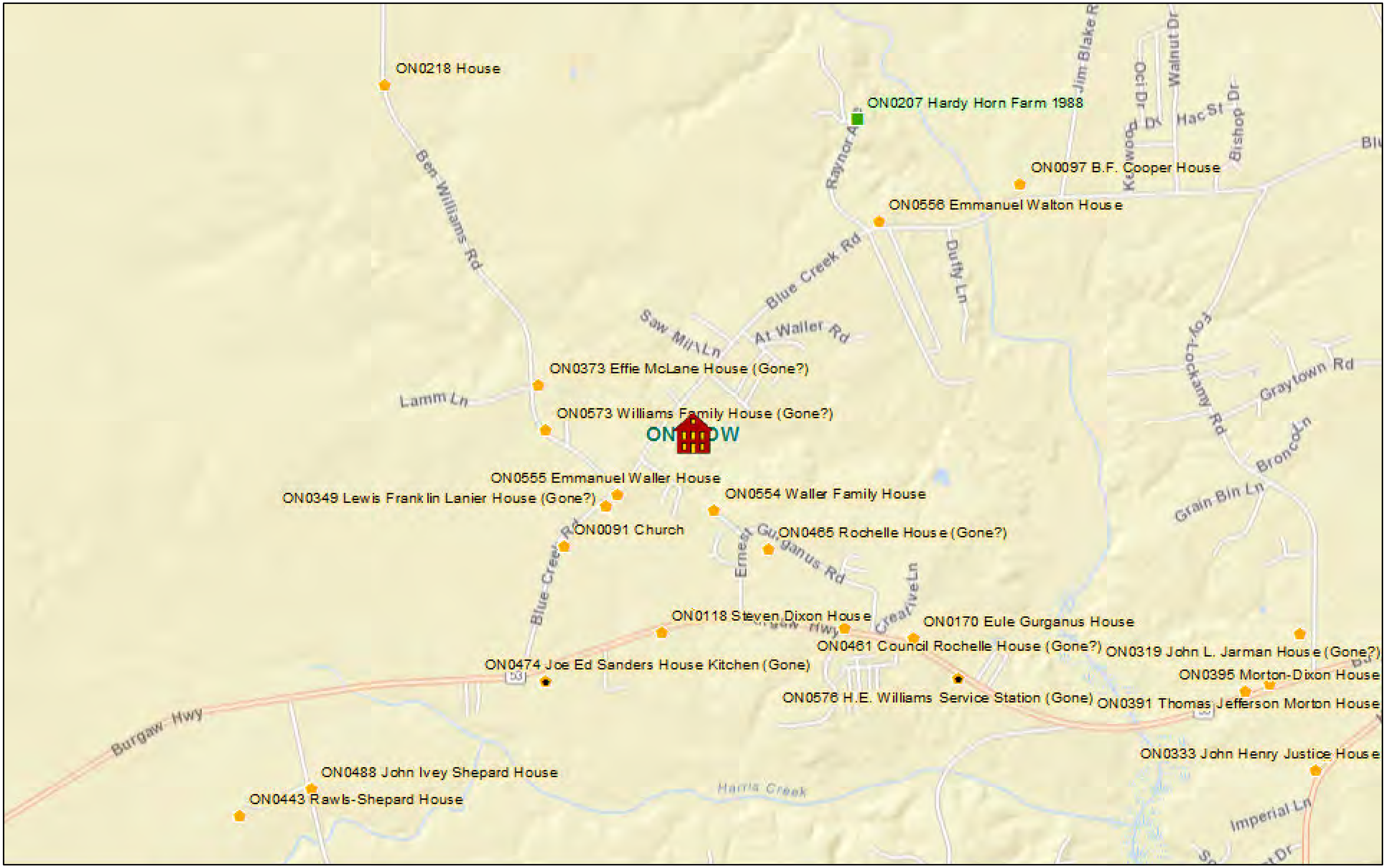
NR Individual Listing

NR Listing, Gone

NRHD Center Point

Point 26

Attachment 2



June 12, 2014

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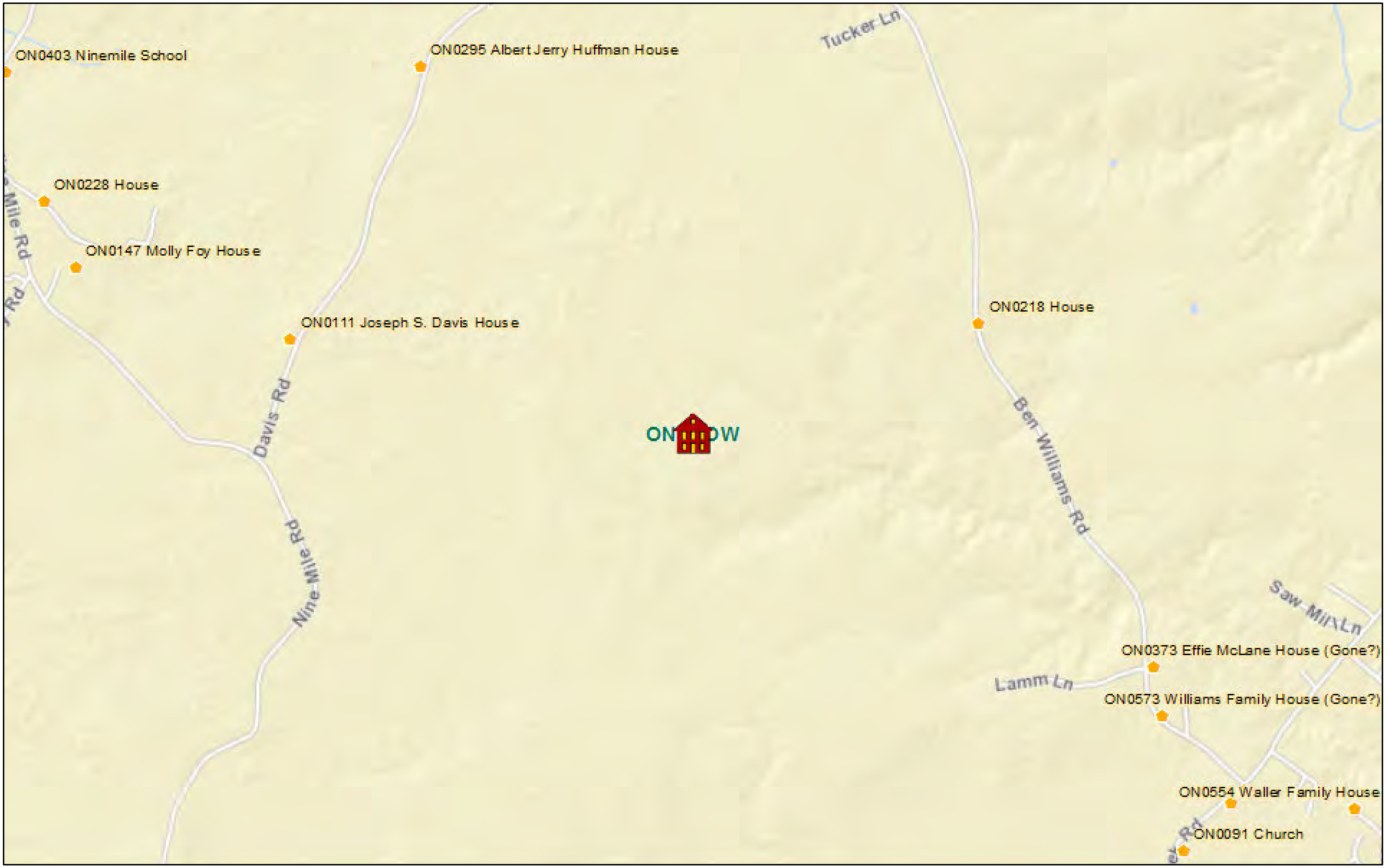
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Shot Point 26B



June 18, 2014

NR Individual Listing

NR Listing, Gone

NRHD Center Point

1:31,598

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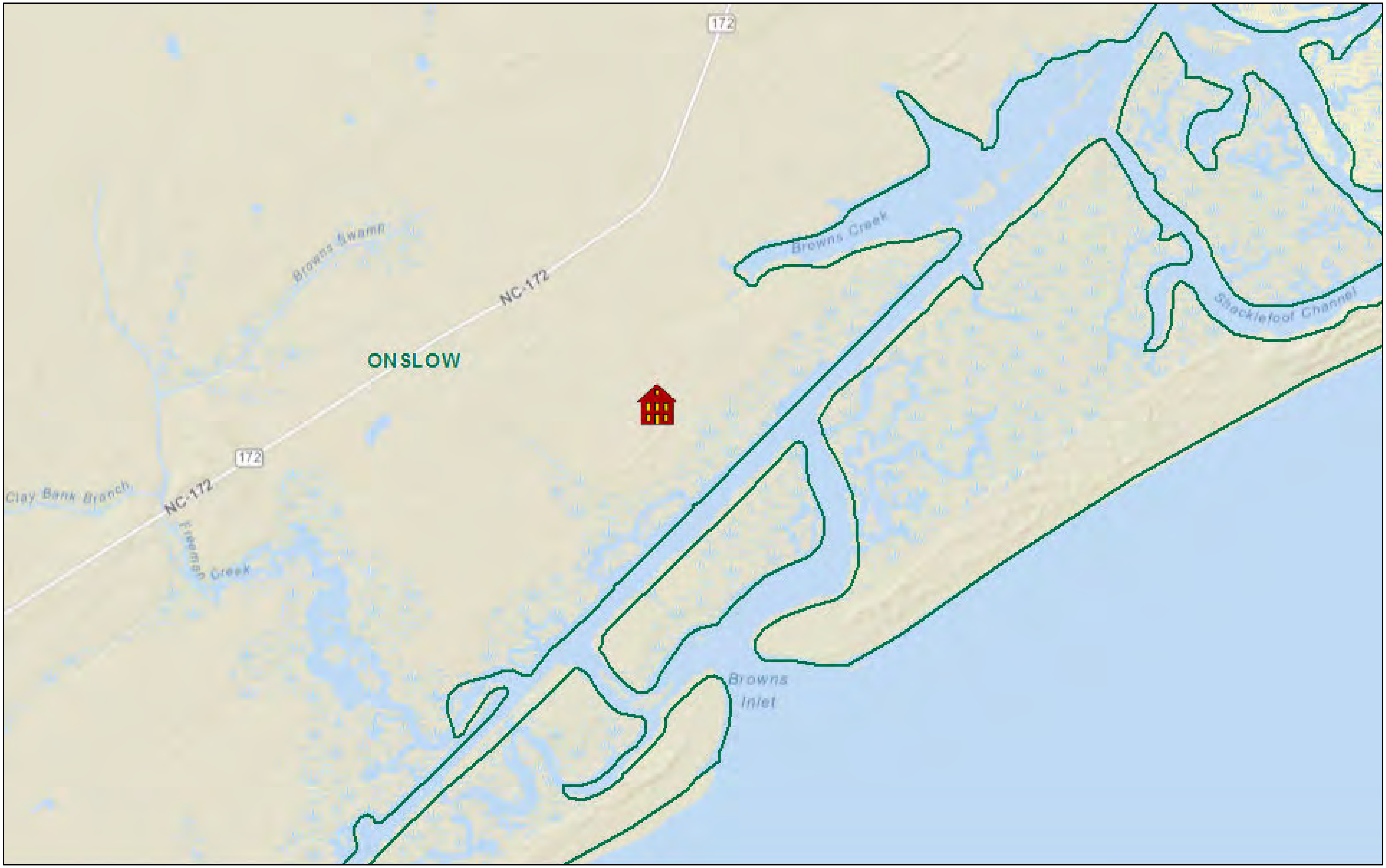
0 0.425 0.85 1.7 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Point 27

Attachment 2



June 12, 2014

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

1:36,112

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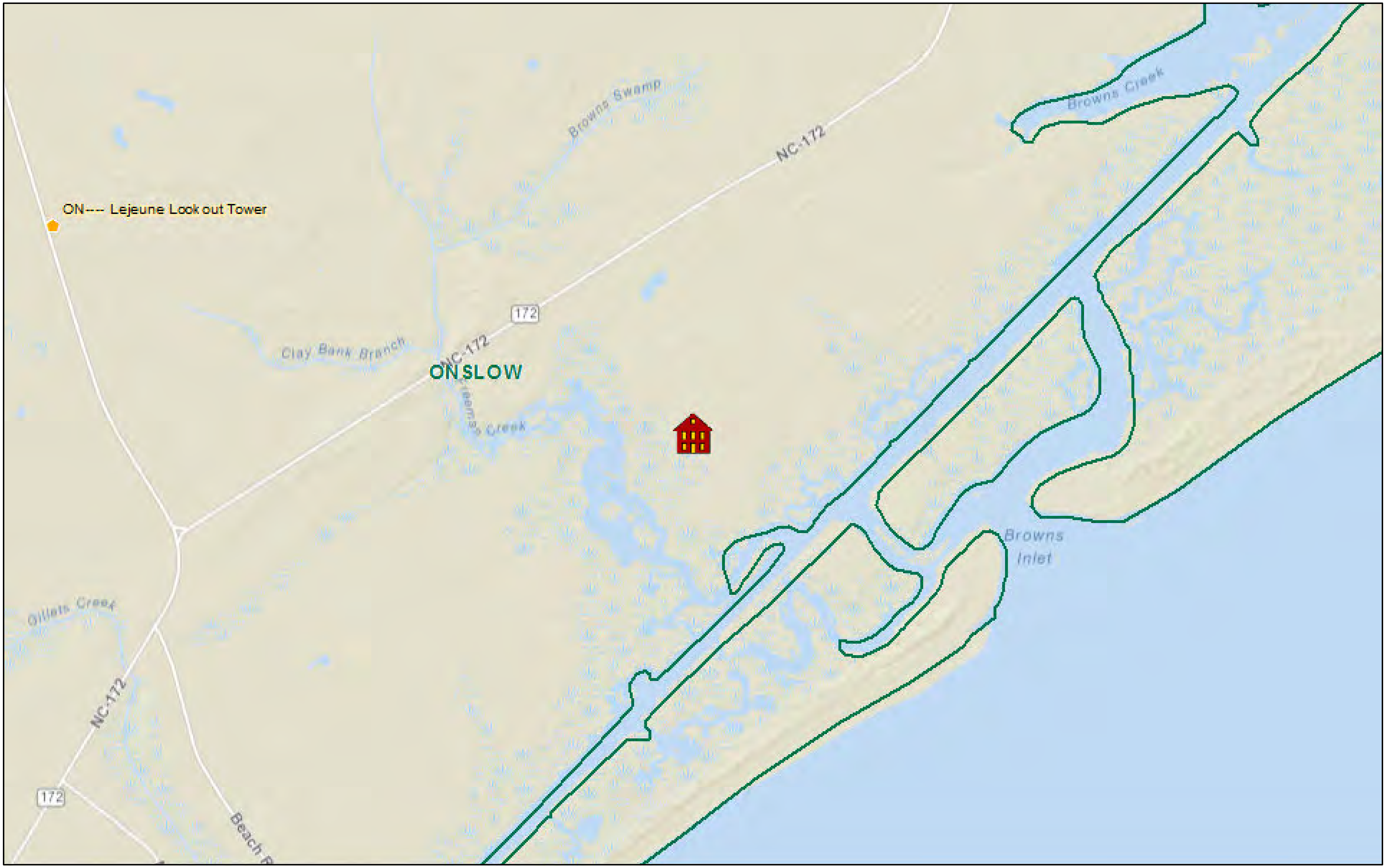
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Point 27A

Attachment 2



June 12, 2014

- NR Individual Listing
- NR Listing, Gone
- NRHD Center Point

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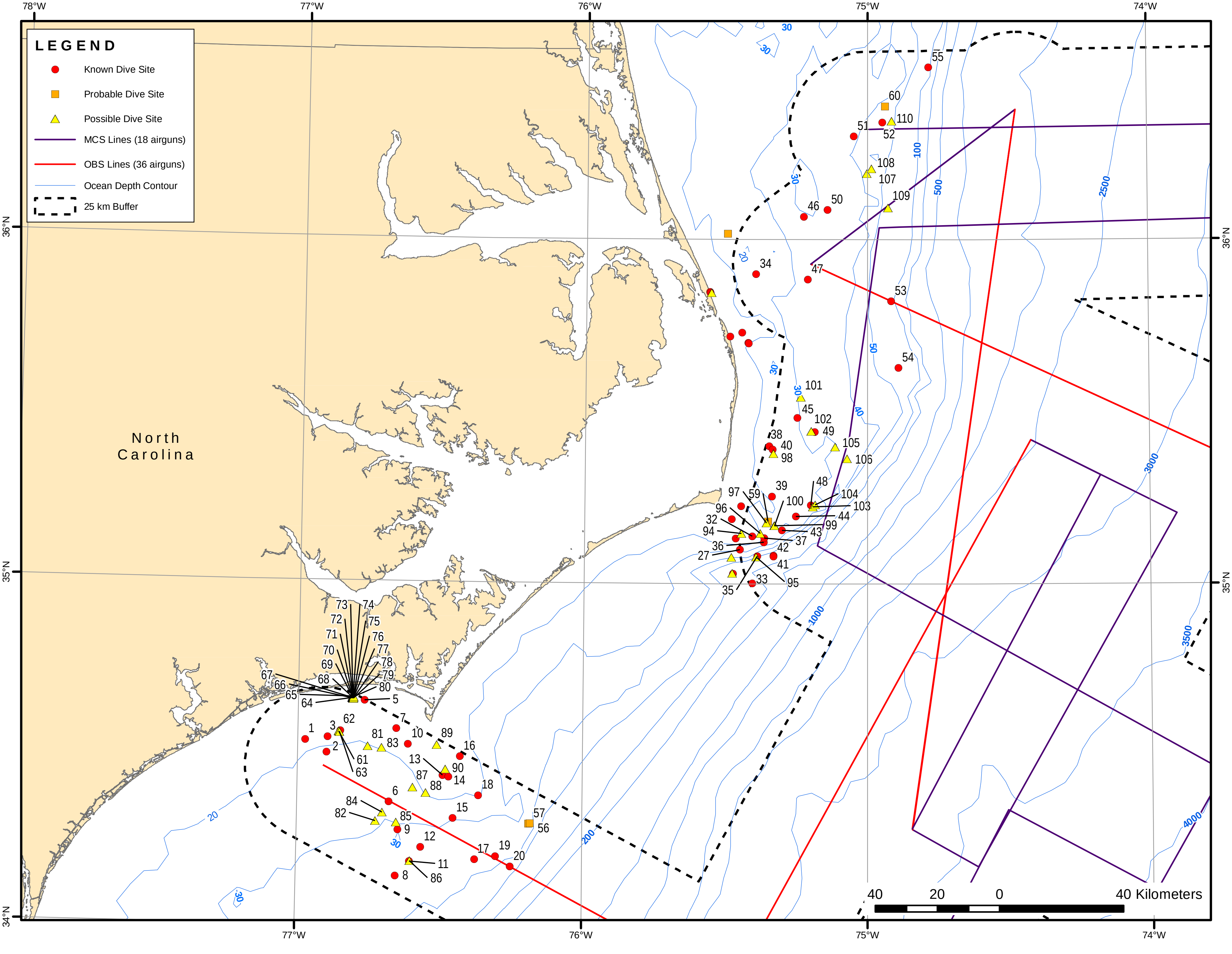
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

APPENDIX H: Additional Dive Site Maps and Artificial Reef Map Information


LEGEND
Known Dive Site
Probable Dive Site
Possible Dive Site
MCS Lines (18 airguns)
OBS Lines (36 airguns)
Ocean Depth Contour
25 km Buffer
North Carolina
78°W
77°W
76°W
75°W
74°W
36°N
35°N
34°N
40 20 0 40 Kilometers
20
30
40
50
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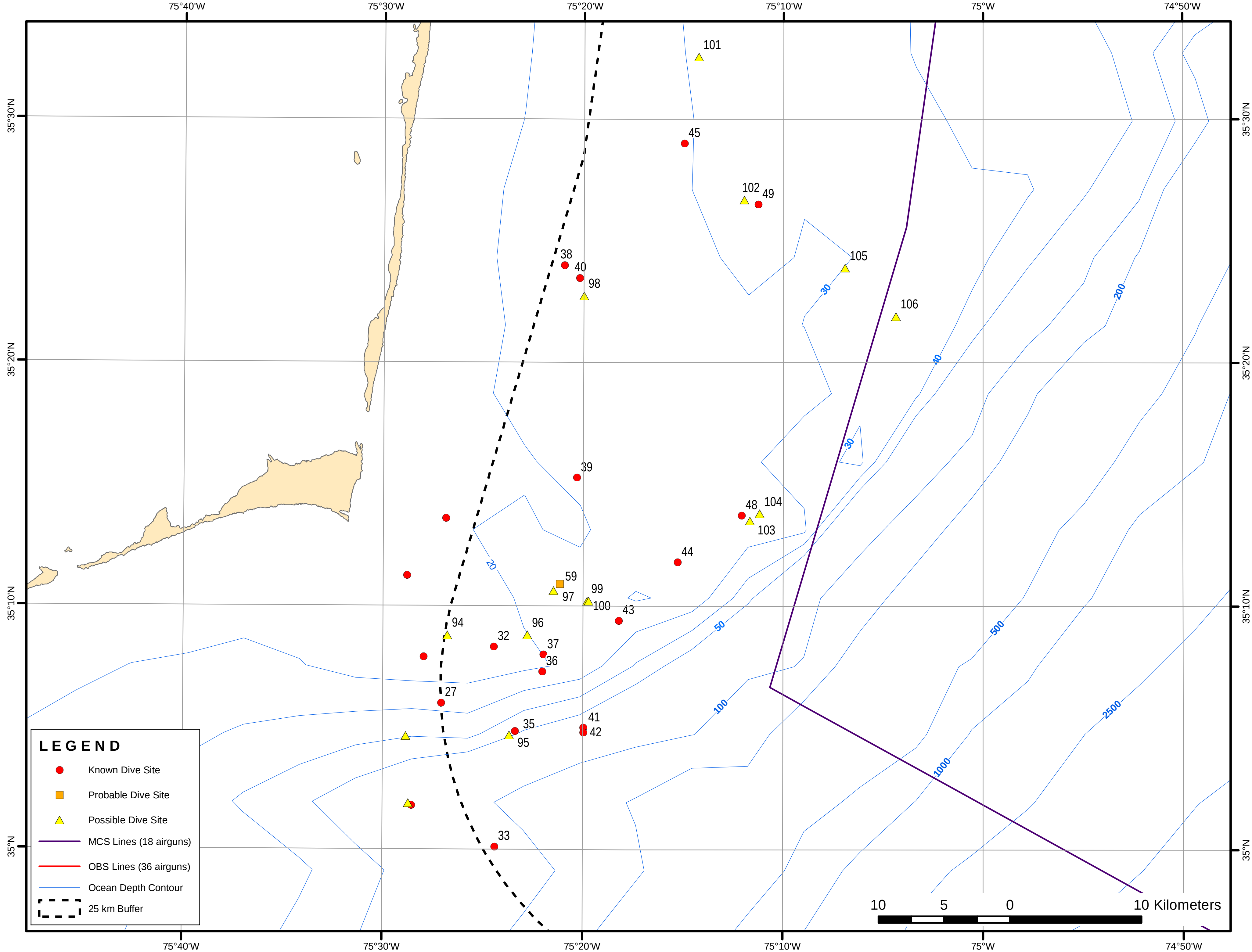
1000
2500
3000
3500
4000



75°40'W
75°30'W
75°20'W
75°10'W
75°W
74°50'W
35°30'N
35°20'N
35°10'N
35°N
101
45
102
49
105
106
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1000
2500
LEGEND
Known Dive Site
Probable Dive Site
Possible Dive Site
MCS Lines (18 airguns)
OBS Lines (36 airguns)
Ocean Depth Contour
25 km Buffer
10
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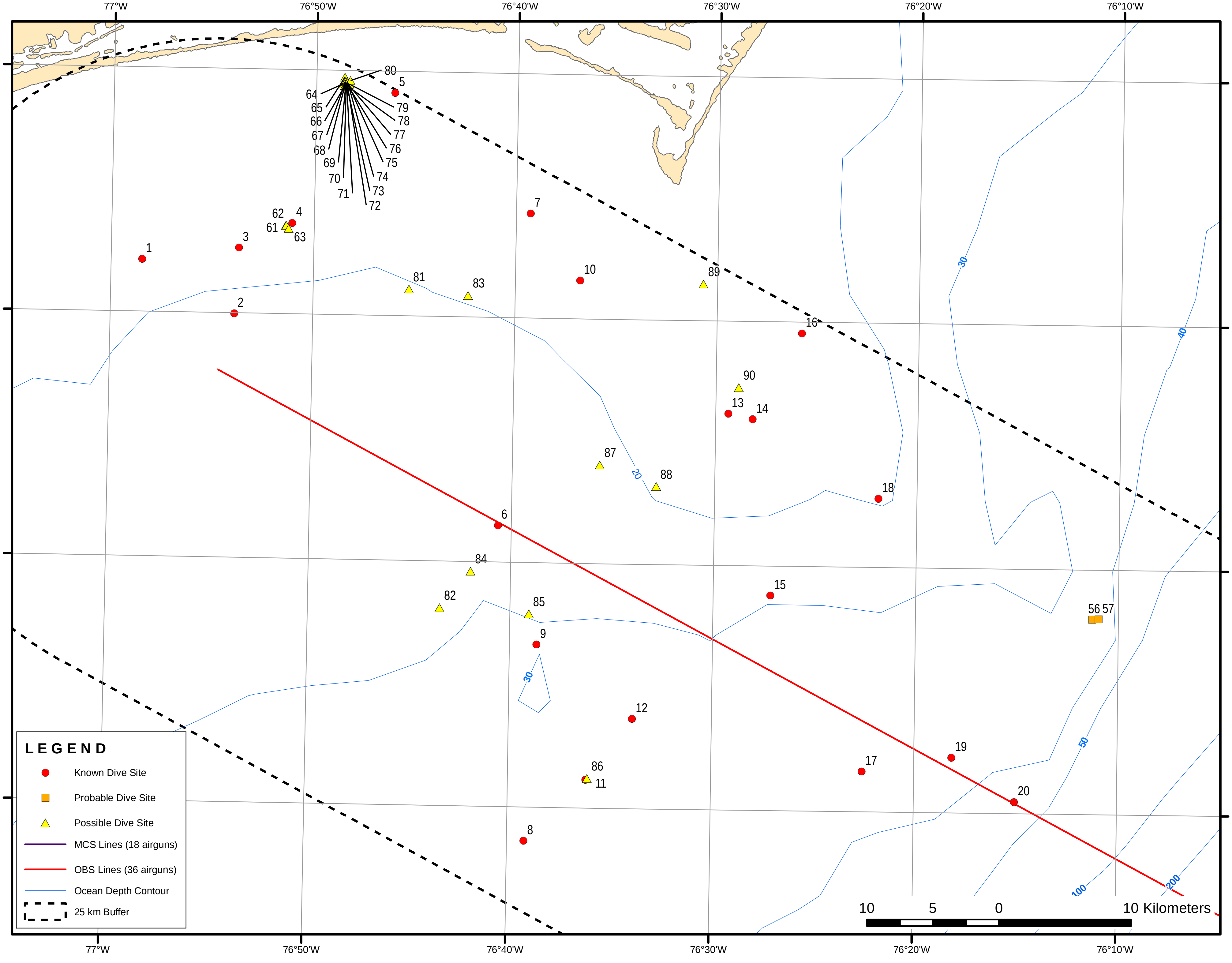
0
10 Kilometers


77°W
76°50'W
76°40'W
76°30'W
76°20'W
76°10'W
34°40'N
34°30'N
34°20'N
34°10'N
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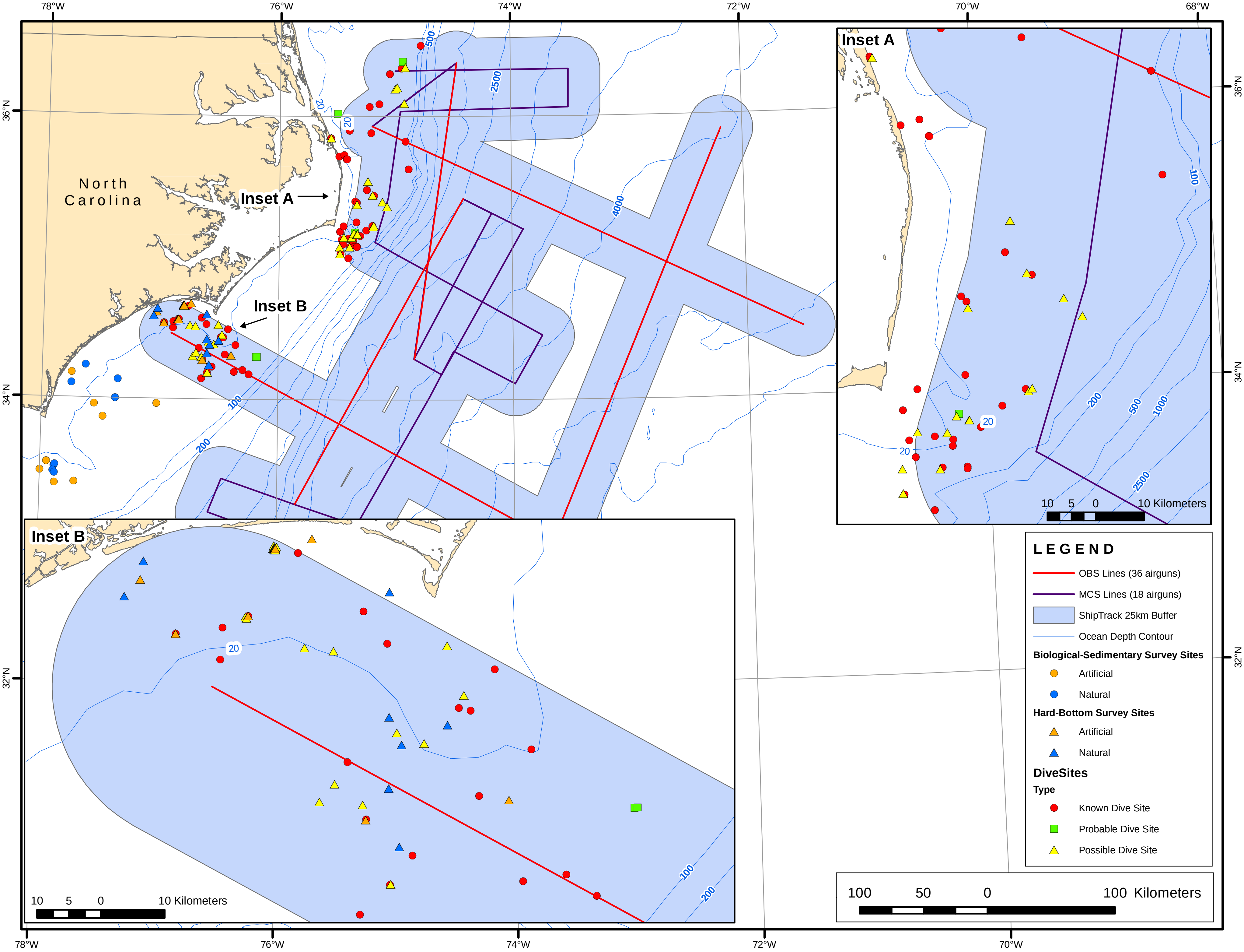
10 5 0 10 Kilometers
LEGEND
Known Dive Site
Probable Dive Site
Possible Dive Site
MCS Lines (18 airguns)
OBS Lines (36 airguns)
Ocean Depth Contour
25 km Buffer



78°W
76°W
74°W
72°W
70°W
68°W
36°N
34°N
32°N
North Carolina
Inset A
Inset B
20
100
200
500
2500
4000
Inset A
100
200
500
1000
2500
20
10 5 0 10 Kilometers
Inset B
20
100
200
10 5 0 10 Kilometers
LEGEND
OBS Lines (36 airguns)
MCS Lines (18 airguns)
ShipTrack 25km Buffer
Ocean Depth Contour
Biological-Sedimentary Survey Sites
Artificial
Natural
Hard-Bottom Survey Sites
Artificial
Natural
DiveSites
Type
Known Dive Site
Probable Dive Site
Possible Dive Site
100 50 0 100 Kilometers