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 Geophysical Surveys by the *R/V Marcus G. Langseth* along the U.S. Atlantic Seaboard, Spring-Summer, 2014-2015

Principal Investigators/Institution: U.S. Geological Survey (USGS)
Project Title: Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards

Introduction

A Final Environmental Assessment (EA) was prepared by the U.S. Geological Survey (USGS) for two marine seismic surveys to be conducted on board the R/V *Marcus G. Langseth* (hereafter *Langseth*) along the U.S. Atlantic Seaboard, spring-summer, 2014-2015. The Final EA was prepared by RPS Evans-Hamilton (RPS), on behalf of USGS, entitled, "Final Environmental Assessment for Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards." The Final EA was based on a Draft EA that had been prepared and used during consultations with federal regulatory agencies and for obtaining public input on the proposed action. The National Science Foundation (NSF), as owner of *Langseth*, participated as a cooperating agency in developing the Draft and Final EA. *Langseth* is operated through a cooperative agreement with Columbia University's Lamont-Doherty Earth Observatory (LDEO).

The conclusions from the Final EA were used to inform the NSF and USGS management of potential environmental impacts of the proposed action and to assist the NSF in its decision of whether or not to allow the use of the R/V *Langseth* in support of the proposed action. The Final EA addressed potential impacts of the seismic surveys on marine mammals, endangered species, and other species of concern in and near the Study Area (Attachment 1, Figure 3), including sea turtles, seabirds, fish, and invertebrates and their habitat.

The Final EA was prepared to fulfill USGS and NSF responsibilities under the National Environmental Policy Act and Executive Order 12114. The Final EA tiers to the Final Programmatic Environmental Impact Statement (PEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or conducted by the U.S. Geological Survey (June 2011), NSF Record of Decision (June 2012), and the USGS Record of Decision (Feb 2013) (referred to herein as NSF/USGS PEIS).

Technical revisions to the Draft EA were made as a result of interactions and discussions among the USGS, NSF, and National Marine Fisheries Service (NMFS). These changes did not alter the overall findings of the Draft EA or USGS's and NSF's concurrence with the Final EA conclusions. The Final EA remained consistent with the NSF/USGS PEIS. The Final EA (Attachment 1) 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

The Draft EA was posted on the NSF website for a 30-day public comment period from May 20 to June 20, 2014. The Draft EA was also cross-posted on the USGS website. No public comments or inquiries were received on the Draft EA during that period. The Draft EA supported requests to NMFS and U.S. Fish and Wildlife Service (USFWS) for the Section 7(a) consultation under the Endangered Species Act and for Essential Fish Habitat (EFH). The Draft EA also provided information in support of the application submitted by the USGS and LDEO to NMFS for an Incidental Harassment Authorization (IHA) under the Marine Mammal Protection Act (MMPA). As noted below, public comments were received during the NMFS IHA process (Attachment 1, Appendix G), and although not received as part of the NSF/USGS NEPA process, NSF and USGS considered the responses with respect to the information included in the Draft EA. After consideration of the public comments received during the NMFS IHA public comment period and discussions during MMPA and ESA consultations with NMFS, refinements to the information presented in the Draft EA were made in the Final EA, such as more detail on the purpose and need for the proposed action, proposed survey timing, and scientific literature published since the NSF/USGS PEIS was issued in 2011.

Marine Mammal Protection Act (MMPA)

USGS and LDEO submitted to NMFS an IHA Application pursuant to the Marine Mammal Protection Act (MMPA). NSF and USGS communicated regularly (often several times per week) by phone and email with NMFS as part of the consultation. As noted above, public comments (Attachment 1, Appendix G) were received by NMFS on the Notice of Intent to Issue and IHA (Attachment 1, Appendix F). NMFS will respond to the public comments in a Notice in the Federal Register. NMFS issued the IHA (Attachment 2) and its terms will serve as conditions for conducting the proposed seismic surveys.

Endangered Species Act (ESA)

USGS, together with 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). USGS and NSF met every two weeks with NMFS and sometimes more frequently during the consultation process. NMFS issued a Biological Opinion and an Incidental Take Statement (Attachment 3) for the proposed activities and consultation was concluded. On August 11, 2014, USFWS provided a letter of concurrence that the proposed action would not adversely affect the avian species under their jurisdiction (Attachment 1, Appendix E).

Magnuson Stevens Act – Essential Fish Habitat (EFH)

The Magnuson-Stevens Act requires that a Federal Action agency consult with NMFS for actions that "may adversely affect" EFH. Although adverse effects on EFH, including a reduction in quantity or quality of EFH, were not anticipated as a result of the proposed activities, USGS contacted the Habitat Conservation Specialists from the Northeast and Southeast offices of the Greater Atlantic Region regarding the proposed action. After reviewing the analysis and proposed mitigation in the Draft EA, it was determined that minor adverse impacts to water column habitats might occur as a result of the proposed activities; however, the EFH Regional Coordinator concluded "...we have no EFH conservation recommendations to provide pursuant to Section 305(b)(2) of the Magnuson-Stevens Act at this time." (Attachment 1, Appendix D).

Coastal Zone Management Act (CZMA)
USGS was the lead federal agency on the proposed action, and as such, NSF had no obligations under CZMA. As the lead federal agency for the proposed activities, the USGS considered whether the proposed activities would have effects on coastal resources of any state along the Atlantic Seaboard. As concluded in the Final EA, any potential impacts from the proposed activities would mainly be to marine species in close proximity to the vessel and would be of short duration and temporary in nature. The proposed surveys would occur in ~2000-5000 m water depth, and would occur mostly beyond 200 nm. The closest approach to land would be ~170 km/~106 statute miles/~92 nautical miles. Additionally, the Level B zone for the project, the area considered by NMFS that has the potential to harass marine mammals would be ~159 km/~99 statute miles/~86 nautical miles to the closest approach to state waters. Because of the proposed surveys' location in deep water and long distances from the U.S. coast, USGS concluded the surveys would have no effect on coastal zone resources. USGS reviewed the Federal Consistency Listings for the states along the Atlantic Seaboard and determined that the proposed activities are not listed. USGS did not receive a request from any state for a consistency review of the unlisted activities. Therefore, it was concluded that the USGS met all of the responsibilities under CZMA. NSF and USGS 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.

Project Objectives and Context
The underlying purpose of this study is to define the seafloor and sub-seafloor that are parts of the Continental Shelf of the U.S. Only after the Extended Continental Shelf (ECS) is delineated can it be evaluated and designated for conservation, management, resource exploitation, or other purposes. The proposed project is part of an ECS Interagency Task Force that has been in existence since 2007 to identify all parts of the U.S. margins beyond 200 nm where the U.S. can potentially exert its sovereign rights. Unless the ECS is delineated as part of the Continental Shelf of the U.S., it could be explored and exploited outside of the U.S. regulatory system. The ultimate determination as to whether the outer limits of the ECS will be delineated as part of the Continental Shelf of the U.S. is partially dependent upon the data that would be collected during these surveys.

As part of estimating sediment thickness in the proposed Atlantic surveys, one objective is to identify the locations of fracture zones, where the sediments could be thicker than in the intra-fracture zone regions. These fracture zones are the result of juxtaposing oceanic crust of different ages across ridge offsets during the spreading process. The 2014 part of the program (with lines parallel to the margin) is intended to identify the possible existence of fracture zones that are sub-perpendicular to the margin. If these fracture zones can be identified, the 2015 component of the seismic program is to then collect seismic data along tracks that follow where the sediment is thickest and therefore the U.S. ECS can be established.

An ancillary objective of the surveys is to assess the potentially tsunamigenic geologic hazards along the Atlantic seaboard. Since the 2004 Banda Aceh tsunami and the more recent 2010 Tohoku tsunami, the U.S. Nuclear Regulatory Agency has contracted with the USGS to evaluate tsunami hazards along the U.S. margins, because of the potential threat to, for example, nuclear power plants, coastal cities, industrial centers, and port facilities, including along the Atlantic Seaboard. Other agencies such as the Federal Emergency Management Agency (FEMA) offices in several coastal states and the City of Boston Office of Emergency Management requested input and assessment from the USGS for their tsunami preparedness. Tsunamis on passive margins such as the Atlantic pose a challenge to regulators because these events are rare (i.e., low probability) but potentially devastating (i.e., high risk). The 1929 Grand Banks tsunami, measured and modeled overpressures on the NJ margin that can cause slope failure, and evidence of enormous submarine landslides (such as the Cape Fear slide) demonstrate that the Atlantic margin is not immune to the potential tsunamigenic hazard. As part of its research into submarine landslides, the USGS has utilized a multi-pronged approach, for example, analytic and numerical models, geomorphologic analysis, regional assessments using existing data, geotechnical analysis, and laboratory studies. No single landslide, however, has been mapped from the location of its origin (headwall on the continental slope) to its run-out position on the lower rise/abyssal plain, with supporting evidence to show the aggradational and structural relationships in the subsurface among the different parts of the composite landslide system. This lack of information prevents further modeling of the processes of these landslides and evaluating the potential tsunamigenic risks they have posed or could pose along the Atlantic margin. The proposed surveys offer the opportunity to study the vertical (depth) aspects of two major landslides on the U.S. margin, and therefore leverage federal resources across two scientific programs and projects (ECS and Natural Hazards). The overlap in the areas of interest for the ECS and natural hazards eliminates the need for redundant surveys if the field programs for the two projects are combined.

Summary of Proposed Action

The USGS proposes to conduct two regional marine geophysical scientific research surveys in the Atlantic over the next two years (2014-2015). The duration of each survey would be approximately three weeks. The surveys would extend from near Georges Bank in the north to near the Blake Outer Ridge in the south, and would be largely in international waters beyond the 200-nm U.S. Exclusive Economic Zone. The approximate bounding coordinates of the surveys would be:

Geographic Location of Surveys
40.5694° N / -66.5324° W
38.5808° N / -61.7105° W
29.2456° N / -72.6766° W
33.1752° N / -75.8697° W
39.1583° N / -72.8697° W

The activities are proposed to be conducted on the *Langseth*. The specific survey method proposed is two-dimensional (2D) seismic reflection profiling, using a 36-airgun array of approximately 6,600 cubic inch total volume, towed approximately 9 meters below the sea surface, and an 8-km long hydrophone streamer, also at 9 meters depth. The airgun array would create a seismic pulse at approximately 20-second intervals during the surveys. Water depths in the Study Area would be no shallower than 1,000 meters, and the closest approaches of the surveys to the Atlantic coastline would be approximately 183 kilometers (98 nautical miles) towards New Jersey and approximately 170 kilometers (92 nautical miles) towards North Carolina. The 2014 survey would consist of approximately 3,165 kilometers (1,707 nautical miles) of survey lines, which would take approximately 18 days to complete at the planned survey speed of 4.3 knots; total survey time would be approximately 21 days. The 2015 survey would be virtually identical in duration and track line distance, and would be scheduled for the April to August time window. The proposed surveys design consists of approximately nine (9) sub-parallel, NW-SE lines perpendicular to the margin across the Study Area, with end-line transits and several NE to SW tie or strike lines. The airgun array would operate continuously during the surveys, except for power/shut downs, equipment repair or weather issues. Data would continue to be acquired on turns between line changes. In addition to the operations of the airgun array, a multibeam echosounder (MBES), sub-bottom profiler (SBP), and acoustic Doppler current profiler are proposed to be operated from the R/V *Langseth* continuously throughout the surveys, except during transits and equipment deployment and recovery.

Impact definitions used in the EA were based on magnitude, geographic extent, and duration of the proposed action. Impact zones, particularly for marine mammals, are defined as the areas within which specific sound level thresholds established by National Marine Fisheries Service (NMFS) / National Oceanic and Atmospheric Administration (NOAA) could occur. For cetaceans, an exclusion zone (i.e., where the airguns would be partially or fully shut down) would occur in areas where the sound pressure exceeds 180 dB re 1μPa rms around the ship and a buffer zone extends to the limit where the sound pressure decreases to 160 dB re 1μPa rms (for cetaceans). These zones would be 190/160 dB re 1μPa rms for pinnipeds and 180/166 re 1μPa rms for sea turtles.

Monitoring and mitigation measures would be an integral part of the proposed activities. The observance of mitigation measures would minimize the potential adverse effects on the environment, including marine species, populations, and habitat. Mitigation proposed in the Draft EA was consistent with measures specified in the NSF/USGS PEIS. Proposed mitigation is described further below, and in the Final EA (Attachment 1), the IHA (Attachment 2) and the Biological Opinion (Attachment 3), and would be implemented during the surveys. All observations and detailed reporting of animals sighted during the surveys would be recorded and submitted to NMFS under the terms of the IHA.

Alternatives to proposed activities considered
One alternative to the proposed action would be to conduct the surveys at different times. The U.S. Interagency Task Force on the Extended Continental Shelf (ECS), under leadership of the Department of State, has established a Project Office to complete work on delineating the outer limits of the U.S. ECS in 5 years from 2014-2019. Delineating the Atlantic margin ECS takes two field surveys (as proposed in this action), at least two years of analysis and interpretation

following data acquisition, as well as one year to develop the appropriate technical documentation for Article 76 of the Law of the Sea Convention. Delaying the proposed 2014 field program by a year jeopardizes completing the necessary steps to meet the 5-year Project Office deadline.

Constraints for vessel operations and availability of equipment (including the vessel) and personnel would need to be considered for alternative cruise 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 period, is another factor for consideration in survey timing. Limitations on scheduling the vessel include the additional research studies planned on the vessel for 2014 and beyond. Other activities, including research activities, planned within the region also would need to be considered if the surveys were scheduled for alternative times.

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 activities were not conducted, the "No Action" alternative would result in no disturbance to marine species attributable to the proposed activities, but data related to establishing the U.S. ECS and tsunami hazards would not be obtained 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. USGS, 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.

Summary of environmental consequences

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 the 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).

As noted previously, the proposed action would include 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 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) and the IHA (Attachment 2) operational monitoring and mitigation measures would include: ramp ups; a minimum of one, but typically two dedicated observers maintaining a visual watch during all daytime airgun operations; two observers for 30 minutes before and during ramp-ups during the day and at night; 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.

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.

Fisheries activities would not be precluded in the Study Area; given the distance to shore, recreational fishing in the Study Area would be unlikely, however, commercial fishing activities could be encountered. LDEO would issue Notices to Mariners to coordinate and provide updates on operations in the Study Area. Given the location of the surveys in deep water, the short duration and transitory nature of the surveys, and the temporary nature of potential environmental impacts, significant impacts on fisheries activities would not be anticipated.

Given the water depths in which the surveys would be conducted (1,000 to >5,000 meters), the project would have minimal impact on fish resources. No detrimental effects on EFH are expected. Impacts of seismic sounds on birds at rest or foraging in the water are possible, although none are expected to significantly affect any bird populations. Sea turtles may be encountered, and would be afforded the same protective measures as marine mammals.

Cumulative effects, such as from commercial vessel traffic, military activities, and other sources of underwater sound were assessed in the Final EA. Cumulative environmental effects resulting from any of the proposed project activities would be negligible and not additive because the project activities would be transitory and temporary, moving about 200 km a day. With the implementation of mitigation measures and the limited spatial overlap with other activities, any potential for cumulative effects would be negligible and therefore not significant on the environment.

The Action Alternative, to conduct the surveys at a different time, would not alter the possible effects of the proposed action; however, it could result in fewer authorized takes of some marine species and greater authorized takes of other marine species due to biological considerations such as migration periods. Weather conditions in the Atlantic and ship schedules constrain the possible survey time window to May through September. In addition, scheduling the surveys in mid-summer when daylight hours are maximized facilitates observations of marine wildlife in accordance with the IHA from NMFS and ESA considerations. Conducting the surveys at an alternative time would result in few if any net benefits. Marine mammals and sea turtles are expected to be found throughout the proposed survey area year-round. Some migratory species are expected to be farther north at the time of the proposed surveys, such as the North Atlantic right whale, so the proposed timing may be beneficial for those species.

The "No Action" alternative, i.e., not conducting the operations, would result in no impacts to the environment, including marine species. However, the seismic data necessary to delineate the outer limit of the ECS would not be acquired, the U.S. could not establish ECS outer limits along the Atlantic margin using the sediment thickness formula as required under the terms of Article 76 of the Law of the Sea Convention, and the area of the potential ECS would not be subject to U.S. regulatory authority. The "No Action" alternative would also result in a lost opportunity to obtain important scientific data and knowledge relevant and necessary for understanding natural hazards that could affect the Atlantic and Caribbean coastal zones.

Conclusions and Decision

NSF has reviewed and concurs with the conclusions of the Final EA (Attachment 1) that implementation of the proposed activities will not have a significant impact on the environment. Consequently, implementation of the proposed activities will not have a significant direct, indirect or cumulative impact on the environment within the meaning of the National Environmental Policy Act (NEPA). 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 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 Act has been completed. Therefore, on behalf of the NSF, I authorize the issuance of a Finding of No Significant Impact for the USGS marine seismic surveys along the U.S. Atlantic Seaboard to be conducted on board the *Langseth* in 2014-2015. I hereby approve the use of the *Langseth* in support of the proposed activities and the Proposed Action to commence.

Bauke Houtman
Head, Integrative Programs Section
Division of Ocean Sciences

8/21/14
Date

Attachments:

1. Final Environmental Assessment
2. NMFS IHA
3. NMFS Biological Opinion

Attachment 1

Final Environmental Assessment

Final Environmental Assessment for Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the US Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards

Prepared for

United States Geological Survey

Prepared by RPS Evan – Hamilton Inc. (EHI) an RPS Group Company
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ACRONYMS AND ABBREVIATIONS

μPa	microPascal
BOEM	Bureau of Ocean Energy Management
2D	Two Dimensional
CR	Critically Endangered
dB	decibel re: 1 μPascal m
DOC	Department of Commerce
EA	Environmental Assessment
ECS	Extended Continental Shelf
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EN	Endangered
ENAM	Eastern North American Margins
ESA	Endangered Species Act
EZ	Exclusion Zone
FLS	Fisheries Log Book System
FMZ	Full Mitigation Zone
HMS	Highly Migratory Species
Hz	Hertz
IHA	Incidental Harassment Authorization
in^3	cubic inches
ICCAT	International Commission for the Conservation of Atlantic Tuna
IVQ	individual vessel quota
kHz	kiloHertz
km	kilometer
kW	kilowatt
LC	Least Concern
LME	Large Marine Ecosystem
L-DEO	Lamont-Doherty Earth Observatory
LNG	Liquefied Natural Gas
m	meter
MAB	mid-Atlantic Bight
MAR	mid-Atlantic Region
MARAD	Maritime Administration
MARPOL	Marine Pollution
MBES	MultiBeam EchoSounder
MCS	Marine Conservation Society
MMS	Mineral Management Service
MPA	Marine Protected Area
MMPA	Marine Mammal Protection Act
ms	millisecond
mt	metric ton
MSDS	Material Safety Data Sheets
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NL	Not Listed
nm	nautical mile
NMFS	National Marine Fisheries Service
NMO	Normal-Moveout

NOAA	National Oceanographic and Atmospheric Administration
NSF	National Science Foundation
OBIS	Ocean Biogeographic Information System
OCS	Outer Continental Shelf
OEIS	Overseas Environmental Impact Statement
OPR	Office of Protected Resources
PAM	Passive Acoustic Monitoring
PEIS	Programmatic Environmental Impact Statement
PLL	Pelagic Long Lines
PSO	Protected Species Observer
PSVO	Protected Species Visual Observer
PTS	Permanent Threshold Shift
rms	Root Mean Square
s	second
SAB	South Atlantic Bight
SAFE	Stock Assessment and Fishery Evaluation
SBP	Sub-Bottom Profiler
SCRS	Standing Committee for Research and Science
SEFSC	Southeast Fishery Science Center
SEL	Sound Exposure Level
SEL_{cum}	cumulative Sound Exposure Level
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
TAC	Total Allowable Catch
TR	Threatened
TTS	Temporary Threshold Shift
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UO	Unexploded Ordnance

EXECUTIVE SUMMARY

The United States Geological Survey (USGS) proposes to conduct regional marine two-dimensional (2D) seismic reflection scientific research surveys in the Atlantic over the next two years (2014-2015). The purposes of the project are two-fold: 1) To establish the outer limits of the U.S. continental shelf, also referred to as the Extended Continental Shelf (ECS), as defined by Article 76 of the Convention of the Law of the Sea, and 2) To study the sudden mass transport of sediments down the continental shelf as submarine landslides that pose potential tsunamigenic hazards to Atlantic and Caribbean coastal communities. The activities are proposed to be conducted on the National Science Foundation (NSF) owned research vessel, *R/V* Marcus G. *Langseth*, which is operated through a cooperative agreement with Columbia University's Lamont-Doherty Earth Observatory (L-DEO).

The 2D seismic surveys are proposed to occur in two phases over a one year period between August, 2014 and August, 2015. The 2014 survey is proposed to commence in mid-August and proceed for approximately 18 days (including transits and equipment mobilization and demobilization). The 2015 survey is proposed to occur for approximately 21 days between April and August, 2015. This Final Environmental Assessment (EA) was prepared to fulfill USGS and NSF responsibilities under the National Environmental Policy Act and Executive Order 12114. NSF is participating as a cooperating agency with USGS on this Final EA.

Scoping for the Final EA was derived from the Final Programmatic Environmental Impact Statement (PEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or conducted by the U.S. Geological Survey (June 2011), NSF Record of Decision (June 2012), and the USGS Record of Decision (Feb 2013) (referred to herein as NSF/USGS PEIS).

Impact definitions used in the Final EA were based on magnitude, geographic extent, and duration. Impact zones, particularly for marine mammals, are defined as the areas within which specific sound level thresholds established by National Oceanic and Atmospheric Administration (NOAA)'s National Marine Fisheries Service (NMFS) / National Oceanic and Atmospheric Administration (NOAA) are exceeded. For cetaceans, NMFS guidelines used to assess potential hearing impairment effects are:

- received sound pressure level (SPL) ≥ 180 dB re 1 μPa^2 for Permanent Threshold Shift (PTS) in hearing (MMPA Level A harassment); and
- received sound pressure level (RMS) >160 dB re 1 μPa for behavior disturbance (MMPA Level B harassment)

Acoustic modeling results provided by the vessel operator Lamont-Doherty Earth Observatory (Appendix A) were used to determine 160 dB and 180 dB isopleth radii.

USGS and NSF are committed to the mitigation measures and monitoring as outlined in the NSF/USGS PEIS, which included both pre-cruise planning and operational activities.

The application of mitigation measures would minimize the possibility of potential adverse effects on the environment including marine species, populations, and habitat.

Other potential activities external to the proposed activity that could occur within or near the survey area include fishing, scientific research surveys, military, submarine cables, marine transportation, and potentially other seismic surveys. Cumulative environmental effects resulting from the proposed action or the proposed action in combination with these other activities would be negligible and not additive because the proposed action would be transitory, moving about 200 km a day. With the implementation of mitigation measures and the limited spatial overlap with other activities, any potential for cumulative effects would be minimized.

USGS and Lamont-Doherty Earth Observatory submitted an Incidental Harassment Authorization (IHA) request to NMFS pursuant to the Marine Mammal Protection Act (MMPA). USGS and National Science Foundation (NSF) requested formal consultation under Section 7 of the Endangered Species Act (ESA) with NOAA and the US Fish and Wildlife Service (USFWS). The IHA application is included in this Final EA as an Appendix B. Consultation for Essential Fish Habitat was also conducted.

1 INTRODUCTION

The US Geological Survey (USGS) proposes to conduct a regional marine two-dimensional (2D) seismic reflection survey program in two separate field seasons in 2014 and 2015. The surveys would be conducted with the *R/V Marcus G. Langseth* (hereafter referred to as the *Langseth*), a research vessel owned by the National Science Foundation (NSF) and operated under Cooperative Agreement by the Lamont-Doherty Earth Observatory (LDEO) of Columbia University. The survey region (hereafter "Study Area") would be in the northwest Atlantic Ocean within the U.S. Exclusive Economic Zone (EEZ) and extending into international waters as far as 350 nautical miles (nm) from the coast (Figure 1). Water depth in the Study Area would range from 1,450 m to 5,400 m. The survey program is proposed to occur in two phases, the first proposed for August to September 2014 and the second in 2015, between April and August (dates are yet to be determined). As the funding agency, the USGS has taken the lead in the environmental compliance requirements and science planning.

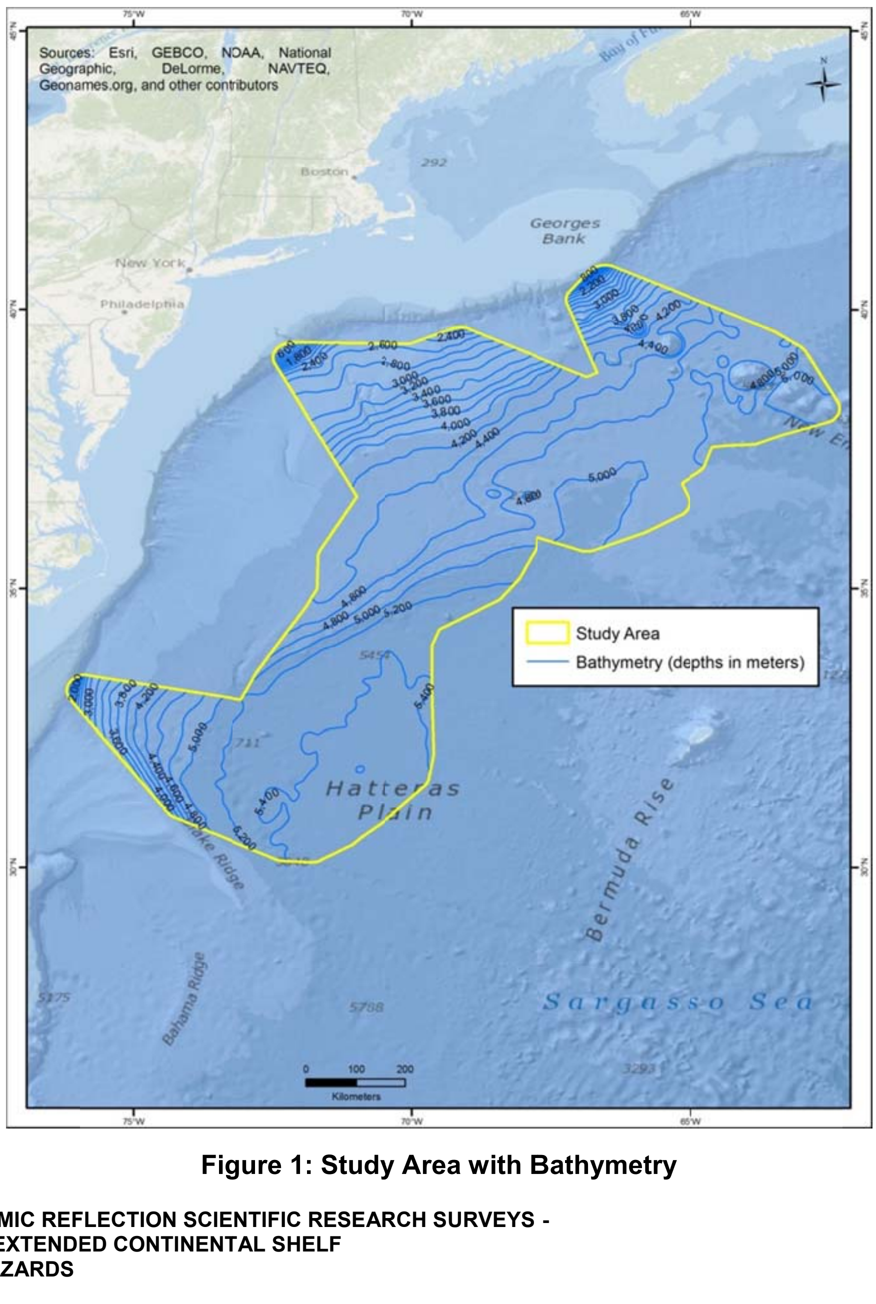

Figure 1: Study Area with Bathymetry

The purpose of this Final Environmental Assessment (EA) is to provide the information needed to assess the potential environmental impacts associated with the proposed seismic surveys.

The Final EA addresses the requirements of the U.S. National Environmental Policy Act (NEPA) and Executive Order 12114, Environmental Effects Abroad of Major Federal Actions. Alternatives addressed in this Draft EA consist of a corresponding program at a different time, along with issuance of an associated Incidental Harassment Authorization (IHA); and the no action alternative, with no IHA and no seismic survey. This Final EA tiers to the Final Programmatic Environmental Impact Statement (PEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (June 2011), the USGS Record of Decision (February 2013) and the NSF Record of Decision (June 2012)[1], referred to herein as NSF/USGS PEIS. Additionally, information from the 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 (NSF, 2014, referred to herein as NSF ENAM Draft EA) prepared for the NSF proposed U.S. GeoPRISMS Eastern North American Margin (ENAM) seismic survey discusses scientific publications subsequent to the issuance of the NSF/USGS PEIS that are relevant to the proposed actions and therefore are incorporated by reference into this Final EA where appropriate.

The USGS and LDEO requested an IHA from the U.S. National Marine Fisheries Service (NMFS). USGS and NSF also requested Section 7 consultations with NMFS and U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (ESA) to authorize the incidental, i.e., not intentional, harassment of small numbers of marine mammals that could occur during the seismic survey. The information in this Final EA supported the IHA application process and provided additional information on marine species that were not addressed by the IHA application, including marine and migratory birds, sea turtles, invertebrates, fish; and socio-economic components. The IHA request is included in this document as Appendix B.

The *Langseth* has conducted research seismic surveys world-wide since 2008. Information from previous EAs and IHAs may be found at:

http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications
http://www.nsf.gov/geo/oce/envcomp/index.jsp

Many of these reports and applications were prepared by LGL Limited, Environmental Research Associates, under contract to L-DEO or the USGS. Because material from earlier documents is owned by the U.S. Government and in the public domain, some material common to these documents may have been used verbatim herein without attribution. The USGS and NSF acknowledge the role of LGL in preparing material that has been used.

[1] http://woodshole.er.usgs.gov/project-pages/environmental_compliance/ and http://www.nsf.gov/geo/oce/envcomp/index.jsp

1.1 PURPOSE AND NEED FOR THE PROJECT

The purposes of the project are two-fold:

1) To establish the outer limits of the U.S. continental shelf, also referred to as the Extended Continental Shelf (ECS), as defined by Article 76 of the Convention of the Law of the Sea[2].

The purpose of the proposed study is to define the seafloor and sub-seafloor that is part of the United States of America's Continental Shelf. Only after the ECS is delineated can it be designated for conservation, for management, for resource exploitation, or for other purpose. The proposed seismic survey is independent of oil and gas exploration, which is regulated by BOEM. The proposed project is part of an interagency task force that has been in existence since 2007 to identify all the parts of the U.S. margins beyond 200 nm where the U.S. can potentially exert its sovereign rights, including, but not limited to conservation, management, or exploitation. Unless the ECS is delineated as part of the United States, it could potentially be developed and utilized outside of the U.S. regulatory framework.

The Atlantic margin is a priority for the US ECS project. The Atlantic is potentially the second largest region of ECS for the US (second to the Arctic). The USGS participated in four field seasons of joint seismic-bathymetric work in the Arctic collaborative with the Geological Survey of Canada as the first priority between 2008 and 2011. An opportunity to collect data for the ECS in the Pacific Ocean was possible in 2011, and at that time, data were collected in the Gulf of Alaska and the Bering Sea, two areas of potential U.S. ECS. Since 2011, the Atlantic has been the highest priority for gathering ECS-relevant seismic data, both for the ECS Interagency Task Force and the Coastal and Marine Geology Program of USGS.

The ECS project has teams that have been working in each region since 2010. A preliminary assessment of existing data for the Atlantic margin was completed in 2012. Since that time, the final track line program has been proposed and modified per presentations to the ECS working group and the ECS seismic methodology team. This fiscal year (2014) is the first opportunity that both a ship and sufficient funding resources have been available for a field program in the Atlantic. Finishing data collection in 2015 provides sufficient time to complete interpretations of the data for ECS by 2017, which allows the Department of State sufficient time to complete the documentation of the outer limits of the ECS by the 2018-2019 deadline established in their 5-year program.

One of the criteria for defining the outer limits of the ECS under Article 76 involves measuring the thickness of the sediments beneath the seafloor but above the oceanic crust. The sediment thickness must be measured continuously from the foot of the continental slope seaward to a point where the outer limit point is identified. The established method for measuring sediment thickness is seismic reflection profiling (Kasuga et al., 2000). Other scientific methods (such as measurements of marine gravity and magnetic anomalies) may be used to augment the geologic interpretation, but the internationally accepted method for measuring sediment thickness is seismic reflection profiling. An extensive review of the existing database

[2] Refer to: http://www.state.gov/e/oes/lawofthesea/ and http://continentalshelf.gov/

(Hutchinson and others, 2004) demonstrated that existing seismic-reflection data are entirely insufficient to meet the line-spacing or velocity control requirements specified in Article 76.

The proposed survey is designed using established methods of measuring sediment thickness according to guidelines established by the Commission on the Limits of the Continental Shelf[3].

2) To study the sudden mass transport of sediments down the continental shelf as submarine landslides that may pose tsunamigenic hazards to the Atlantic and Caribbean coastal areas.

Since the 2004 Banda Aceh tsunami and the more recent 2010 Tohoku tsunami, the U.S. Nuclear Regulatory Agency has contracted with the USGS to evaluate tsunami hazards along the U.S. margins, because of the potential threat to, for example, nuclear power plants, coastal cities, industrial centers, and port facilities, including along the Atlantic. Other agencies such as the Federal Emergency Management Agency (FEMA) offices in several coastal states and the City of Boston Office of Emergency Management requested input and assessment from the USGS for their tsunami preparedness. Tsunamis on passive margins such as the Atlantic pose a challenge to regulators because these events are rare (i.e., low probability) but potentially devastating (i.e., high risk). The 1929 Grand Banks tsunami (Fine et al., 2005), measured and modeled overpressures on the NJ margin that can cause slope failure (Dugan et al., 2000), and evidence of enormous submarine landslides (such as the Cape Fear slide [Hornbach et al., 2007]) demonstrate that the Atlantic margin is not immune to the potential tsunamigenic hazard. As part of its research into submarine landslides, the USGS utilizes a multi-pronged approach, for example, analytic and numerical models (Geist and Parsons, 2006; Geist et al., 2009), geomorphologic analysis (Chaytor et al., 2007; Twichell et al., 2009; Locat et al., 2010), regional assessments using existing data (ten Brink et al., 2009; ten Brink et al., 2014), geotechnical analysis (on-going), and laboratory studies (on-going). No single landslide, however, has been mapped from its origin (headwall on the continental slope) to its runout on the lower rise/abyssal plain, with supporting evidence to show the aggradational and structural relationships in the subsurface among the different parts of the composite landslide system. This lack of information prevents further modeling of the processes of these landslides and evaluating the potential tsunamigenic risks they have posed or could pose along the Atlantic margin. The proposed cruise offers the opportunity to study the vertical (depth) aspects of two major landslides on the U.S. margin, and therefore leverage federal resources across two scientific programs and projects (ECS and Natural Hazards). The overlap in the area of interest for the ECS and natural hazards is an effort to eliminate redundant surveys if the field work for the two projects is not combined.

The study of submarine landslide deposits and the geologic conditions that may trigger them similarly require seismic reflection profiles that transect the sediments perpendicular to the continental shelf. Both subjects (sediment thickness [ECS] and geologic structure [hazards]) require seismic-reflection profiles that resolve features on the scale of meters to tens of meters, and penetration of sediments up to several kilometers. The conversion of seismic reflection travel-times (in seconds) to true depth (in meters) is accomplished through the analysis of the

[3] http://www.un.org/depts/los/clcs_new/documents/Guidelines/ CLCS_11.htm

normal-moveout (NMO) correction used to stack the multichannel data. The accuracy of NMO corrections is proportional to the length of the receiving streamer. The 8-km offset of the *Langseth* streamer and the proposed energy level of the airgun array are sufficient to ensure reflection signal strength at the farthest offsets would provide the highly accurate acoustic velocity information required.

1.2 REGULATORY CONTEXT

Section 1.8 of the NSF/USGS PEIS provides details of the regulatory regime for seismic programs. The federal acts and agencies with regulatory responsibility for the proposed seismic program are provided in Table 1.

Table 1: Responsible Regulatory Agencies and Legislation

Administering Organizations	Act
Council on Environmental Quality	National Environmental Policy Act (NEPA)
Office of the President of the United States	Executive Order 12114
NOAA/National Marine Fisheries Service	Endangered Species Act
	Marine Mammal Protection Act
	Magnuson-Stevens Fisheries Conservation Management Act
NOAA/Office of Ocean and Coastal Resource Management	Coastal Zone Management Act
Fish and Wildlife Service	Endangered Species Act (ESA)

1.3 COORDINATION WITH OTHER AGENCIES

These surveys would be conducted by the USGS on behalf of the U.S. Extended Continental Shelf Interagency Task Force, an interagency body, chaired by the Department of State with co-vice chairs from NOAA and the Department of the Interior. Nine additional agencies (Executive Office of the President, Joint Chiefs of Staff, U.S. Navy, U.S. Coast Guard, Department of Energy, NSF, Environmental Protection Agency, Bureau of Ocean Energy Management, and the Arctic Research Commission) participate in Task Force deliberations. USGS, however, is the scientific lead for the proposed program and is funding the activity.

The proposed surveys are also done in coordination with other surveys planned by NSF in the Atlantic. Two surveys planned in 2014 are summarized in Appendix C. In particular, the NSF Eastern North American (ENAM) survey occurs within the U.S. EEZ offshore North Carolina, and is located in the vicinity of the proposed USGS program. Throughout the planning process of both the USGS and ENAM surveys, trackline locations were compared and refined to avoid duplicate data collection and to optimize scientific objectives of both surveys.

This DraftFinal EA and a Draft EA were prepared by YOLO Environmental Inc. with contributions from Ecology and Environment Inc., both firms under contract to EHI (an RPS company) on behalf of USGS and NSF pursuant to NEPA and Executive Order 112114. The Draft EA was used to initiate consultations with regulating agencies and for obtaining public comment on the proposed action. The Draft EA was posted on the NSF and USGS websites for a 30-day public comment period from May 20 to June 20, 2014. No public comments or inquiries were received on the Draft EA during that period. As noted below, public comments were received during the NMFS IHA process (Attachment 1, Appendix G), and although not received as part of the NSF/USGS NEPA process, NSF and USGS considered the responses with respect to the information included in the Draft EA. After consideration of public comments received during the NMFS IHA public comment period and discussions during MMPA and ESA consultations with NMFS, refinements to the information presented in the Draft EA were made in the Final EA, such as more detail on the purpose and need for the proposed action, proposed survey timing, and scientific literature published since the PEIS issued in 2011.

Potential impacts to endangered species and critical habitat have been assessed in the document; therefore, it was used to support the ESA Section 7(a)(2) consultation process with NMFS and USFWS. This document was also used as supporting documentation for an IHA application submitted by USGS to NMFS, under the U.S. MMPA, for “taking by harassment” (disturbance) of small numbers of marine mammals, for this proposed seismic project. Additionally it was used for consultation for Essential Fish Habitat (EFH).USGS and NSF have coordinated and will continue to coordinate, with other applicable Federal agencies and regulations as required.Further details about the various consulatation processes are provided below.

Marine Mammal Protection Act (MMPA)

The Marine Mammal Protection Act (MMPA) procedures for issuance of an IHA involve publication of a proposed IHA notice in the Federal Register, solicitation of comments on that notice, and publication of a notice of issuance in the Federal Register, in addition to compliance with NEPA, and, if applicable, the ESA. USGS and LDEO submitted to NMFS an IHA Application pursuant to the MMPA. NSF and USGS communicated every two weeks by phone with NMFS during the consultation process, and sometimes more frequently. As noted above, public comments (Appendix G) were received by NMFS on the Notice of Intent to Issue an IHA (Appendix F). NMFS will respond to the public comments in a Notice in the Federal Register. Based on consultation discussions, the requirements for issuing an IHA for the proposed action have been met (small take and negligible impacts) and, therefore, it is anticipated that NMFS will issue an IHA. The IHA terms will serve as conditions for conducting the proposed seismic surveys.

Endangered Species Act (ESA)

USGS, together with 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). USGS and NSF met every two weeks by phone with NMFS, and sometimes more frequently, during the consultation process. NMFS does not anticipate a jeopardy finding for the proposed action. Based on consultation discussions, it is anticipated that NMFS will issue a Biological Opinion and an Incidental Take Statement for the proposed action. On August 11, 2014, USFWS provided a letter of concurrence that the proposed action would not adversely affect the avian species under their jurisdiction (Appendix E).

Magnuson Stevens Act – Essential Fish Habitat (EFH)
The Magnuson-Stevens Act requires that a Federal Action agency consult with NMFS for actions that "may adversely affect" EFH. Although adverse effects on EFH, including a reduction in quantity or quality of EFH, were not anticipated as a result of the proposed activities, USGS contacted the Habitat Conservation Specialists from the Northeast and Southeast offices of the Greater Atlantic Region regarding the proposed action. After reviewing the analysis and proposed mitigation in the Draft EA, it was determined that minor adverse impacts to water column habitats might occur as a result of the proposed activity; however, the EFH Regional Coordinator concluded "…we have no EFH conservation recommendations to provide pursuant to Section 305(b)(2) of the Magnuson-Stevens Act at this time." (Appendix D).

Coastal Zone Management Act (CZMA)
USGS was the lead federal agency on the proposed action, and as such, NSF had no obligations under CZMA. As the lead federal agency for the proposed activity, the USGS considered whether the proposed activities would have effects on coastal resources of any state along the Atlantic Seaboard. As concluded in the Final EA, any potential impacts from the proposed activities would mainly be to marine species in close proximity to the vessel and would be of short duration and temporary in nature. The proposed survey would occur in ~2000-5000 m water depth, and would occur mostly beyond 200 nm. The closest point of approach to land would be ~170 km/~106 statute miles/~92 nautical miles. Additionally, the Level B zone for the project, the area considered by NMFS that has the potential to harass marine mammals would be ~159 km/~99 statute miles/~86 nautical miles to the closest approach to state waters. Because of the proposed surveys' location in deep water and long distances from the U.S. coast, USGS concluded the survey would have no effect on coastal zone resources. USGS reviewed the Federal Consistency Listings for the states along the Atlantic Seaboard and determined that the proposed activity is not listed. USGS did not a receive request from any state for a consistency review of the unlisted activity. Therefore, it was concluded that the USGS had met all of the responsibilities under CZMA. NSF and USGS 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 activity.

1.4 ENVIRONMENTAL ASSESSMENT SCOPE AND METHODOLOGY

The Final EA scope and methodology for the project have been developed to meet the regulatory requirements under NEPA and Executive Order 112114. The Final EA includes consideration of the following factors:

- the environmental effects of the project, including any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or would be carried out; and
- measures that are technically and economically feasible and that would mitigate any adverse environmental effects of the project.

1.5 APPROACH

The approach used in this report stresses the importance of focusing the assessment on environmental and socio-economic components of greatest concern to society or as indicators of environmental health. In general, the methodology is designed to produce an EA analysis that:

- focuses on issues of greatest concern;
- addresses issues raised by the public and other stakeholders;
- addresses regulatory requirements;
- integrates mitigation and monitoring; and
- considers cumulative effects

The methodology for this Final EA included an evaluation of the potential effects from routine activities. The evaluation of potential cumulative effects with regard to other projects and activities includes past, present, and future activities that would be carried out and would interact temporally or spatially with the proposed project.

Preparation of this Final EA consisted of several steps including:

- assembling project baseline information, including a clear description of the proposed project (Section 2) and developing an understanding of existing conditions (Section 3);
- establishing the scope of the assessment (this section);
- assessing the potential environmental effects of the project (Section 4) and cumulative effects (Section 5).
- consulting with the relevant regulatory agencies; and
- making final determinations that are reflected appropriately throughout this document.

1.6 SCOPE OF THE ASSESSMENT

A scoping process focuses the environmental assessment on the project components and activities to be assessed, the key environmental issues, and the appropriate spatial and temporal boundaries. The scope of an EA must be established early in the process to ensure the analysis remains focused and manageable. The scoping process for this assessment included the following:

- project description prepared by USGS;
- previous site-specific NSF EA: Environmental Analysis of a Marine Geophysical Survey by the *R/V Marcus G. Langseth* in the Northeast Atlantic Ocean, June–July 2013;
- previous site-specific NMFS EA: Environmental Assessment for Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Maine Geophysical Survey in the Northwest Atlantic Ocean, June-August 2014 (NMFS 2014);
- review of the Final Programmatic Environmental Impact Statement (PEIS) Atlantic Outer Continental Shelf (OCS) Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas (BOEM 2012);

- 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);
- preliminary research, which included a review of existing literature, relevant scientific research publications, and regulatory guidelines; and
- professional judgment of the EA preparation team.

This Final EA tiers to the NSF/USGS PEIS document. The Final BOEM PEIS for Mid-Atlantic and South Atlantic planning areas overlaps with the proposed project area for this survey thus provided useful scientific regional information in deep water. The NSF/USGS PEIS assessed global areas and one detailed analysis area of the northwest Atlantic: a nearshore shallow water location off the coast of New Jersey. Figure 2 shows the area coverage of the BOEM PEIS and the location of the NSF/USGS PEIS NW Atlantic detailed analysis area in relation to the Study Area for this Final EA.

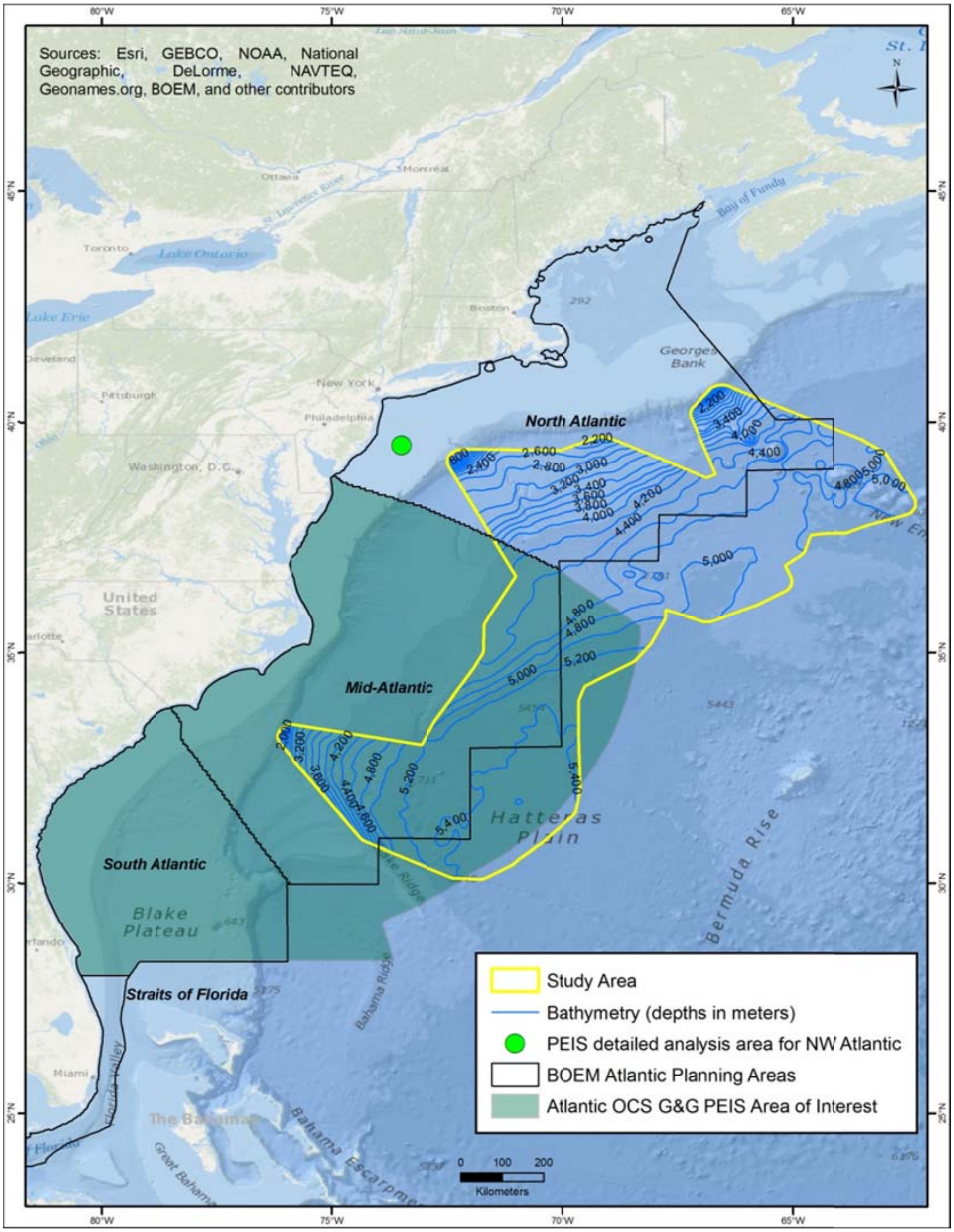

Figure 2: Study Area with NSF/USGS PEIS NW Atlantic detailed analysis area and BOEM Atlantic OCS G&G PEIS Area of Interest

A focused EA requires a process of scoping to define the components and activities that are to be considered in the assessment, to identify the key environmental issues, and to set the spatial and temporal boundaries of the assessment. While the project activities are generally focused within the footprint of the project activities (i.e., area of influence), the effects of these activities may extend beyond these footprints.

1.6.1 Scoping Requirements

As described in the NSF/USGS 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. Initial review and analysis of the proposed project activities determined that the following resource components identified in Table 2 did not require further analysis.

Table 2: Resource Components Determined to Require No Further Analysis

Component	Assessment Considerations
Transportation	Only the R/V *Langseth* would be used during the marine seismic surveys. Therefore, 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.
Land Use	All activities are proposed to occur in the marine environment. Therefore, no changes to land uses would result from the proposed program.
Benthos and Geological Resources (Topography, Geology and Soil	The proposed project would not interact with the soil or seafloor sediments; therefore benthic habitat would also not physically be affected.
Terrestrial Biological Resources	All proposed program activities would occur in the marine environment and would not impact terrestrial biological resources.
Socioeconomic and Environmental Justice	Implementation of the proposed program would not affect, beneficially or adversely, socioeconomic resources, environmental justice, or the protection of children. No changes in the population or additional need for housing or schools would occur; human activities in the area around the survey vessel would be limited to commercial fishing activities and at most minor interaction with recreational fishing; however, because of the distance from local ports, short duration of the proposed activities (<1 month), and survey design, interaction with fishing activity is expected to be very limited in the Study Area. Further description about potential impacts to fishing are described in this document. No other socio-economic impacts would be anticipated as result of the proposed activities.

Visual Resources	No visual resources would be anticipated to be negatively impacted as the area of operation is significantly outside of the land and coastal view shed.
Cultural Resources	There are no known cultural resources in the proposed study area. Therefore, no impacts to cultural resources would be anticipated.

1.7 ASSESSMENT METHODOLOGY

1.7.1 Identification of Valued Environmental Components

The scoping process identified a focused list of environmental components. Scoping considerations for these components are presented in Table 3 along with the rationale for inclusion or exclusion of an environmental factor for further evaluation.

Table 3: Selection of Environmental and Socio-economic Components

Environmental Component	Scoping Considerations
Air Quality	Compliance with US Coast Guard regulations, American Bureau of Shipping Certification, and best vessel-operational practices
Marine Water Quality	Compliance with US Coast Guard regulations, American Bureau of Shipping Certification, and best vessel-operational practices
Marine Benthos	The BOEM PEIS (2012) showed lack of groundfish or shellfish commercial fisheries in the Study Area. Coral and sponge protected areas occur in the Study Area.
Marine Fish	Spawning activity may be affected by seismic operations. Vessel and airgun noise may affect fish behavior by causing fish to avoid areas of vessel travel and/or by causing a 'startle response'. Fish spawning has been included as an environmental factor.
Marine Mammals	Several species of marine mammals are likely to be present in the Study Area year-round and could potentially be affected by Project noise and vessel traffic. Marine mammals of particular concern (ESA-listed) would be assessed.

Environmental Component	Scoping Considerations
Sea Turtles	An assessment of the potential adverse environmental effects on ESA-listed sea turtle species would be undertaken.
Marine Birds	An assessment of the potential adverse environmental effects on ESA-listed seabird species would be undertaken.
Special Areas	The project is situated adjacent to several marine protected areas, but does not encroach into any of them.
Commercial Fisheries	The commercial fishery is an important element in the US Atlantic seaboard socio-economic environments. Although unlikely, seismic operations could interact with commercial fisheries directly and indirectly (*i.e.*, potential effects on fish). The assessment would address commercial fisheries occurring within the Study Area.
Military Operations or Research Surveys	Other resources users (*e.g.,* Department of Defense, seismic research, *etc*.) conduct activities on the OCS and Slope within the Study Area, thereby potentially interacting with the project. Other research surveys may be conducted within the Study Area and may interact with project activities and are included in the assessment of other ocean users.

1.7.2 Description of Existing Conditions

Section 3 of this report provides a description of the existing conditions (i.e., pre-project) for each environmental or socio-economic factor. The description is focused on the status and characteristics of the environmental or socio-economic factors within the boundaries established for the assessment and focuses on aspects that are relevant to potential project interactions. In some cases, baseline data are only available on a larger regional basis extending beyond the boundaries of the assessment, but are still considered relevant and appropriate for the purposes of the assessment.

1.7.3 Study Area

The Study Area encompasses the region over which the 2D seismic survey extends (Figure 3, yellow outline). The study area extends beyond the start and ends of the survey tracks by 30 km to account for the estimated turning radius and distances (<6 km) at which the acoustic level

(160 dB re 1 µPa SPL) from the 2D seismic airgun survey may affect the behavior of marine species. Although unlikely, this area also includes potential interactions with other vessels.

1.7.4 Temporal, Spatial and Ecological Boundaries and Study Area

Temporal and spatial boundaries encompass those periods during, and areas within which, the environmental or socio-economic factors are likely to interact with or be influenced by the project.

The temporal boundaries considered for this assessment include seismic activities from the time the vessel arrives within the Study Area, until it departs the Study Area, and estimated time frames for recovery of pelagic and nektonic communities. Effects of the routine activities associated with the proposed project have been assessed from August to September in 2014 and April to August 2015.

Spatial boundaries encompass those periods during, and areas within which, the environmental or socio-economic factors are likely to interact with, or be influenced by, the project.

Ecological boundaries are determined by the spatial and temporal distributions of the biophysical environmental factors under consideration. Factors such as population characteristics and migration patterns are important considerations in determining ecological boundaries, and may influence the extent and distribution of an environmental effect. Spatial socio-economic boundaries are determined by the nature of the environmental factors under consideration (e.g., the spatial distribution of fishing activity). Such boundaries are particularly important for assessing cumulative environmental effects.

Temporal ecological boundaries consider the relevant characteristics of environmental components or populations, including the natural variation of a population or ecological component, response and recovery times to effects, and any sensitive or critical periods of an environmental factor's life cycle (e.g., spawning, migration), where applicable.

The scope of the proposed program includes all of the components and activities detailed in this section of this report, including any potential accidental events that may occur in relation to the project. To further focus the assessment, the interactions between survey activities and the environmental factors need to be identified (Table 4:). A potential interaction, signified by an "X", does not necessarily indicate a predicted effect, but warrants further analysis in the EA. A full assessment of these interactions is contained in Section 4 (planned routine events and accidental events). Where appropriate, the assessment includes a summary of main concerns regarding the effect of each survey activity on the environmental factors being considered. Knowledge may exist in the scientific literature and is referred to where possible. Negligible interactions are blank and are not discussed further. An interaction may be negligible due to the limited nature of the activity and interaction, strict regulations, or lack of sensitive receptors.

Table 4: Potential Project - Environment Interaction Matrix

Environmental Factors	Marine Mammals	Sea Turtles	Marine Fish	Marine and Migratory Birds	Special Areas	Commercial Fisheries	Marine Traffic	Military Operations or Research
2D Seismic Survey - Noise Emissions (Acoustic Array)	X	X	X	X	X	X		X
Vessel Presence	X	X		X		X	X	X
Presence of Streamers and Cables	X	X				X	X	X
Routine Vessel Discharges	X	X	X	X	X	X		

1.7.5 Analysis, Mitigation and Environmental Effects

For each environmental factor, the potential interactions are investigated and described based on current scientific knowledge with regard to each interaction. .

Where applicable, operational mitigation measures are identified that would minimize potential impacts.

Additionally, pre-cruise planning mitigation measures included 1) evaluating the minimum source level needed for the proposed research and 2) considering environmental conditions such as the seasonal presence of marine mammals, sea turtles, and seabirds when scheduling the survey.

1.8 FOLLOW-UP AND MONITORING

Monitoring by the proponent may be undertaken for a number of reasons including compliance, permit approval/renewal, evaluation of mitigating measures, strengthening predictive capacity in future EAs, and commitments to regulatory agencies.

Monitoring and follow-up requirements are evaluated for each environmental or socio-economic factor and are linked to the sensitivity of an environmental or socio-economic factor to both project related and cumulative environmental effects.

1.9 CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT

Individual environmental effects could accumulate and interact to result in cumulative environmental effects. Past and ongoing human activities have affected the region's natural and human environments. An environmental assessment must include consideration of the cumulative environmental effects that are likely to result from the program in combination with other projects or activities that have been or would be carried out. A critical step in the environmental assessment, therefore, is determining what other projects or activities have reached a level of certainty (e.g., “would be carried out”) such that they must be considered in an environmental assessment.

Certain requirements must be met to consider cumulative environmental effects:

- there must be a measurable environmental effect of the project being proposed;
- the environmental effect must be demonstrated to interact cumulatively with the environmental effects from other projects or activities; and
- it must be known that the other projects or activities have been, or would be, carried out and are not hypothetical.

These criteria were used to guide the assessment of cumulative environmental effects. The other projects and activities considered in this assessment include those that are likely to proceed (such as those listed in the Federal Register), and those which have been issued permits, licenses, leases or other forms of approval.

Past and present activities that may impact cumulatively with the project have been assessed as part of the assessment of routine project activities in Section 5. Future activities that have the potential to interact cumulatively with the project include marine traffic (domestic and international), military activity, submarine cable installations, commercial fishing activities, research surveys, and energy and/or mineral exploration.

2 PROPOSED ACTION AND ALTERNATIVES

2.1 PROJECT OVERVIEW

USGS proposes to conduct an offshore regional 2D seismic reflection survey program, totaling 3,400 nm (6,300 km) on the Outer Continental Shelf (OCS), slope and abyssal plain over the next two years (2014 and 2015). Figure 3 depicts all the proposed survey lines. No survey lines are within 12 nm territorial waters of the United States nor in water depths shallower than 1,000 m.

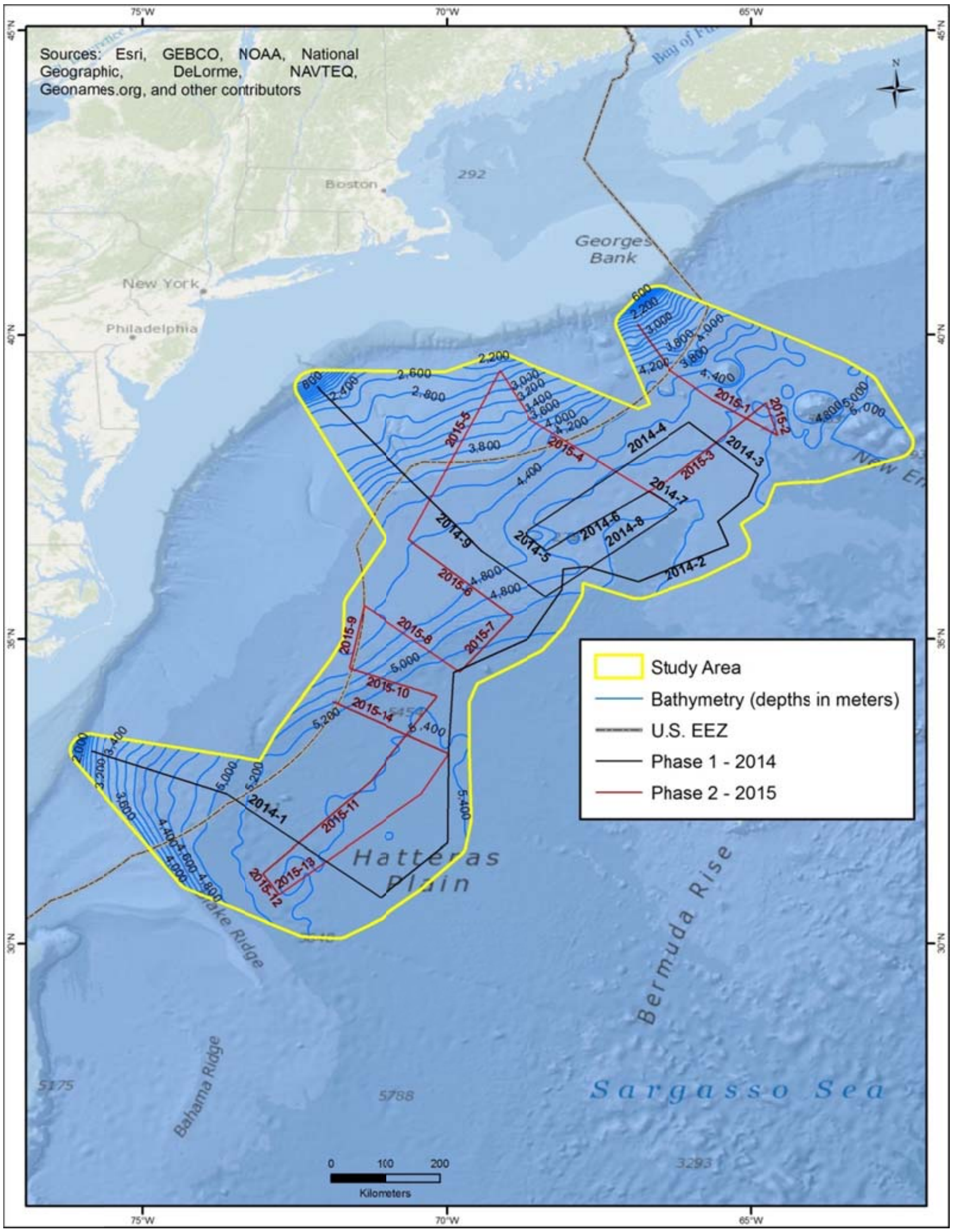

Figure 3: 2D Seismic Lines (2014 and 2015)

The survey in 2014 is proposed for August 16 to September 6. The exact dates of the second survey would depend on the weather conditions, budget and vessel availability; the time period to conduct the survey would be proposed sometime between April and August, 2015. Each program would be about 18-21 days in duration, including transit, equipment mobilization and retrieval.

The vessel would be at sea and operate continuously (i.e., 24-hour operations) during survey operations. There would no crew changes planned and no additional support vessel or helicopter service anticipated.

To address environmental mitigations for the planned scientific research surveys, Protected Species Observers (PSO's) would form a component of the operational crew. Standard mitigation procedures would be implemented to minimize effects on the local marine ecosystem.

2.2 PROJECT LOCATION

The proposed survey area would be bounded by the following geographic coordinates:

Table 5: Geographic Location of Survey

40.5694° N / -66.5324° W
38.5808° N / -61.7105° W
29.2456° N / -72.6766° W
33.1752° N / -75.8697° W
39.1583° N / -72.8697° W

These coordinates define an area where the most easterly survey lines are outside the US EEZ, and extend into international waters. No survey lines extend into the U.S. 12 nautical mile (nm) limit for territorial seas and State waters.

The nearest-to-land extent is in the northwest (39N, 73W) approximately 130 nm (241 km) from shore. Similarly, in the southwestern end of the Study Area (33N, -76W), the nearest-to-land extent is about 155 nm (290 km) from shore.

2.3 PROJECT COMPONENTS

The USGS plans to conduct seismic reflection scientific research surveys off the US Atlantic Seaboard in 2014 and 2015. Each survey would consist of an approximate 21-day leg comprising 1,700 nautical trackline miles (3,165 km) of 2D seismic reflection coverage (total 3,400 nm total over two years). The 2014 survey is currently scheduled to commence in mid-August 2014; the second survey would be conducted in April to August, 2015 time window.

The proposed survey design consists of approximately nine (9) sub-parallel, NW-SE lines (perpendicular to the margin) across the Study Area, with end-line transits and several NE to SW tie or strike lines. The airgun array would operate continuously during the survey, except for power/shut downs, equipment repair or weather issues. Data would continue to be acquired between line changes. The locations of the 2015 tracks for ECS purposes may require minor adjustments depending on analysis of the 2014 data.

Marine seismic surveys for scientific research use arrays of airguns as the source of seismic signals. All conventional seismic surveys share the same basic concept. Seismic airgun sources send sound waves through the water, and formations beneath the seafloor reflect the sound waves back to receivers, such as hydrophone streamers trailing behind the vessel. The components of the proposed 2D surveys would include a seismic vessel, the towed source array (consisting of 36 airguns) and the receiver (hydrophone streamer). These components are shown in Figure 4.

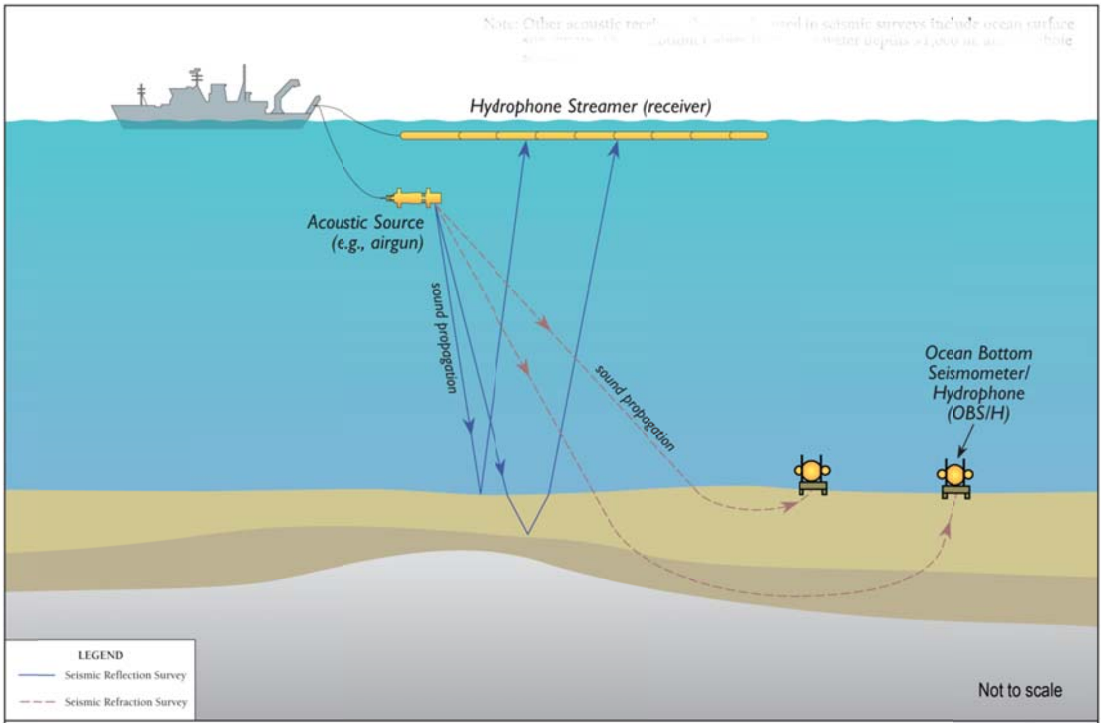

Figure 4: Seismic vessel and towed system (Source NSF/USGS PEIS)

The requirement to establish sediment thickness along the continental margin, where in the Atlantic the sediment thicknesses can be in excess of 8-10 km, requires large sources and low frequencies. For the proposed ECS cruise, the multichannel streamer (8 km), augmented by widely spaced free-floating sonobuoys (acquiring data up to 30 km from the ship) provides the ability to acquire oblique angles to better resolve sedimentary velocities and determine accurate sediment thicknesses. In considering survey design, the guidelines regarding Article 76 of the Law of the Sea Convention state, “The low frequencies allow good penetration. The oblique angles allow the detection and measurement of velocity gradient zones as well as the more abrupt changes, which show up well on reflection profiles.” (CLCS, 2009, §8.2.7). The acquisition of refraction information from widely spaced sonobuoys provides an independent check on sediment thickness and the identification of basement, which reduces uncertainty in determining the outer limit points of the ECS. The guidelines also state “the survey must be designed to prove the continuity of the sediments from each selected fixed point to the foot of the slope (see sect. 8.5).” (CLCS, 2009, §8.2.21). The proposed Langseth source (6600 in^3)

size is appropriate for imaging sediment thickness where the sediments are thickest (near the foot of the slope) and also to have the resolution to determine the base of the sediments with between 5 and 10 % error. Additionally, the survey tracklines are designed to avoid areas of reduced sediment thickness (such as around seamounts).

Most of the track locations are designed to fulfill the requirements of Article 76 of the Law of the Sea Convention. Trackline spacing and coverage is specified in the treaty to be no more than 60 nm apart. However, the 60 nm maximum is impractical unless the points on the tracks are exactly orthogonal between tracks at 60 nm spacing. Any deviation of points from orthogonal between adjacent tracks will result in a distance greater than 60 nm between points, which will not satisfy Article 76. Hence the tracks are generally planned to be 30-50 nm apart. The proposed program is for two field seasons, the first (2014) as a reconnaissance in the area of interest and the second to finalize outer limit points after interpretation of the data from the first field program is completed. The guidelines also note that "…it is evident that …minimum data coverage could miss some important details of the morphology of the outer limit of the continental margin, and the resulting 1 percent line could only be a rough approximation of the true geological limit. Coastal States that suspect that such an approximation will be to their disadvantage will benefit from executing more comprehensive and detailed surveys. In general, the data coverage should reflect the complexity of the outer margin." (8.2.22). The Atlantic margin is inferred to have geologic complexity in the form of fracture zones, where the sediments could be thicker than in the intra-fracture zone regions. These fracture zones are the result of juxtaposing oceanic crust of different ages across ridge offsets during the spreading process. The 2014 part of the program (with lines parallel to the margin) is intended to identify the possible existence of fracture zones that are sub-perpendicular to the margin. If these fracture zones can be identified, the 2015 component of the seismic program is to then collect seismic data along tracks that follow where the sediment is thickest and therefore the size of the US ECS can be established.

Four tracks (2014-1, 2014-9, 2015-1, 2015-4, Figure 3) are located to address tsunami hazards associated with down-slope mass movement and submarine landslides. These lines are intended to image, from south to north, the Cape Fear landslide, the Southern New England Landslide complex, a control line outside of landslide occurrence, and the Munson-Nygren-Retriever Landslide complex. These tracks optimize scientific benefits of the proposed survey by collecting data on transects to and from the area of ECS study. By combining objectives of the USGS Hazards Program (to understand and assess tsunami hazard on the East Coast) with the USGS ECS project (to identify the outer limits of the ECS), ship and personnel resources are leveraged together, saving personnel and ship costs.

2.3.1 Seismic Vessel

The *Langseth* (Figure 5), owned by the National Science Foundation and operated by Lamont-Doherty Earth Observatory of Columbia University would be used as the seismic survey vessel.

Figure 5: Survey Vessel *R/V Marcus G. Langseth*

The *Langseth* was designed as a seismic research vessel, with a propulsion system designed to be as quiet as possible to avoid interference with the seismic signals. The operation speed during seismic acquisition is typically 7.8 to 8.3 km/h (4.2 to 4.5 knots). When not towing seismic survey gear, the *Langseth* can cruise at approximately 20 to 24 km/h (10 to 12 knots). The *Langseth* would tow the 36-airgun array along predetermined lines (see Figure 3). When the *Langseth* is towing the airgun array and the hydrophone streamer, the turning rate of the vessel is limited to five degrees per minute. Thus, the maneuverability of the vessel is limited during operations with the streamer.

The vessel would have equipment, systems, and protocols in place for prevention of pollution by oil, sewage, and garbage in accordance with international standards and certification authorities. The survey vessel would comply with all applicable regulations concerning management of waste and discharges of materials into the marine environment. The vessel has a ballast water management plan. The International Maritime Organization (IMO; http://www.imo.org/) is the United Nations specialized agency with responsibility for the safety of shipping and the prevention of marine pollution by ships. The Shipboard Oil Pollution Emergency Plan (SOPEP) is written in accordance with the requirements of regulation 37 in compliance with latest revision of Marine Pollution (MARPOL) Annex I of the International Convention for the Prevention of Pollution from Ships, 1973. The SOPEP is a guide to the vessel Masters, bridge officers and crew onboard the ship with respect to the steps to be taken when an oil pollution incident has occurred, or is likely to occur.

The *Langseth* would also serve as the platform from which vessel-based Protected Species Visual Observers (PSVO's) would be responsible for visually monitoring, data collection and reporting on marine mammals and sea turtles before and during airgun operations. Resources onboard include two sets of big eyes and handheld binoculars to scan the surrounding area for all protected species plus Passive Acoustic Monitoring (PAM) system would also be monitored 24 hours a day during seismic operations by experienced PAM Operators. The PAM system would consist of a data processing unit, deck cable, hydrophone cable, computers, headphones, and special translation software to listen and read vocalizations of marine mammals under the water.

The *Langseth* has been used to conduct successful seismic surveys world-wide since 2008, rigorously obeying mitigation and monitoring requirements to avoid and minimize Level B harassment of marine mammals. Environmental assessments, IHA's and post-cruise environmental impact reports can be found for more than a dozen *Langseth* cruises at:

http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications or http://www.nsf.gov/geo/oce/envcomp/index.jsp.

2.3.2 2D Seismic Towed Array and Hydrophone Streamer

Survey equipment for the program is described below in Table 6.

Table 6: Seismic Equipment and Survey Parameters

Total Linear Length of Lines (km)	3,400 nm (6,300 km) two year program, 1,700 nm per year
Number and Length of Streamers	1 X 8 km multi-channel, Thompson-Marconi SENTRY solid streamer
Group Interval	12 groups per section; 12.5 m
Airgun Array	36 guns of Bolt 1500LL and Bolt 1900LLX 6,600 in^3 total volume
Maximum number of sub-arrays	4, 9 guns per sub-array (plus 1 spare)
Source Array Tow Depth	9 m
Airgun Operating Pressure	2000 pounds per square inch
Frequency	2 to188 Hz
Source output	zero to peak (0-p) 84 bar-m (259 dB re 1 μPa m); peak to peak is 177 bar m (265 dB)
Hydrophone	Dual sensor
Type of firing sensors	Pressure activated

Firing duration	0.01 s
Shot Time Interval	50 m or ~22 to 23 s
Recording Time	14 to 16 s
Vessel Speed	4.2 to 4.5 knots while surveying, 10-12 knots in transit
Turning Radius	10 to 12 km

2.3.3 Multibeam Echosounder and Sub-bottom Profiler

Along with the airgun operations, two additional acoustical data acquisition systems would be operated during the survey. The ocean floor would be mapped with the Kongsberg EM 122 multi-beam sounder (MBES) and a Knudsen Chirp 3260 sub-bottom profiler (SBP). These sound sources would be operated from the *Langseth* continuously throughout the cruise (exclusive of transits).

The Kongsberg model EM122 MBES operates at 10.5 to 13 (usually 12) kHz and is hull-mounted on the *Langseth*. The transmitting beam width is 1° or 2° fore–aft and 150° athwartship. The maximum source level is 242 dB re 1 µPa m. Each ping consists of eight (in water >1000 m deep) or four (<1000 m) successive fan-shaped transmissions, each ensonifying a sector that extends 1° fore–aft. Continuous wave (CW) pulses increase from 2 to 15 ms long in water depths up to 2,600 m, and Frequency Modulation (FM) chirp pulses up to 100 ms long are used in water >2,600 m. The successive transmissions span an overall cross-track angular extent of about 150°, with 2-ms gaps between the pulses for successive sectors.

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 water depths of 10,000 m and penetrating tens of meters into the sediments. 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 dependent on water depth, between 3 and 6 seconds.

MONITORING AND MITIGATION MEASURES

Table 7 summarizes the key monitoring and mitigation measures that would be followed during the proposed activity.

Table 7: Summary of Key Monitoring and Mitigation Measures

Pre-Cruise Planning Measures:

- Survey Timing: Consider environmental conditions (i.e., seasonal presence of marine species, weather, equipment and personnel availability), weather conditions, equipment availability, and other proposed seismic surveys utilizing *Langseth*. - Energy Source: Evaluate research objectives and optimize source selection - Mitigation Zones: Calculate mitigation zones based on LDEO modeling and current NMFS acoustic threshold guidance
Marine Mammal Species
- PSVO's would be based aboard the seismic source vessel, and would watch for marine species during daylight (civil dawn to civil twilight) airgun operations - Five PSVO's would be deployed aboard *Langseth*. Two PSVO's would remain on watch during daytime seismic operations; at least one PSVO would be on watch during meal and restroom breaks. PSVO watch shifts would not exceed 4 hours. - PSVO's would watch for marine mammals and turtles near the seismic vessel for at least 30 minutes (min) prior to the start of airgun operations after any total airgun shutdown longer than 10 minutes. - Based on PSVO observations, airguns would be powered down (see below) or, if necessary, shut down completely when marine mammals are observed within or about to enter a designated Exclusion Zone (EZ). Establishment of the EZ is based on consideration of criterion of ≥180 dB re 1 μPa rms - PSVO's monitor for species to the Full Mitigation Zone (FMZ) which includes the area identified for potential behavioral harassment (Level B harassment). FMZ represents the distance at which the SPL is >160 dB re 1μPa_{rms} - PSVO's would make observations during daytime periods when the seismic systems are not operating for comparison of animal abundance and behavior during seismic and non-seismic periods for similar geographic regions, as feasible. - Passive Acoustic Monitoring (PAM) would be used during seismic operations in conjunction with visual monitoring. PAM would be monitored continuously during seismic operations by a specialized PAM operator or PSVO, in shifts of no greater than 6 hours duration. - Shutdown of airguns for marine mammals and sea turtles detected inside of Exclusion Zone. Unless the marine mammal or sea turtle is observed to leave EZ, ramp up (procedure described below) would commence 15 minutes for small cetaceans or 30 minutes for large cetaceans after the last sighting.
General Ship Operations
Speed or course alteration. If a marine mammal or sea turtle is detected outside the EZ but is likely to enter it based on relative movement of the vessel and the animal, if safety of

operations allow, the vessel speed and/or course would be adjusted to minimize the likelihood of the animal entering the EZ. It should be noted that major course and speed adjustments may be impractical when towing long seismic streamers.
Power down procedures. A power down involves reducing the number of airguns operating to a single 40 in^3 ("mitigation") airgun in order to minimize the size of the EZ. The continued operation of one airgun is intended to alert marine mammals and turtles to the presence of the seismic vessel nearby. If a marine mammal or sea turtle is detected within, or is likely to enter the EZ of the array in use, and if vessel course/speed changes are impractical or would not be effective to prevent the animal from entering the EZ, then the array would be powered down to ensure the animal remains outside the smaller EZ of the single airgun. If the animal appears on course to enter the EZ of the single mitigation airgun, then a total shutdown would be required, as described below. Following a power down, airgun activity would not resume until the marine mammal or sea turtle is outside the EZ for the full array. The animal would be considered to have cleared the EZ if it: - is visually observed to have left the EZ; - has not been observed within the EZ for 15 min in the case of small odontocetes; - has not been observed within the EZ for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales; or - the vessel has moved outside the applicable EZ in which the animal in question was last seen. Following a power down and subsequent animal departure as noted above, the airgun array would resume operations.
Shutdown procedures. If a marine mammal or sea turtle is within or about to enter the EZ for a single airgun, or for a single airgun following a power down, all operational airguns would be shut down immediately. Airgun activity would not resume until the animal had cleared the EZ for the full array of airguns to be used, as described above.
Ramp-up procedures. A ramp-up procedure would be followed when an airgun array begins operating after a specified period without operations.. Ramp-up would begin with the smallest airgun in the array. Airguns would be added in a sequence such that the source level of the array would increase in steps not exceeding 6 dB per 5-min period. A 36-airgun array would take approximately 30 min to achieve full operation via ramp-up. During ramp-up, the PSVO's would monitor the EZ, and if marine mammals or sea turtles are sighted, decisions about course/speed changes, power down, and shutdown would be implemented as though the full array were operational. An exception occurs when the shut-down period is less than 10 minutes. In this situation, the length of time of the shut down is defined as the time taken for the source vessel to travel the radius of the EZ specified for the array to be used; for this survey the period would be

approximately 10 minutes for the vessel traveling at 3.0 knots. Initiation of ramp-up procedures from shutdown requires that the full EZ must be visible by the PSVO's for 30 min, whether conducted in daytime or nighttime. This requirement would often preclude startups under nighttime or poor-visibility conditions except for small sources with small EZs. Ramp-up is allowed from a power down under reduced visibility conditions if the single mitigation airgun has been operating continuously during the power-down period. It is assumed that the single airgun would alert marine mammals and turtles to the approaching seismic vessel, allowing them to avoid the seismic source. Ramp-up procedures would not be initiated if a marine mammal or sea turtle is observed within the EZ of the airgun array to be operated.
Special mitigation measures: airgun arrays would be shut down (not just powered down) if North Atlantic Right whale is sighted from the vessel, even if outside the EZ, due to their rarity and conservation status. In case of confirmed sightings, airgun operations would not resume until 30 min after the last documented visual sighting and the PSVO is confident that the whale is no longer in the vicinity of the vessel.
US Coast Guard Notice to Mariners.. LDEO would issue Notices to Mariners to alert and inform vessels in the vicinity of *Langseth* about the project activity and to avoid entanglement with towed equipment.

Section 2.4.1.1 of the NSF/UGSG PEIS details standard monitoring and mitigation for NSF and USGS marine seismic surveys. With the proposed monitoring and mitigation provisions, potential effects on most if not all individual marine species are expected to be limited to minor behavioral disturbance. Those potential effects are expected to have negligible impacts both on individual marine mammals and on the associated species population or stocks. To minimize the likelihood that impacts would occur to the speciespopulations or stocks, sound source operations would be conducted in accordance with all applicable U.S. federal regulations and IHA requirements. The proposed mitigation procedures to be followed are based on NSF/USGS PEIS protocols used during previous L-DEO seismic research surveys based on best practices recommended in Richardson et al. (1995), Pierson et al. (1998), Weir and Dolman (2007), and Wright (2014) and/or required under NMFS-issued IHA's.

The standard operational monitoring and mitigation strategies would include:

- Visual monitoring by PSVO's
- Passive acoustic monitoring
- PSVO Report submitted to NMFS within 90 days after the end of the cruise
- Proposed safety Exclusion Zones based on acoustic modeling
- Operational Mitigation
    - Ramp-up procedures
    - Power-down procedures

- Shut-down procedures
- Vessel course/speed alteration

In addition to operational mitigation measures, measures to mitigate potential impacts were also considered during survey planning. The USGS worked with L-DEO and NSF to identify potential time periods to carry out the survey, taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals, sea turtles, and seabirds), weather conditions, equipment, and optimal timing for other proposed seismic surveys using the *Langseth*. Most marine mammal species are expected to occur in the area year-round, however, so altering the timing of the proposed project likely would result in no net benefits for those species.

The USGS proposes to use the standard *Langseth* 36-airgun array with a total volume of approximately 6,600 in3. This tuned array features spectral content and power appropriate for the objectives of the survey. The 6,600 in^3 array would be required to image full sediment thickness back to the upper continental rise. Given the research goals, location of the survey and associated deep water, this energy source level was deemed appropriate.

2.4 ALTERNATIVES TO THE PROJECT

Two alternatives were evaluated:

1) "No Action" alternative.

2) A corresponding seismic survey at an alternative time, along with issuance of an associated IHA.

Additionally, alternative technologies to conduct seismic surveys were considered in the PEIS and are described further below, including why they were eliminated from further consideration.

2.4.1 No Action

An alternative to the proposed seismic surveys is the No Action Alternative, i.e., do not issue an IHA and do not conduct the research operations. If the survey was not conducted, the "No Action" alternative would result in no disturbance to the environment, including marine species, due to the proposed activities.

A No Action Alternative would preclude the establishment of outer limit points using the sediment thickness criteria, and would jeopardize the ability of the U.S. to define the seafloor and subseafloor where it is entitled to certain sovereign rights, such as managing, exploring or conserving the region. The USGS has examined the existing seismic reflection data in the area of interest, and determined that the current coverage is entirely insufficient in both extent and quality to meet the criteria required by Article 76.

The No Action Alternative could also, in some circumstances, result in delay of other studies that would be planned on the *Langseth* for 2014 and beyond, depending on the timing of the decision. An evaluation of the effects of this alternative is given in section 4.5.

2.4.2 Alternative Time

An alternative to issuing the IHA for the period requested for conducting the project is to issue the IHA for another time and to conduct the project with the same monitoring and mitigation measures at that alternative time. The U.S. Interagency Task Force on the Extended Continental Shelf (ECS), under leadership of the Department of State, has established a Project Office to complete work on delineating the outer limits of the U.S. ECS in 5 years from 2014-2019. Delineating the Atlantic margin ECS takes two field surveys (as proposed in this action), at least two years of analysis and interpretation following data acquisition, as well as one year to develop the appropriate technical documentation for Article 76 of the Law of the Sea Convention. Delaying the proposed 2014 field program by a year jeopardizes completing the necessary steps to meet the 5-year Project Office deadline.

The ECS task force has been in existence since 2007 to identify and support collecting data in all the parts of the U.S. margins beyond 200 nm where the U.S. can potentially exert its sovereign rights. The current proposed time for the first of the two field programs (August – September, 2014) has been planned for more than two years, is the most suitable time for the participating USGS scientists and technical support staff; and accomdates the task force schedule for finishing delineating the outer limits of the ECS. The proposed time also takes into consideration the limited maneuverability of the vessel when towing and 8-km streamer, which makes late fall, winter and early spring, with its associated stormy weather, impractical and unsafe in this part of the Atlantic Ocean. Because of ship scheduling, delaying the 2014 field program to a later time effectively delays the survey until 2015 because no more suitable weather window exists nor are technical staff available until 2015. The planned 2015 survey would then be delayed until 2016, which would delay analysis and interpretation of the complete dataset that in turn would delay finishing delineation of the outer limits of the ECS according to funding and priorities of the ECS Interagency Task Force. Because the multichannel seismic methodology is a requirement for delineating the outer limits of the ECS when using sediment thickness (CLCS, 1999), delaying to an alternate time would not change the need for an IHA or Section 7 Consultation or establishing incidental takes.

2.4.3 Alternative Technologies

While alternative technology was considered, none is appropriate for the survey requirements. As discussed in the PEIS (Section 2.6), alternative technologies to airguns were considered but eliminated from further analysis as those technologies were not commercially viable. USGS, NSF, and L-DEO continue to closely monitor the development and progress of these types of systems. However, at this point in time, these systems are still not commercially available. Geo-Kinetics has a potentially viable option for marine vibroseis but does not have a viable towable array and its current testing is limited to transition zone (shallow water) settings. The hull-mounted transducer is intended for use in shallow water, sensitive environments and the vicinity of pipelines or other infrastructure and is not designed nor suited to deep-water, long-offset reflection profiling. Other possible vibroseis developments lack even prototypes to test. As noted by Pramik (2013) as recently as last November, the leading development effort by the Joint Industry Program "has the goal of developing three competing designs within the next few years". Similarly, engineering enhancements to airguns to reduce high frequencies are currently under development by industry; however at present, these airguns are not commercially available. The BP North America staggered burst technique would have to be developed well beyond the patent stage to be remotely practicable and would require extensive modification and testing of the Langseth source and recording systems. None of the other technologies mentioneded (gravity, EM, DTAGS, etc.) produce the resolution or sub-seafloor penetration required to resolve sediment thickness and geologic structure at the requisite scales. Improving the streamer signal to noise through improved telemetry (e.g. fibre optic cable) would involve replacing the Langseth streamers and acquisition units, requiring a major capital expenditure.

L-DEO and USGS maintain contact with a number of developers and companies and have expressed a willingness to serve as a testbed for any such new technologies. As noted in the PEIS (Section 2.6), should new technologies to conduct marine geophysical surveys become available, USGS and NSF would certainly consider whether they would be effective tools to meet research goals.

Lower-power sources (such as sparker or Chirp) do not have sufficient capacity to penetrate the entire sediment column, which in the Atlantic Ocean may be as great as several kilometers. The compressed air array proposed for the current survey uses a proven technology and program design that is standard throughout the world. More than 30 countries have proposed ECS limits using sediment thickness, and all have based those limits on seismic reflection data acquired with compressed air sources and multichannel hydrophone technology.

3 AFFECTED ENVIRONMENTS

This section covers the primary environments that would be effected by the proposed action. A number of environments were identified in section 1.6.1 as not requiring further analysis and therefore are not covered here.

3.1 METOCEAN DATA

The proposed Study Area is solely in offshore mid-Atlantic waters. Bathymetry ranges between 1,450 m and abyssal depths of 5,400 m. The majority of the proposed project occurs at depths below 3,500 m (Figure 6).

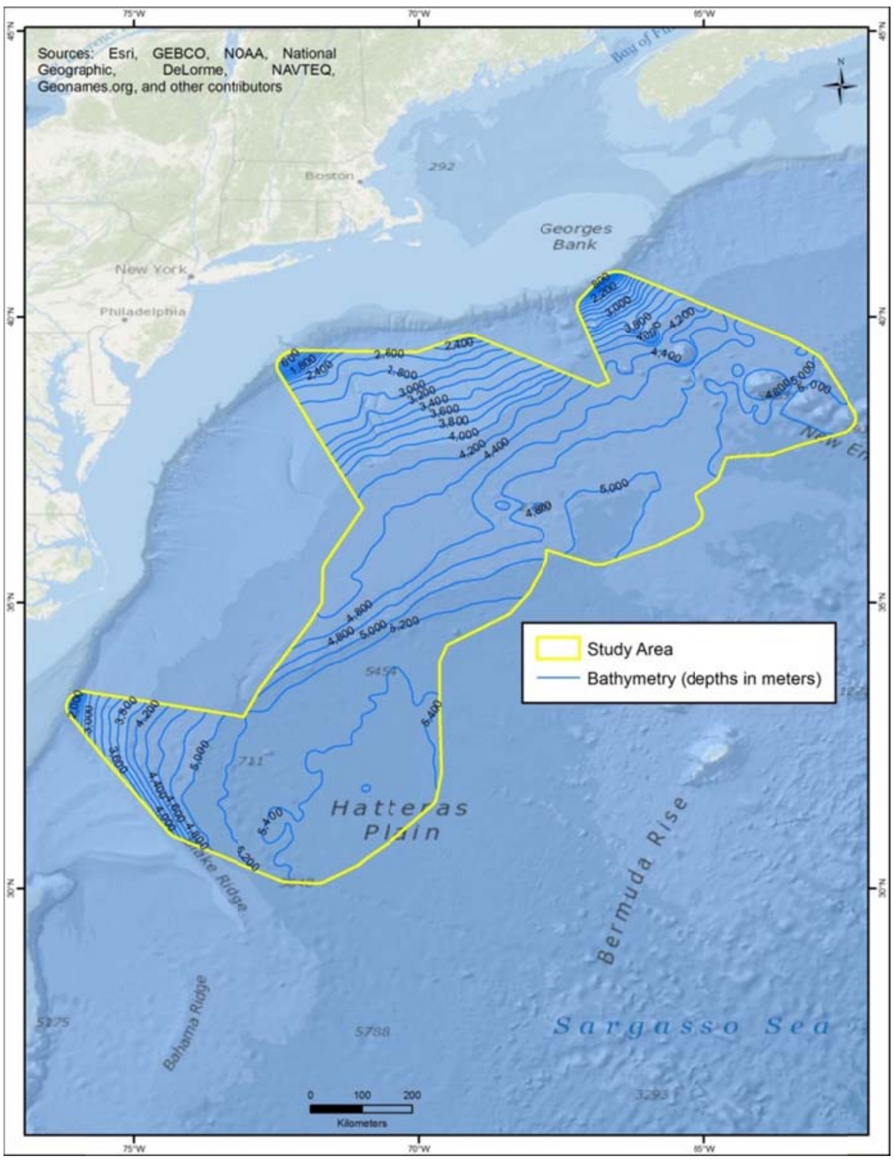

Figure 6: Study Area with Bathymetry

The Study Area is situated well east of the Mid-Atlantic Bight (MAB), a 621 mi (1,000 km) coastal region running from Massachusetts to North Carolina. The western edge of the Study Area lies at the base of the continental shelf-slope and is east of physiographical features such as the Baltimore Canyon, Washington Canyon, and Norfolk Canyon, and northeast of features such as the Blake Ridge.

The region is greatly influenced by a prominent ocean current system, the Gulf Stream. This is a powerful, warm, and swiftly flowing current that flows northward, generally along the shelf edge, carrying warm equatorial waters into the North Atlantic (Pickard and Emery, 1990; Verity et al., 1993) (Figure 7). Upwelling along the Atlantic coast is both wind-driven and a result of dynamic uplift (Shen et al., 2000; Lentz et al., 2003).

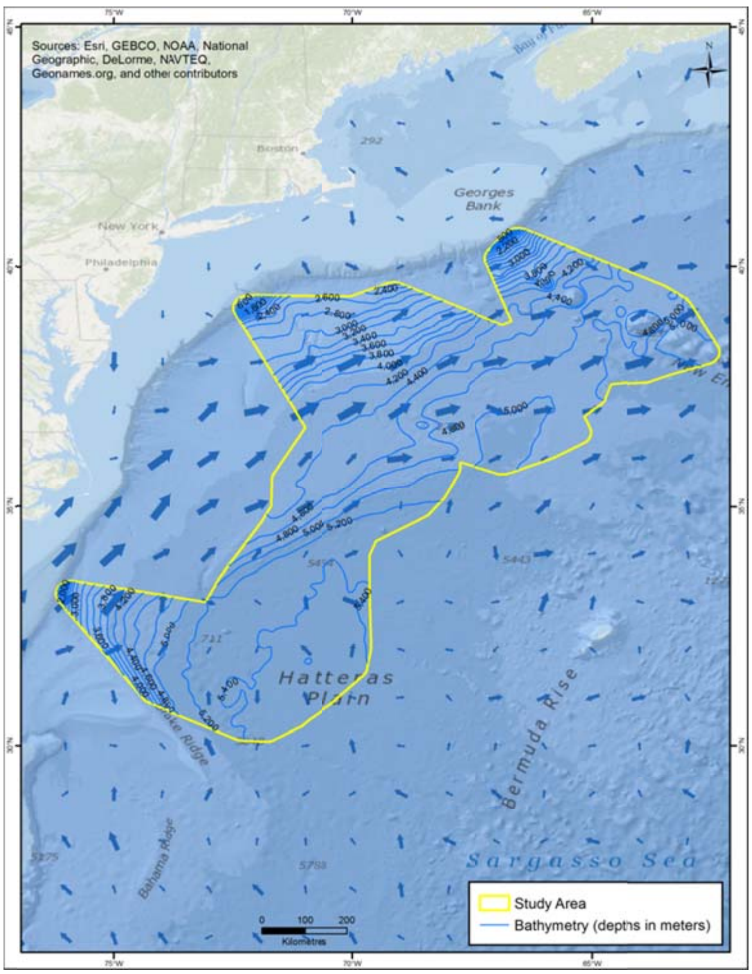

Figure 7: Gulf Stream

In addition to the Gulf Stream, currents originating from the outflow of both the Chesapeake and Delaware Bays influence the surface circulation in the MAB. The Chesapeake Bay plume flows seaward from the mouth of the Bay and then turns south to form a coastal jet that can extend as far as Cape Hatteras. Similarly, the Delaware Coastal Current begins in Delaware Bay and flows southward along the Delmarva Peninsula before entrained into the Chesapeake Bay plume.

The climate for the Study Area is of a typical marine environment. It is influenced to varying degrees year–round by passing systems, prevailing winds, and warm Gulf Stream waters. Of considerable influence, are three atmospheric pressure systems that control the wind patterns and climate for this region: The Bermuda-Azores High, the Icelandic Low, and the Ohio Valley High (Blanton et al., 1985). The Bermuda-Azores High dominates the climate in the region from approximately May through August, and produces south-easterly winds of <6m/s (<20ft/s) (BOEM, 2012a). Persistent high levels of humidity and moisture during this time reduces visibility, increases precipitation levels, and increases levels of fog.

The proposed Study Area is susceptible to tropical and sub-tropical cyclones, which can greatly influence the weather and sea state. During the summer and fall, tropical cyclones are severe, but infrequent (BOEM 2012a). In contrast, during the winter and spring, extra-tropical cyclones frequent the area. Most storms, including hurricanes occur during the North Atlantic hurricane season, which occurs from June through November.

3.2 GEOLOGY AND SEDIMENTOLOGY AND SEDIMENTARY BASINS

Appendix F, Section 1.2 of BOEM (2012a) provides information on geological history and sedimentary basins for the general area. As such, the information is pertinent for this proposed action. Small portions of this Study Area lie within the Carolina Trough, the Baltimore Canyon Trough, and the Georges Bank Basin. Parts of the study area are on the Hatteras Abyssal Plain.

Appendix F, Section 1.3 of BOEM (2012a) provides a summary of the seafloor sediments found in this project Study Area, along with adjacent sediment structures. The western edge of the Study Area is situated at the base of the Continental Slope and extends eastwards. Slope sediments are highly variable, consisting mainly of sandy silts on the upper slope and silts and clays on the lower slope (McGregor, 1983). Much of the seafloor is fine sand or mud associated with the distal ends of turbidity systems (Pilkey and Cleary, 1986) or fine-grained hemipelagic and biogenic deposition (Amato, 1994; McCave and Tucholke, 1986).

3.3 UNDERWATER SOUND ENVIRONMENT

Section 3.1 and 3.1.2 of the NSF/USGS PEIS (2011) provides a full description of ambient underwater sound and factors affecting sound propagation. Underwater sound is generated by many sources, and in the uppermost part of the ocean, weather can contribute to increased sound in the oceans at certain frequencies. Ambient sound is made up of contributions from many sources, both natural and anthropogenic. These sounds combine to give the continuum of noise against which all acoustic receivers have to detect required signals. Ambient sound is generally made up of three constituent types – wideband continuous sound, tonals and impulsive sound and covers the whole acoustic spectrum from below 1 Hz to well over 100 kHz. Above this frequency the ambient sound level drops below thermal sound levels.

3.4 PROTECTED AREAS

No marine protected areas (MPAs) (existing or proposed) are located within the proposed Study Area (Figure 8). Within US Atlantic waters, six MPAs exist and one is proposed. The closest proximity of the Study Area to the Bermuda Whale Sanctuary is 43 km at the most eastern boundary of the Study Area.

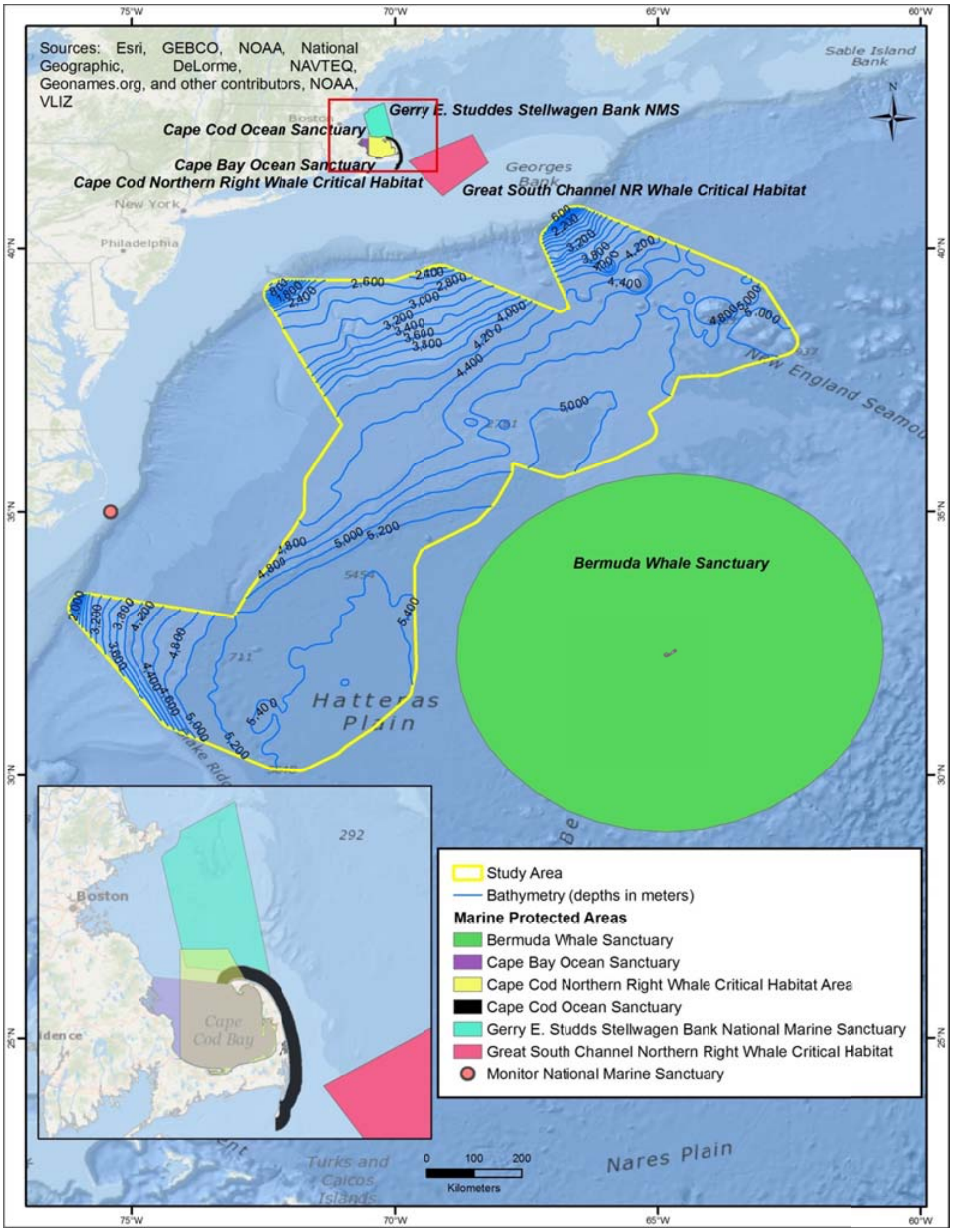

Figure 8: Marine Protected Areas and the Proposed Study Area

3.5 MARINE MAMMALS

Forty-one (41) species of marine mammals, including 27 odontocetes and 7 mysticetes, and 7 pinnipeds, are known to occur in the North Atlantic Ocean. Of those, 34 cetacean species (7 mysticetes and 27 odontocetes) could occur near the proposed Study Area. Pinnipeds are not recorded to occur in the proposed Study Area. Six of the 34 cetacean species that are listed under the U.S. Endangered Species Act (ESA) as endangered are the sei, blue, fin, North Atlantic right, humpback, and sperm whales.

Table 8 summarizes the habitat, regional abundance, distribution, and conservation status of these marine mammals. General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of mysticetes and odontocetes are given in Section 3.6.1 and Section 3.7.1, respectively, of the NSF/USGS PEIS (2011). The general distribution of mysticetes and odontocetes in the North Atlantic and on the mid-Atlantic Region (MAR) is discussed in Sections 3.6.3.4 and 3.7.3.4 of the NSF/USGS PEIS (2011), respectively. Figure 9 and Figure 10 illustrate the observations of baleen whales relative to the Study Area. Figure 11 shows the observations of North Atlantic right whale habitats adjacent to the Study Area. Figure 12 and Figure 13 show observations of odontocete whales, and Figure 14 and Figure 15 show location of dolphins and porpoise.

The rest of this section deals specifically with species distribution near the proposed Study Area. The main source of information used here is the Ocean Biogeographic Information System (OBIS) database hosted by Rutgers and Duke University (Read et al., 2009).

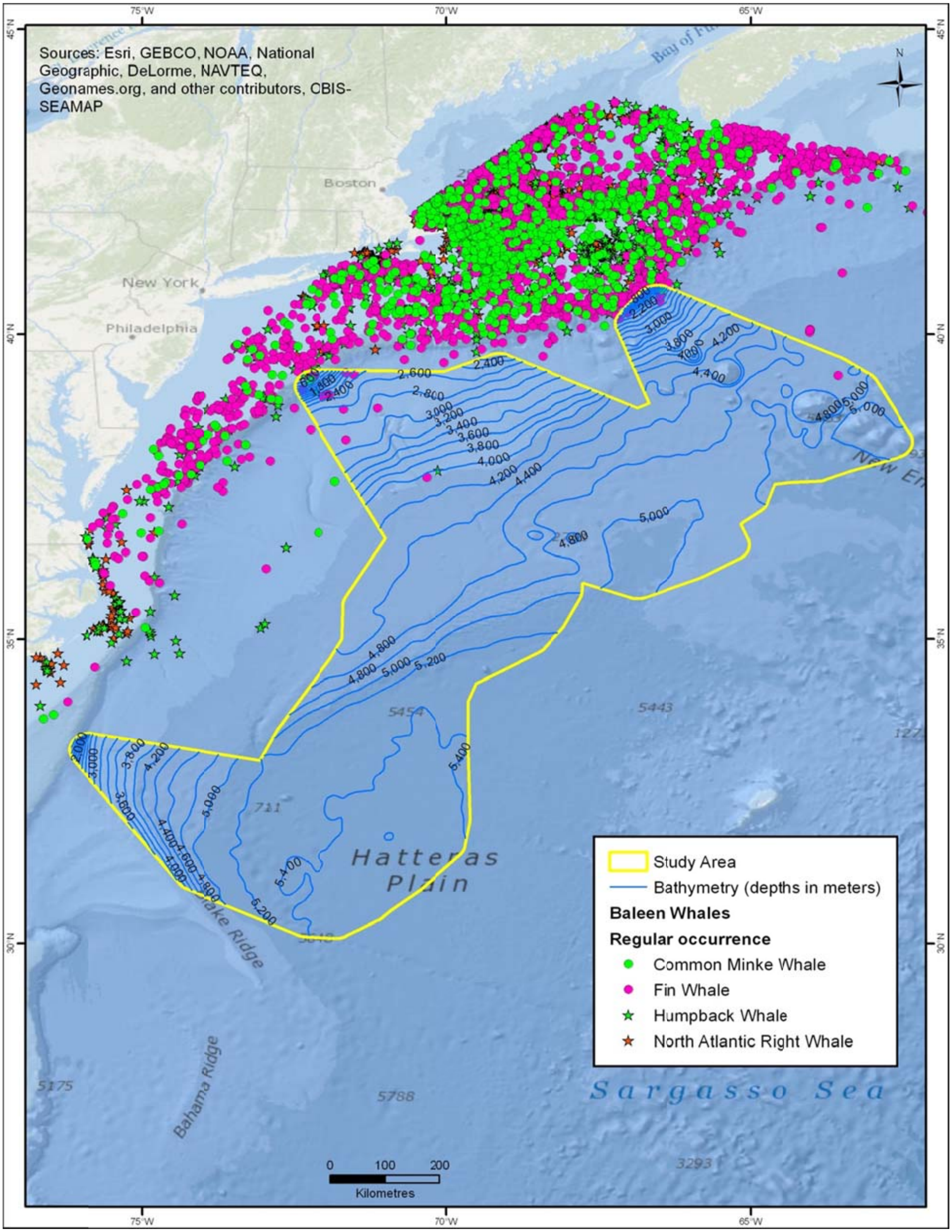

Figure 9: Baleen Whales (regular occurrence, multiyear observations)

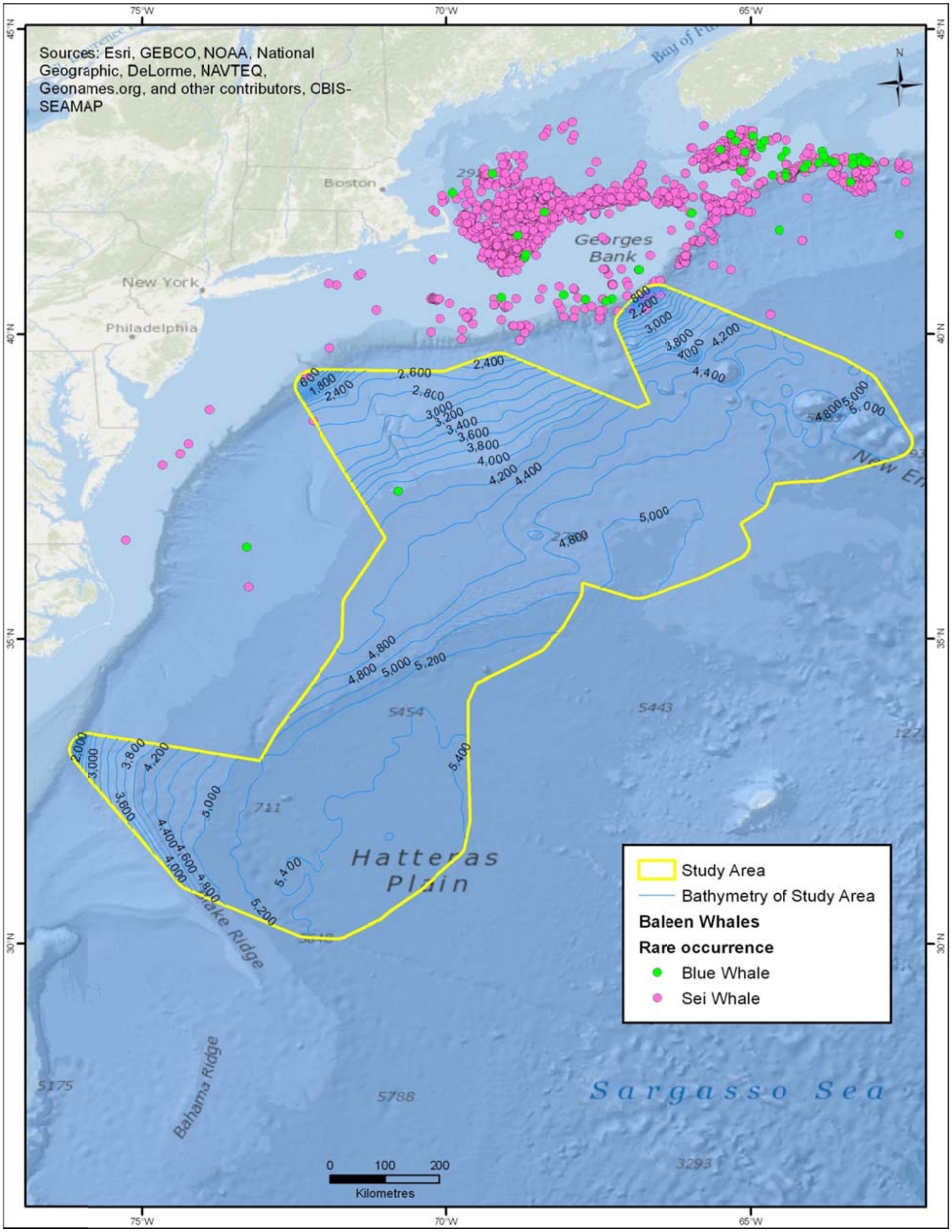

Figure 10: Baleen Whales (rare occurrence, multiyear observations)

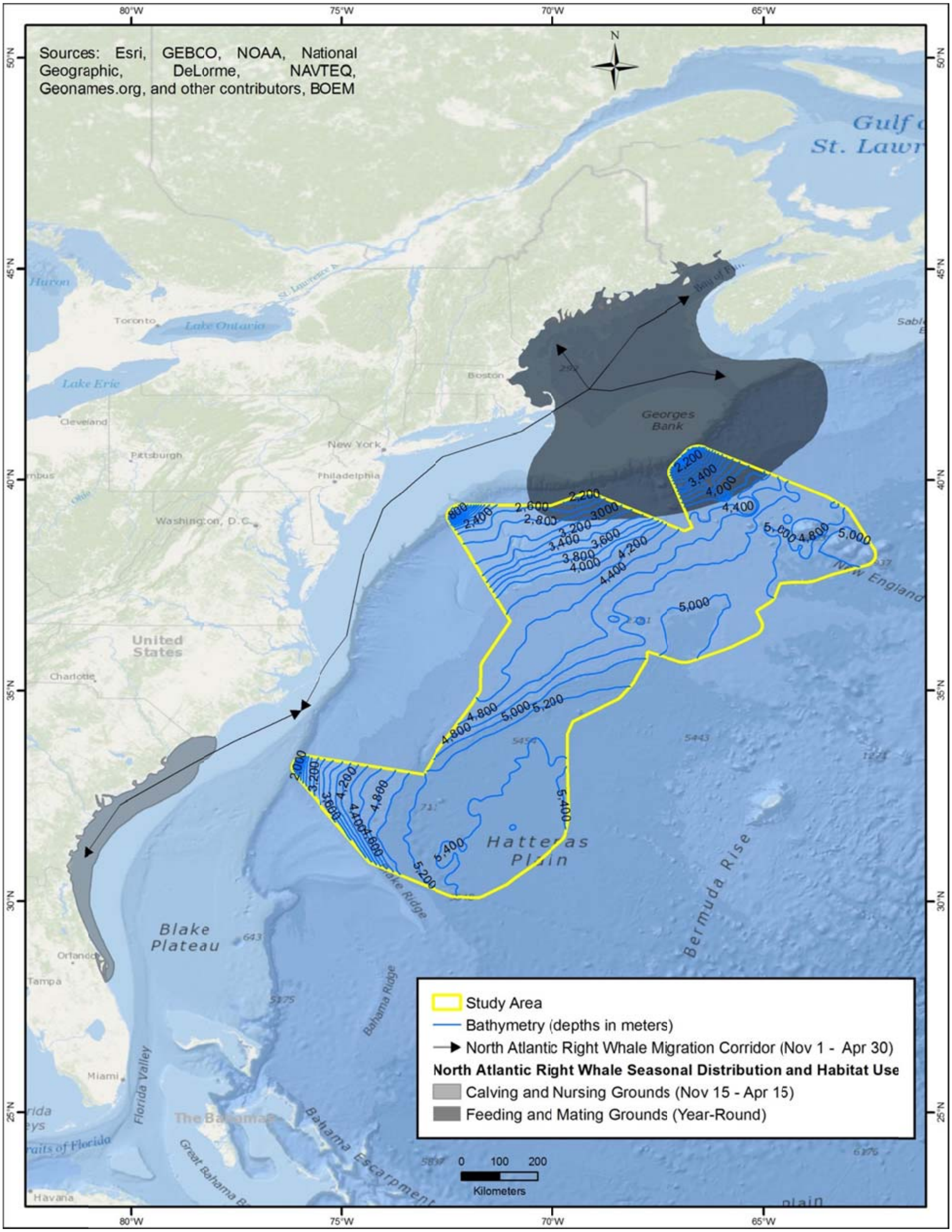

Figure 11: North Atlantic Right Whale Seasonal Distribution and Habitat Use

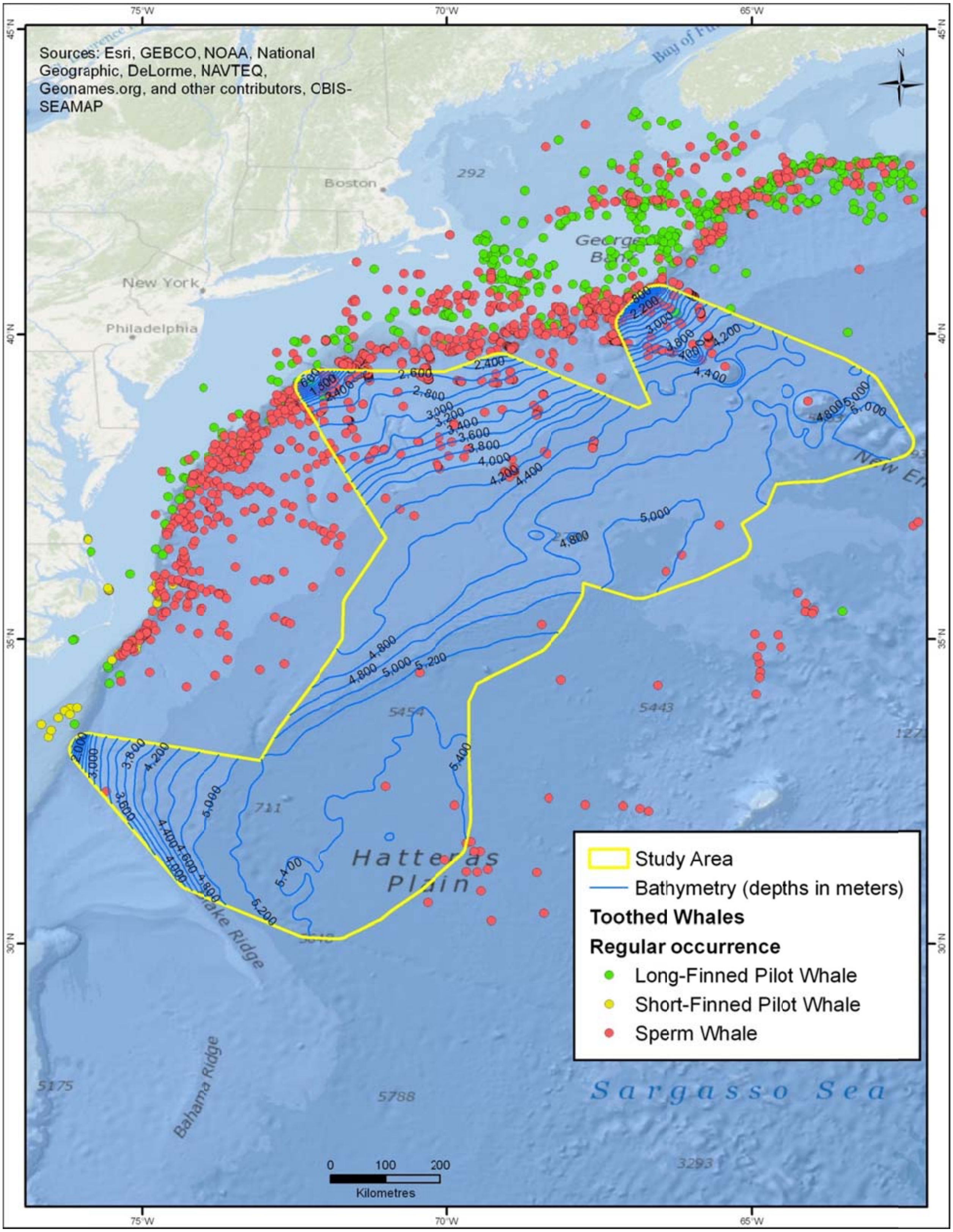

Figure 12: Toothed Whales (regular occurrence, multiyear observations)

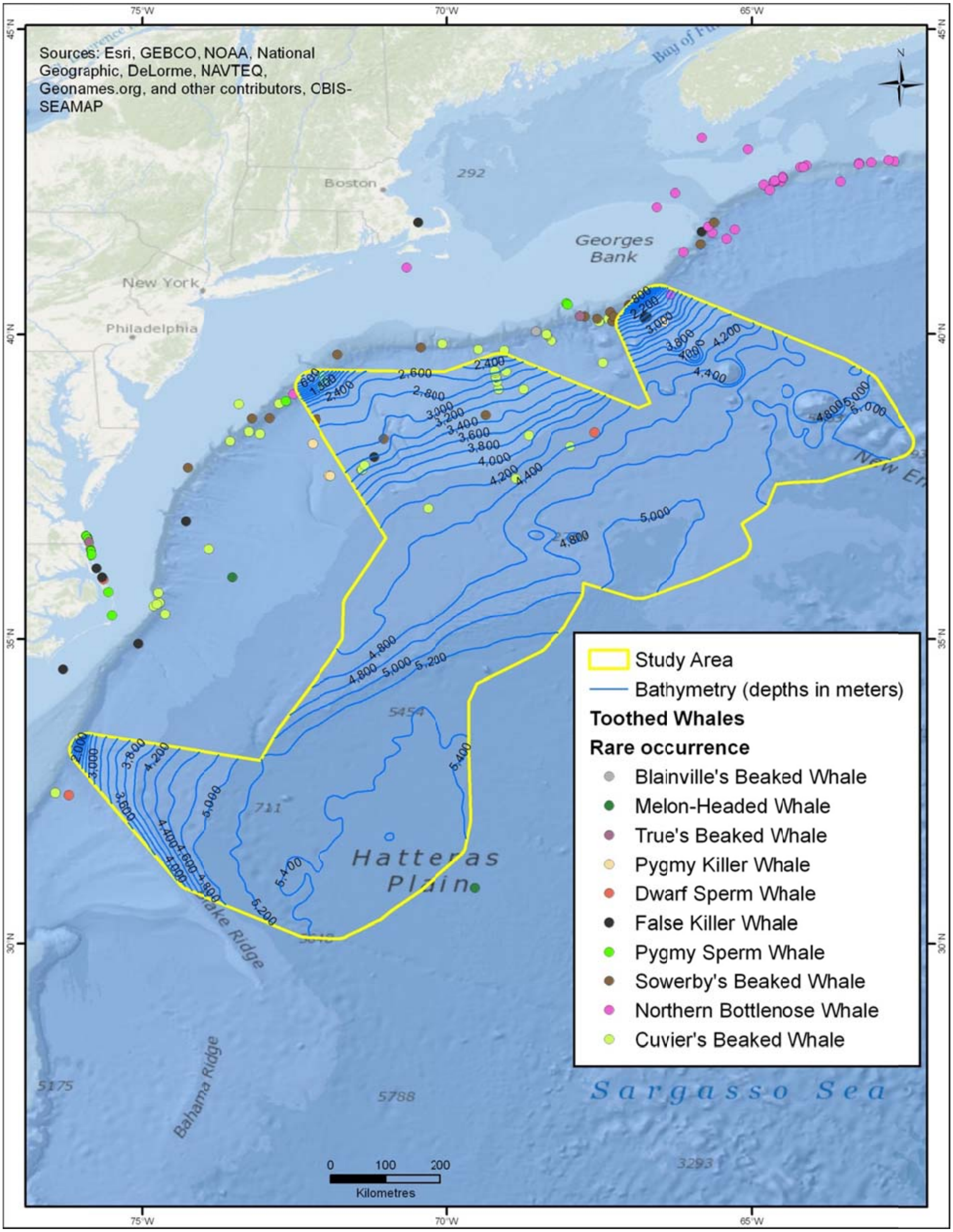

Figure 13: Toothed Whales (rare occurrence, multiyear observations)

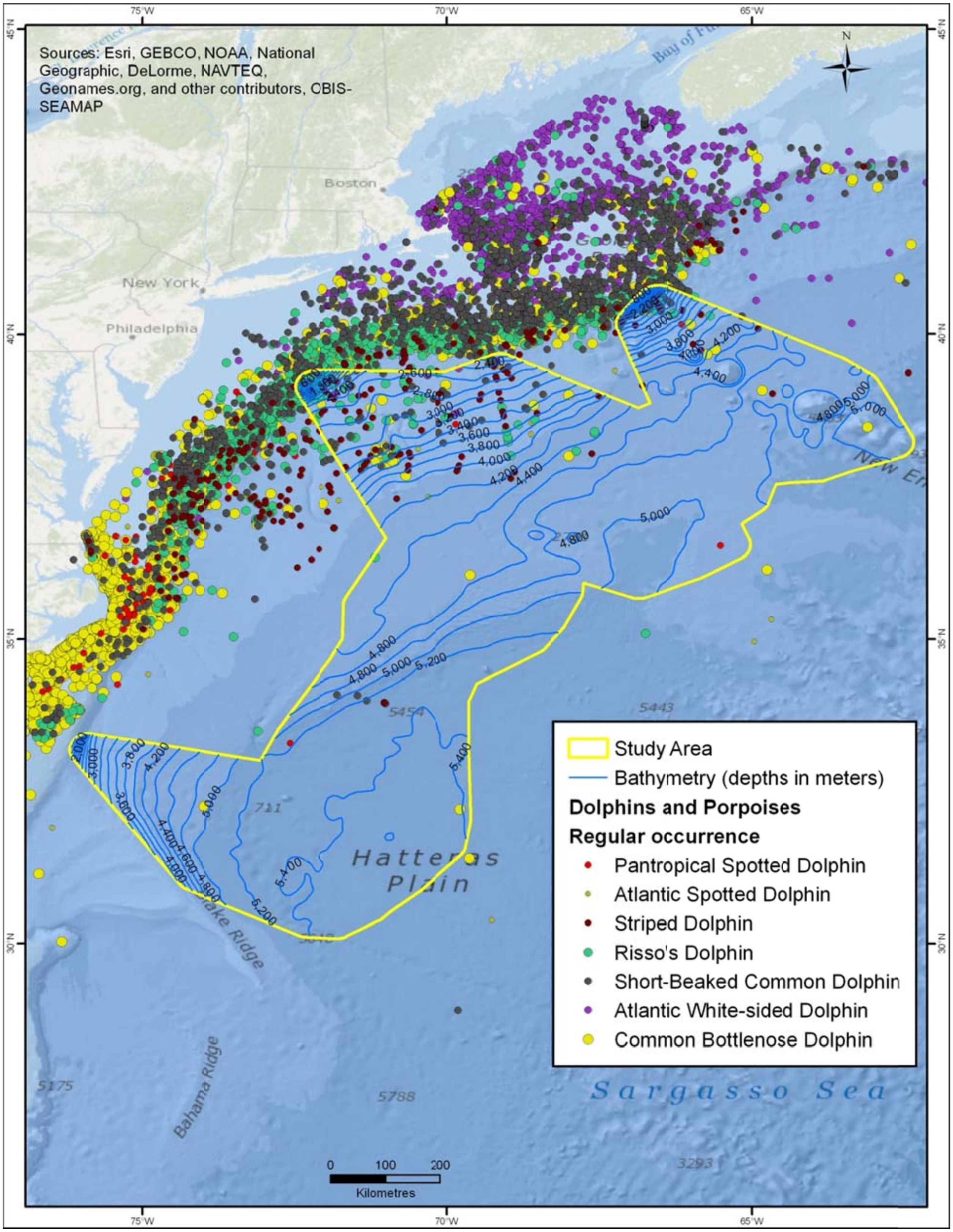

Figure 14: Dolphins and Porpoises (regular occurrence, multiyear observations)

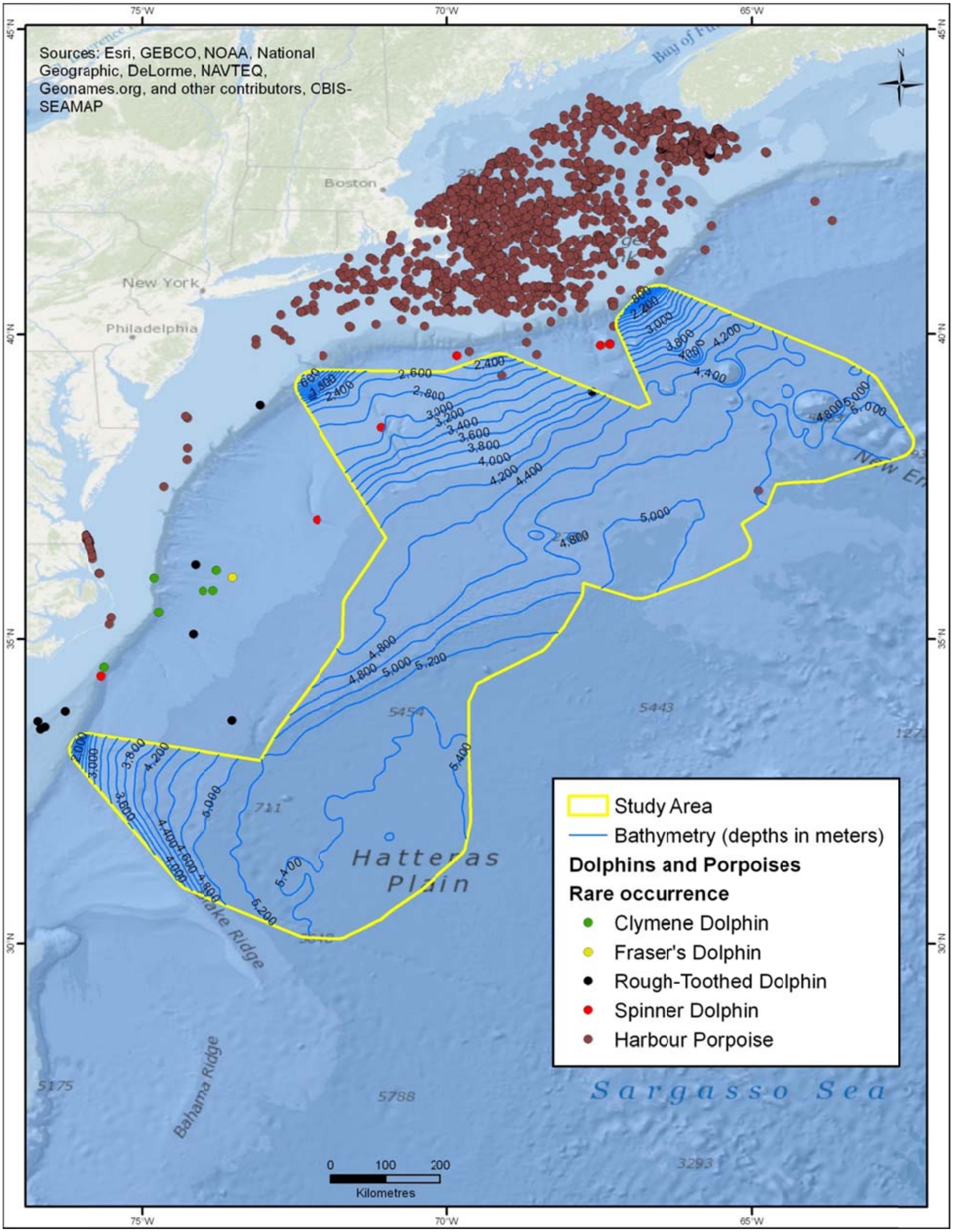

Figure 15: Dolphins and Porpoises (rare occurrence, multiyear observations)

Table 8: Marine Mammals Occurring in the Study and Regional Areas

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	
***Suborder Mysticeiti* (Baleen Whales)**							
Common Minke Whale (*Balaenoptera acutorostrata*)	Regular	Coastal, banks, shelf	8,987[4]; 125,000[5]	NL	LC	I	The common minke whale are among the most widely distributed and most abundant of the baleen whales (Carwardine 1998). The OBIS database reports several sightings of the common minke whale along the western edge of the proposed Study Area. The sightings increase toward the northwest, in the area identified as the year-round feeding and mating grounds for the NA right whale. In 1980, OBIS reported three sightings of the common minke whale within the proposed Study Area.
Sei Whale (*Balaenoptera borealis*)	Rare	Mostly pelagic, some offshore	386[4]; 12-13,000[6]	EN	EN	I	Sei whales are typically associated with steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges where prey is concentrated (Kenney and Winn 1987; Schilling et *al.* 1992; Best and Lockyer 2002). This highly migratory species' (Jefferson et *al.* 2008) range includes the continental shelf waters of the northeastern U.S. and extends to south of Newfoundland. Sei whales are not common in U.S. Atlantic waters (NMFS 2012), however, OBIS reports six sightings of the sei whale within the proposed Study Area. The most recent being in October, 2006, and June 2001, both during the Northeast Fisheries Science Center (NEFSC) Right Whale Survey.
Bryde's Whale (*Balaenoptera brydei*)	Rare	Coastal, offshore	N/A	NL	DD	I	Bryde's whales are considered rare within the waters of the proposed Study Area, and there are no OBIS sightings reported in its vicinity. The season distribution of this whale is not well known (Reilly et al. 2008).
Blue Whale (*Balaenoptera musculus*)	Rare	Coastal, shelf, and pelagic	937[7]	EN	EN	I	Blue whales are considered rare within the proposed Study Area. OBIS sightings identified one blue whale within the Study Area boundary back in 1969.

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	
Fin Whale (*Balaenoptera physalus*)	Regular	Coastal, banks	3,985[4]; 24,887[8]	EN	EN	I	Fin whales are one of the more common mysticeiti species found within the proposed Study Area, and in the waters surrounding it. According to Palka (2006), they are the most commonly sighted ESA-listed large whale in the western North Atlantic. There are hundreds of OBIS sightings logged of this species near the Study Area boundaries, and 14 logged within it. The three most recent sightings are in 2003 and 2004 observed during the NEFSC Right Whale Survey. All other sightings are from the 1970s and 1980s. The USDOC, NMFS (2010) reports summer feeding grounds mostly between 41°20' and 51°00'N latitude (shore to 1,829m [6,000ft]). The proposed Study Area and project dates coincide with this cycle of the fin whale. Fin whale mating and births occur in the winter (November-March), with reproductive activity peaking in December and January. Hain et al. (1992) suggested that calving takes place during October to January in latitudes of the U.S. Mid-Atlantic region. The proposed survey period of April to September would not interfere with these important times.
North Atlantic Right Whale *(Eubalaena glacialis)*	Regular	Coastal and shelf waters	361[44]; 396[9]	EN	EN	I	Research results suggest the existence of six major congregation areas for the NA right whales: the coastal waters of the southeastern U.S., the Great South Channel, Georges Bank/Gulf of Main, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf (Waring et al., 2010). Movements of individuals within and between these congregation area are extensive, and data show distant excursions, including into deep water off the continental shelf (Mate et al., 1997; Baumgartner and Mate, 2005). The congregations in U.S. eastern seaboard waters are recorded west of the Study Area; however, movements of the NA right whale could result in their presence in the proposed Study Area. In addition, year-round feeding and mating grounds exist for the NA right whale, which overlaps the north section of the proposed Study Area (Figure 11). While the OBIS database makes reference to hundreds of sightings in the vicinity of the proposed Study Area, mainly along the continental shelf, along the western boundary edge of the proposed Study Area, and in the year-round feeding and mating grounds, OBIS does not report any sightings within the confines of the Study Area.

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	
Humpback Whale (*Megaptera novaeangliae*)	Regular	Coastal, banks	847[4]; 11,570[10]	EN	LC	I	Sightings data show that humpback whales traverse coastal waters of the southeastern U.S., including the proposed Study Area (Waring et al. 2010). Reports of humpback whale sightings off Delaware Bay and Chesapeake Bay during the winter, suggest that the Mid-Atlantic region, including the proposed Study Area, may serve as wintering grounds for this species (Swingle et al. 1993; Barco et al. 2002). OBIS logged four sightings of humpback whales within the Study Area. The most recent sighting is from 2006, logged by the NEFSC Right Whale Survey spotted near the latter coordinates.
Suborder Odontoceti (Toothed Whales, Dolphins, and Porpoises)							
Sperm Whale (*Physeter macrocephalus*)	Regular	Pelagic, slope, canyons	4,804[4]; 13,190[15]	EN	VU	I	The sperm whale is the most commonly occurring odontoceti species within the proposed Study Area, and in the adjacent waters. The sperm summers in the Mid-Atlantic Bight off the Eastern U.S. coast from Virginia to Massachusetts (Reeves et al, 2002; Palka 2006). Hundreds of OBIS sightings of the sperm place them primarily in shelf and slope waters of the northeast U.S. and Nova Scotia which is customary given that groups commonly consist of 20 to 40 animals, including adult females, their calves, and juveniles (Waring et al. 2006). OBIS also recorded several sightings at abyssal depths ~ 16,400-ft (5000m). Within the proposed Study Area, there is in excess of 300 OBIS sightings of sperm whale, with the majority occurring in the slope waters in the northern and western extent.
Short-Finned Pilot Whale (*Globicephala macrorhynchus*)	Regular	Mostly pelagic, high relief	24,674[4,9]; 780,000[11]	NL	DD	II	The short-finned pilot whale is considered uncommon in mid-Atlantic waters, including the proposed Study Area. While there are no OBIS sightings of this species recorded within the Study Area, OBIS has records of 18 sightings of this species, all of which occurred since 2004.
Long-Finned Pilot Whale (*Globicephala melas*)	Regular	Mostly pelagic	12,619[4,9]; 780,000[8]	NL	DD	II	Similar to the short-finned pilot whale, the long-finned is also considered uncommon in the mid-Atlantic waters, including the proposed Study Area. There are five OBIS sightings of this species within the Study Area boundary. Three sightings from the 1980s. OBIS has hundreds of sightings of this species along the shelf and coastal waters of the U.S. and Canada.

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	
Killer Whale *(Orcinus orca)*	Rare	Coastal	unknown	NL	DD	II	There are five reported sightings in the OBIS Database (no dates, or further information for sightings available).Four sightings occurred near the north north-east extent of the Study Area, of which two were in the slope waters.1 sighting occurred in the south-central extent of the Study Area (34°41' and 71°87'N).
Pygmy Killer Whale (*Feresa attenuata*)	Rare	Pelagic	N/A	NL	DD	II	There is only one OBIS sighting of the pygmy killer whale in the proposed Study Area. It was observed in 1981 during the Bureau of Land Management Cetacean and Turtle Assessment Program (BLM CETAP) Air Sightings survey. Two other OBIS sightings were recorded along the shelf-waters, near the proposed Study Area.
Northern Bottlenose Whale (*Hyperoodon ampullatus*)	Rare	Pelagic	~40,000[12]	NL	DD	II	The northern bottlenose whale is considered rare within the proposed Study Area and adjacent waters. There is only one OBIS sighting of this species from 2006, recorded by the NEFSC Right Whale Survey.
Pygmy Sperm Whale (*Kogia breviceps*)	Rare	Deep waters off shelf	395[4,6,13]	NL	DD	II	Considered rare in the mid-Atlantic region, the pygmy sperm whale has no OBIS recorded sightings within the proposed Study Area. However, three sightings have been recorded in the slope waters near the Study Area. The single sighting was in 2004, during the NEFSC Mid-Atlantic Marine Mammal Abundance Survey 2004, while the other was in 1998 during the NERSC Survey.
Dwarf Sperm Whale (*Kogia sima*)							Similar to the pygmy sperm whale, the dwarf sperm whale is also considered rare in the mid-Atlantic region, including in the proposed Study Area. Nonetheless, OBIS has logged two sightings of this species. One in 2004 during the NEFSC mid-Atlantic Marine Mammal Abundance Survey 2004. The other sighting occurred in 1998 during the NEFSC Survey.
Sowerby's Beaked Whale (*Mesoplodon bindens*)	Rare	Pelagic, deep slope, canyons	3,513[4,9,14]	NL	DD	II	OBIS reports eight sightings of the Sowerby's beaked whale within the proposed Study Area. Six have occurred along the shelf with the other two being in the slope waters.
Blainville's Beaked Whale (*Mesoplodon densirostris*)							OBIS reports only one sighting of the Blainville's beaked whale recorded in 2004 during the NEFSC Mid-Atlantic Marine Mammal Abundance Survey 2004. A second sighting near the northeast extent of the Study Area was logged in 1995 by NEFSC.

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	
Gervais' Beaked Whale (*Mesoplodon europaeus*)							There are no OBIS sightings of the Gervais' beaked whale within the proposed Study Area on in any adjacent waters.
True's Beaked Whale (*Mesoplodon mirus*)							OBIS does not have any records for sightings of the True's beaked whale within the proposed Study Area. However, of the 20 OBIS sightings for this species, two exist in the waters adjacent to the northwest boundary line of the Study Area. In 1995, during the NERSC 1995 per 9502 survey one True's was spotted along the shelf edge. In 2003, during the Virginia Aquarium Marine Mammal Strandings 1998-2008 the second was reported stranded near ~ 76°N, 37°W. Survey details do not report on the type of stranding.
Cuvier's Beaked Whale (*Ziphius cavirostris*)				NL	LC	II	Of all the beaked whales, the Cuvier's was the most common recorded in OBIS sightings in the shelf and slope waters adjacent to and within to the proposed Study Area. The 15 sightings within the Study Area occurred mostly in the slope waters in the northwest.
Melon-Headed Whale (*Peponocephala electra*)	Rare	Deep waters off shelf	N/A	NL	LC	II	The melon-headed whale is considered rare within the proposed Study Area and in all adjacent waters. While there are no OBIS sightings within the Study Area, one sighting was recorded near the southeastern extent of its boundary. This sighting occurred in 2005 during the Sargasso 2005 cetacean sightings survey.
Harbour Porpoise (*Phocoena phocoena*)	Rare	Shelf, coastal, pelagic	89,054[4]	NL	LC	II	OBIS has records for thousands of sightings of the harbor porpoise in the coastal and shelf water around the Gulf of Maine. Within the proposed Study Area, three sightings have been reported. Two in the slope waters near the northern extent of the Study Area, and one at abyssal depth ~ 16,400-ft (5000m). The latter was spotted in 1978 during the Programme Integre de recherches sur les oiseaux pelagiques (PIROP) Northwest Atlantic survey
False Killer Whale (*Pseudorca crassidens*)	Rare	Pelagic	N/A	NL	DD	II	The false killer whale is considered rare within the proposed Study Area and adjacent waters. There are only 11 OBIS sightings of this species off the U.S. coast with two occurring within the Study Area. One record in 1971, the other two occurred in 1997.

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	
Shorted-beaked Common Dolphin (*Delphinus delphis*)	Regular	Shelf, pelagic, high relief	120,743[4,9]	NL	LC	II	The short-beaked common dolphin is considered common within the proposed Study Area and surrounding waters. Within the Study Area, OBIS reports 83 sightings. Four studies have reported sightings since the year 2000. In 2001 and 2002, the NEFSC Right Whale Survey recorded 14 and four sightings respectfully. Also in 2001, the Canada Maritime Regional Cetacean Sightings identified one short-beaked common dolphin. Lastly, in 2004 the NEFSC Mid-Atlantic Marine Mammal Abundance Survey 2004 reported spotting eight of these species.
Risso's Dolphin (*Grampus griseus*)	Regular	Shelf, slope, seamounts	20,479[4,9]	NL	LC	II	The Risso's dolphin is considered common within the proposed Study Area. OBIS has over 100 sightings of this species within the boundaries, and thousands along adjacent coastal, shelf and slope waters. Many of the sightings occur in the shelf and slope waters, nine sightings occurred in the deeper waters, in isobaths of ~ 14,438-ft (4,400m).
Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)	Regular	Shelf and slope	63,368[4]	NL	LC	II	The Atlantic white-sided dolphin has thousands of OBIS sightings in coastal, shelf and slope waters, with the majority occurring on the shelf north of the proposed Study Area. Within the Study Area boundaries OBIS has recorded ten sightings of this species. While nine of the sightings were from the late 1970s and early 1980s, one sighting was reported in 2002 from the NEFSC Right Whale Survey.
Striped Dolphin (*Stenella coeruleoalba*)	Regular	Offshore convergence zones and upwellings	94,462[4,9]	NL	LC	II	OBIS records indicate ~ 75 sightings of the striped dolphin within the proposed Study Area, nearly all occurring along the shelf and slope waters in the north and west extent.
Atlantic Spotted Dolphin (*Stenella frontalis*)	Regular	Shelf, offshore	50,987[4,9]	NL	DD	II	Within the proposed Study Area, OBIS records indicate that eight Atlantic spotted dolphins have been sighted. The sightings were divided between mid and base slope waters. Four were observed in 1998 during the NEFSC Survey 1998 1. The other four in 2004 during the NEFSC Mid-Atlantic Marine Mammal Abundance Survey.

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	
Common Bottlenose Dolphin (*Tursiops truncates*)	Regular	Coastal, shelf, pelagic	81,588[4,16]	NL	LC	II	Of the NW Atlantic stock, there are at least five genetically distinct stocks of the common bottlenose dolphin distributed from southern Long Island, New York to central Florida (NMFS 2001; McLellan et al. 2003). These are further divided into two morphotypes: coastal and offshore (Waring et al. 2006). OBIS sightings are in the thousands for the common bottlenose dolphin in coastal and shelf, slope and abyssal waters. There are ~ 100 sightings of this species in the proposed Study Area and likely consist of the offshore morphotype. NOAA has declared an Unusual Mortality Event (UME) along the east coast for bottlenose dolphin (NOAA, 2013). The UME appears to be a result of morbillivirus and seems to be affecting the dolphin populations in nearshore waters <50m. There remains some uncertainty on cause and populations affected.
Fraser's Dolphin (*Lagenodelphis hosei*)	Rare	Shelf and slope	N/A	NL	LC	II	There are no OBIS sightings of the Fraser's dolphin within the proposed Study Area, and only one OBIS sighting in the waters adjacent to its boundaries. This dolphin was observed near the western boundary of the Study Area.
Pantropical Spotted Dolphin (*Stenella attenuata*)	Regular	Coastal, shelf and slope	4,439[4,9]	NL	LC	II	There are six OBIS sightings of the pantropical spotted dolphin within the proposed Study Area. Three occurred in shelf and slope waters one in slopes waters, one at the base of the slope, and one in abyssal depths of ~ 16,400-ft (5000m). The latter was observed in 2005 during the Sargasso 2005 cetacean sightings survey.
Clymene Dolphin (*Stenella clymene*)	Rare	Coastal, shelf and slope	N/A	NL	DD	II	There are no OBIS sightings for the clymene dolphin within the proposed Study Area and only seven sightings in shelf and slope waters in southern U.S. waters.
Spinner Dolphin (*Stenella longirostris*)	Rare	Mainly nearshore	N/A	NL	DD	II	OBIS only has one sightings record of the spinner dolphin within the proposed Study Area. It occurred in 1997, during a BLM CETAP Ship sighting. Other sightings in adjacent waters occurred in the slopes west of the Study Area.
Rough-Toothed Dolphin (*Steno bredanensis*)	Rare	Mostly pelagic	N/A	NL	LC	II	Within the proposed Study Area, there are two OBIS sightings of the rough-toothed dolphin. One occurred in 1998 during the NEFSC Survey 1998 1, near the shelf edge in slope waters. The other occurred near the base of the slope in 1979 during an ELM CETAP Ship sighting.

Species (Common Name)	Frequency of Occurrence Near Study Area	Habitat	Population Estimates	Status			Comments
				ESA[1]	IUCN[2]	CITES[3]	

N/A – Not available or not assessed

U.S. Endangered Species Act: EN = Endangered; NL = Not listed (ECOS 2013)

[2] Codes for IUCN classification: EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient. Classifications are from the IUCN Red List Threatened Species (IUCN 2013).

[3] 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.

[4] Best population estimate "NBest" from Table 1 of Waring et *al*. (2010) stock assessment report.

[5] Central and Northeast Atlantic (IWC 2012)

[6] North Atlantic (Cattanach et at. 2003)

[7] Central and Northeast Atlantic (Pike et *al.* 2009)

[8] Central and Northeast Atlantic (Vikingsson et al. 2009)

[9] Western North Atlantic, in U.S. and southern Canadian waters (Waring et *al.* 2012)

[10] Likely negatively biased (Stevick et *al.* 2003)

[11] *Globicephala sp.* combined, Central and Eastern North Atlantic (IWC 2012)

[12] Eastern North Atlantic (NAMMC 1995)

[13] Both *Kogia* species

[14] *Ziphius* and *Mesoplodon* spp. Combined

[15] For the northeast Atlantic, Faroes-Iceland, and the U.S. east coast (Whitehead 2002)

[16] Offshore, Western North Atlantic (Waring et *al.* 2012)

[17] Western Atlantic Population (NOAA 2012)

[18] All stocks of NW Atlantic (Thomas et *al.* 2011)

[19] Northwest Atlantic (Hammill, M.O. and Stenson, G.B. 2011)

[20] Northwest Atlantic (Andersen, J.M. et *al.* 2009)

3.5.1 ESA-listed Cetacean Species

Several large cetacean species are listed as threatened or endangered by NMFS (Table 9Table 9:). Many cetacean species, which have very low reproductive potentials, are particularly vulnerable to anthropogenic impacts such as accidental entanglement in fishing gear, collisions with ships, and noise and chemical pollution, which threaten many populations and may prevent depleted populations from recovery. The sei, blue, fin, humpback, sperm, and North Atlantic right whales are listed by NMFS as endangered species under the ESA.

Table 9: ESA-listed Marine Mammal Species that May Occur in the Study Area

Species	Status			Comments
	ESA1	IUCN2	CITES3	
Sei Whale	EN	EN	I	During the 19th and 20th centuries, sei whales were targeted and greatly depleted by: commercial hunting and whaling, with an estimated 300,000 animals killed for their meat and oil. Other threats that may affect sei whale populations are ship strikes and interactions with fishing gear, such as traps/pots.
Blue Whale	EN	EN	I	Whaling reduced the original blue whale population. There are fewer than 250 mature individuals and strong indications of a low calving rate and a low rate of recruitment to the studied population. Today, the biggest threats for this species come from ship strikes, disturbance from increasing whale watch activity, entanglement in fishing gear, and pollution. They may also be vulnerable to long-term changes in climate, which could affect the abundance of their prey (zooplankton).
Fin Whale	EN	EN	I	The fin whale population has been decimated by exploitation. Populations have also been impacted by commercial whaling, collisions with vessels, entanglement in fishing gear, reduced prey abundance due to overfishing, and habitat.
North Atlantic Right Whale	EN	EN	I	North Atlantic right whales, found only in the North Atlantic, were heavily reduced by whaling. The total population currently numbers about 322 animals (about 220-240 mature animals), has been decreasing during the last decade, and is experiencing high mortality from ship strikes and entanglement in fishing gear.

Species	Status			Comments
	ESA1	IUCN2	CITES3	
Humpback Whale	EN	LC	I	Humpback whales face a series of threats including: entanglement in fishing gear (bycatch), ship strikes, whale watch harassment, habitat impacts, and harvest. Humpbacks are increasing in abundance in much of their range.
Sperm Whale	EN	VU	I	Commercial whaling reduced the sperm whale population. Sperm whales face a series of threats such as ship strikes, entanglement by fishing gear, and accumulation of stable pollutants.

[1] U.S. Endangered Species Act: EN = Endangered; TR = Threatened; DE = Delisted; UR = Under Review; NL = Not listed (ECOS 2013)
[2] Codes for IUCN classification: EN = Endangered; CR = Critically Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient. Classifications are from the IUCN Red List Threatened Species (IUCN 2012).
[3] 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.

3.6 MARINE AND MIGRATORY BIRDS

General information on the taxonomy, ecology, distribution and movement, and acoustic capabilities of seabird families is given in Section 3.5.1 of the NSF/USGS PEIS (2011).

There are numerous marine and coastal bird species that may be present in or near the study area, including both resident and migratory species. Resident species are present throughout the year, whereas migratory species may be present only during breeding and wintering seasons, or they may only migrate through the area. There are three distinct taxonomic and ecological groups: seabirds, waterfowl, and shorebirds, which comprise 18 taxonomic families. Species within a given taxonomic family of birds share common physical and behavioral characteristics that allow these birds to be presented in this document by family rather than by individual species. Because of these common characteristics, the potential for exposure to geophysical activities would be similar for species within a given family that share similar behavioral characteristics. Table 10: provides a summary of this information, including OBIS sightings data for seabird species that could occur within the proposed Study Area. The distribution of which is dependent on availability and distribution of preferred prey and the breeding status of the species.

Table 10: Conservation Status and Sightings of Seabirds That May Occur In or Near the Proposed Study Area

Group/Species	Occurrence Near Study Area	ESA[1a] / IUCN[1b] / CITES[1c]	OBIS Sightings Within Study Area
Common Loon (Gavia immer)	Rare	NL / LC / N/A	None

Group/Species	Occurrence Near Study Area	ESA[1a] / IUCN[1b] / CITES[1c]	OBIS Sightings Within Study Area
Grebes (Podiceps grisegena, Podiceps auritus Podiceps conutus, Podilymbus podiceps)	Rare	N/A / LC / N/A	None
Petrel (Pterodroma hasitata[i], Pterodroma arminjoniana[ii])	Regular	UR[i]; N/A[ii] / EN[i]; VU[ii] / N/A	7 (spp. *hasitata*)
Shearwaters (Puffinus gravis, Puffinus lherminieri, Calonectris diomedea, Fulmarus glacialis)	Regular	N/A / LC / N/A	Hundreds along the shelf, slope and oceanic waters
Pelicans (*Pelecanus occidentalis*[iii], Pelecanus erythrorhynchos[iv])	Rare	DE[iii]; NL[iv]/ LC / N/A	None
Gannets/Boobies (Morus bassanus, Sula leucogaster)	Regular	N/A / N/A / N/A	~15 sightings (spp. *bassanus*) in shelf and slope waters in northern extent
Cormorants (Phalacrocorax auritus[v], Phalacrocoracidae carbo[vi])	Rare	NL[v]; N/A[vi] / N/A / N/A	None
Gulls (Larus argentatus[vii], Larus atricillav[viii], Larus marinus[vii], Larus philadelphia[vii], Rissa tridactyla[vii])	Regular	N/A[vii]; NL[viii] / N/A / N/A	~ 100 sightings in shelf, slope and oceanic waters (mostly spp. *argentatus* then spp. *marinus*)

Group/Species	Occurrence Near Study Area	ESA[1a] / IUCN[1b] / CITES[1c]	OBIS Sightings Within Study Area
Tern (Sterna hirundo[ix], Sterna anaethetus[x], Sterna dougallii[xi])	Regular [5]; Rare[6]	NL[ix]; N/A[x]; EN & TR[xi] / N/A / N/A	6 sightings in shelf, slope and oceanic waters (spp. *hirundo* and unk.)

N/A – Not available or not assessed
[a] U.S. Endangered Species Act: EN = Endangered; TR = Threatened; DE = Delisted; UR = Under Review; NL = Not listed (ECOS 2013)
[1b] Codes for IUCN classification: EN = Endangered; CR = Critically Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient. Classifications are from the IUCN Red List Threatened Species (IUCN 2012).
[1c] 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 by may become so unless trade is closely controlled.

Seabirds are defined as those species that live in the marine environment and feed at sea (Schreiber and Burger, 2002). Seabirds may be categorized by the marine zones in which they tend to forage. Pelagic birds forage away from the coastal zone and in open ocean and shorebirds forage in coastal waters, while other seabirds use both nearshore and pelagic zones (Michel, 2011). Certain waterfowl (Order Anseriformes) taxa commonly termed sea ducks feed and rest within coastal (nearshore and inshore) waters outside of their breeding seasons. They typically form large flocks and are often observed in large rafts on the sea surface during this period. Shorebirds utilize coastal environments for nesting, feeding, and resting. They are included within Order Charadriiformes (along with gulls and terns). The shorebird group consists of four families and includes sandpipers, plovers, and stilts.

In offshore waters, prey distribution is generally of prime importance. The upwelling and subsequent mixing of the water at the edge of the shelf is attractive to seabirds as it concentrates prey. Pelagic seabirds spend most of their lives at sea, coming to land only to breed. Most pelagic seabirds subsist on a diet of small fish including sand lance, capelin and herring and plankton.

The temporal distribution of marine seabirds offshore is typically as follows:

- The offshore seabird community consists primarily of shearwaters and storm-petrels during the summer months, and of kittiwakes, fulmars during the winter.
- Nearly all the pelagic birds found on the Shelf and Slope do not breed in the Study Area waters.
- Greater Shearwaters are abundant from April to December.
- Northern Fulmars have been observed in proximity of the Study Area throughout the year.
- Large numbers of Storm-petrels arrive in offshore waters in May. They remain abundant on the Shelf until early autumn when they migrate south at the end of the breeding season.

3.6.1 ESA-listed Bird Species

Section 4.2.4.1.1 of the BOEM Final PEIS (2014) and 3.3 of BOEM 2012 Biological Assessment provides a species overview and critical habitat designation for three ESA listed, species: the Roseate Tern (*Sterna dougallii*), Bermuda Petrel (*Pterodroma cahow*), Piping Plover

(*Charadrius melodus*), and one non-listed seabird, the Red Knot (*Calidris canutus*). Piping Plover and Red Knot are shorebirds that are unlikely to come into contact with geophysical activities.

Table 11 describes the two ESA-listed marine bird species relevant to the Study Area. Roseate Terns are more likely to come into contact with geophysical activities, as they forage offshore and feed by plunge-diving, often submerging completely when diving for fish. The Bermuda Petrel is also known to occur within the area, but feeds by snatching prey from the sea surface. USGS has submitted a request for formal consultation under Section 7 of the ESA with the USFWS concerning these bird species.

Table 11: ESA-listed Bird Species That May Occur in the Study Area

Species	Status	Comment
Roseate Tern (Sterna dougallii)	Endangered, ESA Atlantic Coast south to North Carolina *Threatened* in all other areas of the Western Hemisphere (USFWS 2012b), *Least Concern* - 2012 IUCN Red List of Threatened Species (IUCN 2012)	Human exploitation (trapping for market) of the Roseate Tern on its wintering grounds has been the main threat for the species. Toxic chemicals passed through the food chain and their effects on reproduction (thinning of eggshells, premature breakage of eggs, and reduced reproductive success) are also a concern. Breeding habitat includes sandy or rocky offshore islands and barrier beaches (Gochfeld et al. 1998). European populations winter in West Africa, between Guinea and Gabon (del Hoyo et al. 1996). During the breeding season, roseate terns are strictly coastal, whereas during the non-breeding season, they migrate well offshore and may be primarily pelagic. Roseate terns feed primarily on small marine fish taken over sandbars or shoals, or over schools of pelagic predatory fish (Gochfeld et al. 1998).
Bermuda Petrel (Pterodroma cahow)	*Endangered,* ESA (USFWS 2012a) Endangered- 2012 IUCN Red List of Threatened Species (IUCN 2012).	The Bermuda petrel was exploited for food and was thought to be extinct by the 17th century. It was only rediscovered in 1951, at which time the population consisted of 18 pairs (del Hoyo et al. 1992). The population has been the subject of an ongoing recovery effort and by 2008 was up to 85 breeding pairs (Maderios et al. 2012). This population is now increasing slowly, but remains vulnerable to storm damage, erosion, and predation (BirdLife International 2012a; Maderios et al. 2012).

3.7 MARINE FISH

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine fish are given in Section 3.3.1, of the NSF/USGS PEIS (2011. The Study Area encompasses demersal and pelagic habitats in the open ocean that support approximately 600 fish species (Ray et al., 1998, Smith-Vaniz et al., 1999). From a geographic perspective, the Study Area is offshore from two broad eco-regions:

(1) the Mid-Atlantic Bight (MAB) from Delaware Bay to Cape Hatteras, North Carolina; and

(2) the South Atlantic Bight (SAB) from Cape Hatteras to Cape Canaveral, Florida.

3.7.1 Demersal Fish

Demersal fish are fish that live near the seafloor for the majority of their adult lives. They are commonly referred to as groundfish and historically supported the largest fisheries in the western Atlantic. A selection of demersal fish known to occur in the Study Area are described here, including the codfishes (Family Gadidae), the flounders (Family Pleuronectidae), the redfishes (Family Scorpaeniudae), the skates (Family Rajidae). moray eels (Muraenidae), squirrelfishes (Holocentridae), groupers and sea basses (Serranidae), scorpionfishes (Scorpaenidae), grunts (Haemulidae), snappers (Lutjanidae), porgies (Sparidae), wrasses (Labridae), damselfishes (Pomacentridae), angelfishes (Pomacanthidae), blennies (Labrisomidae and Blenniidae), and triggerfishes (Balistidae). (Ophichthidae), searobins (Triglidae), drums and croakers (Sciaenidae), lizardfishes (Synodontidae), sand flounders (Paralichthyidae), and tonguefishes (Cynoglossidae).

3.7.2 Pelagic Fish

Pelagic fish are those species that spend the majority of their lives at the surface or in the water column off the seafloor. Within this broad life history classification, there exists three sub-divisions: the epipelagic fishes that live from coastal to oceanic waters, but only within the upper 100 m layer of water; the mesopelagic fishes that live between the euphotic zone and approximately 1,000 m; and the bathypelagic species that live in the water column below 1,000 m. Most epipelagic species are migratory and present on the shelf and slope typically during the summer and fall. The primary coastal pelagic families occurring in the SAB and MAB are sharks (Carcharhinidae, Lamnidae and Sphyrnidae), dogfish sharks (Squalidae), anchovies (Engraulidae), herrings (Clupeidae), mackerels (Scombridae), jacks (Carangidae), mullets (Mugilidae), bluefish (Pomatomidae), and cobia (Rachycentridae), flyingfishes (Exocoetidae), halfbeaks (Hemiramphidae), oarfishes (Regalecidae and Lophotidae), snake mackerels (Gempylidae), jacks (Carangidae), dolphinfish (Coryphaenidae), pomfrets (Bramidae), marlins, sailfish, and spearfish (Istiophoridae), swordfish (Xiphiidae), tunas (Scombridae), medusafishes (Centrolophidae), molas (Molidae), and triggerfishes (Balistidae). A number of these species, e.g., dolphin (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*), white marlin (*Tetrapterus albidus*), blue marlin (*Makaira nigricans*) and tunas are important to commercial and recreational fisheries. These species tend to school, undergo migrations, and are generally piscivorous.

Smaller coastal pelagic fishes exhibit similar life history characteristics, but the species are usually planktivorous. Smaller coastal pelagic fishes occurring in the Study Area include herrings such as alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), Atlantic herring (*Clupea harengus*), thread herring (*Opisthonema oglinum*), Spanish sardine (*Sardinella aurita*), round herring (*Etrumeus teres*), and Atlantic menhaden (*Brevoortia tyrannus*).

In the mesopelagic and bathypelagic zones of the Study Area, fish assemblages are numerically dominated by lanternfishes (Myctophidae), bristlemouths (Gonostomatidae), and hatchetfishes (Sternoptychidae).

3.7.3 Fish Species Listed as Threatened or Endangered

Section 3.3 of the NSF/USGS PEIS (2011) provides the species overview, distribution, and critical habitat designation for fish species that could occur within the proposed Study Area. The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a proposed threatened/ endangered species found in shelf waters (including areas offshore of Virginia and North Carolina) during fall and winter months. Two anadromous species, the blueback herring (*Alosa aestivalis*) and the alewife (*Alosa pseudoharengus*), are candidate species currently undergoing a status review to be listed as threatened. Atlantic bluefin tuna (*Thunnus thynnus*) is now designated as a species of special concern.

3.7.4 Fish Eggs and Larvae

Section 4.2.5.1.2 of the BOEM PEIS (2012) describes ichthyoplankton in the Study Area. Pelagic eggs and larvae found in the SAB are products of spawning mainly from warm temperate and tropical. The warm temperate species are spawned within the SAB, whereas the tropical eggs and larvae are carried into the area from more southerly spawning locations. Several of the region's commercially important species, including Atlantic menhaden, Atlantic croaker, spot, summer flounder, and southern flounder (*Paralichthys lethostigma*), migrate from nearshore shelf waters to the shelf edge to spawn. The larvae of these species are transported back across the shelf and eventually into inshore/estuarine nursery areas. Depending on the position of the Gulf Stream front, the ichthyoplankton in the SAB forms a mixture of slope and shelf/slope groups. The slope group is typified by lanternfish throughout the year. During spring, mackerel larvae reach peak abundance. Members of the slope group at other times of the year include inshore species such as gobies, wrasses, and flounders. The shelf/slope group includes fishes such as lefteye flounders, jacks, mullets (Mugil spp.), bluefish, filefish (Monacanthidae), goatfish (Mullidae), and sea basses (Serranidae); several of these are economically important species. The composition and abundance of ichthyoplankton at any particular time depends upon the position of the Gulf Stream front (Govoni 1993).

Fish eggs and larvae found in the MAB come from warm temperate, cold temperate, and boreal regions (Doyle et al., 1993). In general, the most abundant fish eggs and larvae found during winter months are those of cold temperate species originating in more northerly waters. During spring, summer, and fall months, ichthyoplankton is dominated by warm temperate species originating from more southerly waters. Lanternfishes (*Benthosema glaciale* and *Ceratoscopelus maderensis*) define the slope/oceanic group (Doyle et al., 1993) and some flatfish larvae occur with *C. maderensis*. The outer shelf group includes witch flounder, silver hake, Atlantic bonito, cusk-eels (Ophidiidae), and species from more southerly waters such as razorfish (*Xyrichtys* spp.), lefteye flounders (Bothidae), and gobies (Gobiidae) (Hare and Cowen, 1991; Cowen et al., 1993; Doyle et al., 1993).

3.8 BENTHIC INVERTEBRATES

Section 3.2 of the NSF/USGS PEIS (2011) addresses marine benthic invertebrates status, ecological importance, general ecology, and distribution. Of relevance to marine seismic activities are those invertebrates potentially sensitive to low-frequency seismic noise. Limited studies suggest that a few invertebrate groups are capable of detecting seismic noise. Among invertebrates, only decapods (lobsters, crabs and shrimps, including prawns [e.g., Offutt, 1970]), and mollusks (cephalopods such as octopuses, squids, cuttlefishes, and nautiluses [e.g., Budelmann and Williamson, 1994]) are known to sense low-frequency sound. No decapod crustaceans or cephalopod species of invertebrates are listed as vulnerable, threatened, or endangered within the Study Area.

3.8.1 Deep-Sea Corals and Sponges

Deep-sea coral species have been shown to occur in the Northeastern U.S. waters (NOAA NMFS 2011) and in close proximity to the Study Area with a few known locations (Figure 16). Deep-sea corals are important components for benthic habitats and contribute to structure and species diversity (Templeman, 2010). They provide structural complexity to relatively homogeneous seafloor and therefore likely to provide shelter, food, or substrate for epifaunal growth for other organisms (Watanabe et al., 2009) including commercial fish (Gilkinson and Edinger, 2009). Damage to corals caused by humans results in slow recovery, and the potential to alterations in associated benthic and fish communities (Templeman, 2010).

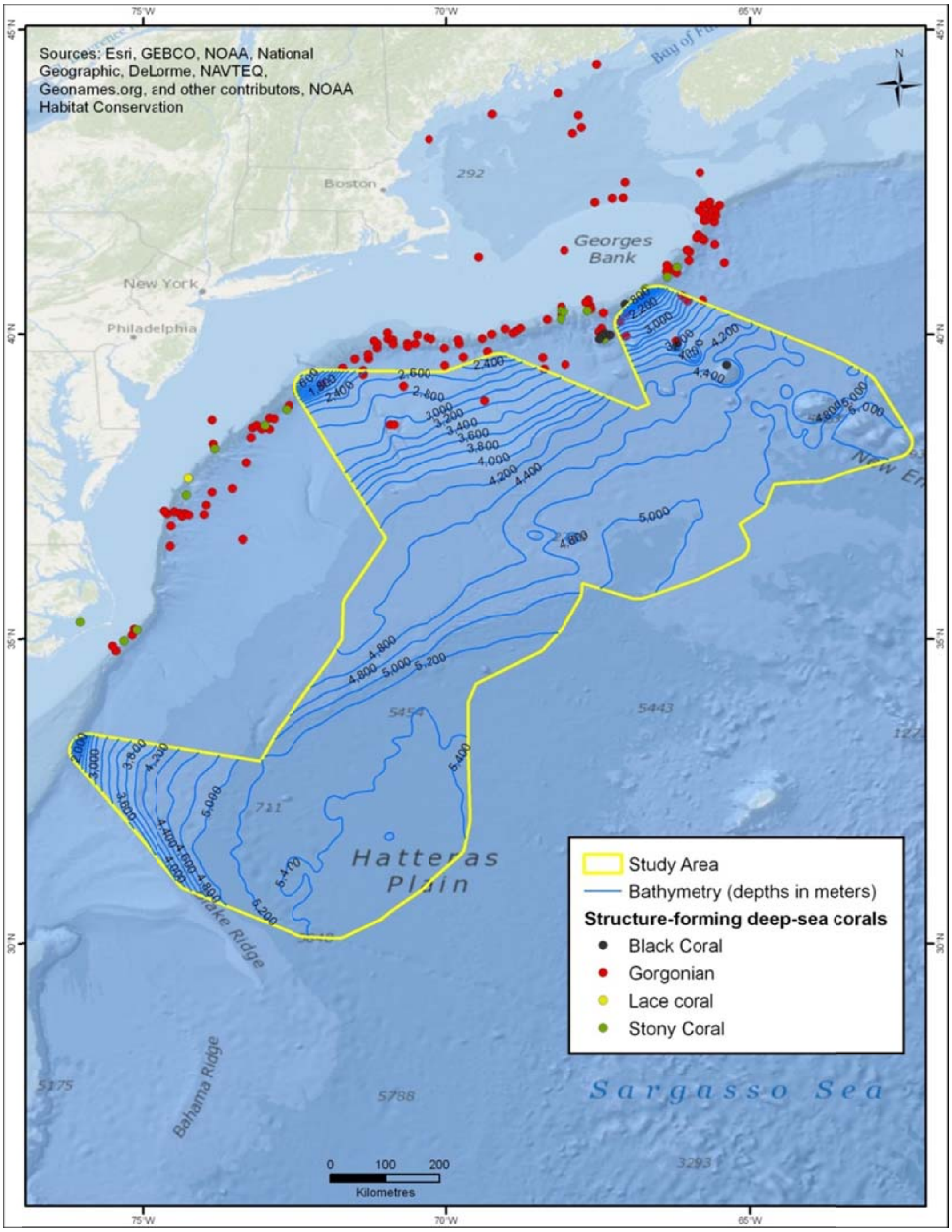

Figure 16: Deep-sea Corals

Deep corals in the northeastern U.S. belong to three major groups. There are the Hexacorals (or Zoantharia), which include the hard or stony corals (Scleractinia); the Ceriantipatharians which includes the black and thorny corals (Antipatharia), and finally there are the Octocorals (or Alcyonaria), with flexible, partly organic skeletons that include the true soft corals (Alcyonacea), gorgonians (Gorgonacea or sea fans and sea whips), and sea pens (Pennatulacea). Among all three groups, there appear to be a suite of species that occurs at depths of less than 500 m (shelf and upper slope), and a separate suite that occurs at depths greater than 500 m (lower slope and rise) (NOAA, n.d.). Population trends for deep-sea corals are not currently available, and therefore population statuses are generally unknown (NOAA NMFS, 2011). Although there are no known coral reefs in the northeast U.S. waters, deep corals can be found from shallow waters to 6,000 m depth, and are most common at depths of 50 to 1,000 m on hard substrate (NOAA NMFS, 2011).

Similar to deep-sea corals, sponges also provide deep-sea habitat, enhance species richness and diversity, and exert clear ecological effects on other local fauna. Sponge grounds and reefs support increased biodiversity compared to structurally-complex abiotic habitats or habitats that do not contain these organisms.

Physical damage or dislodgement of organisms and hard substrate, and/or crushing of corals and sponges can result from: anchoring and/or mooring of floating vessels, and seabed placement of equipment. Given the nature of seismic surveys, survey equipment is not expected to come in contact with the seafloor and deep-water corals and sponges.

3.8.2 Essential Fish Habitat

By definition, Essential Fish Habitat (EFH) is “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” The entire East Coast from shoreline to the 200 nm limit is considered EFH. The proposed Study Area borders the Northeast U.S. Continental Shelf Large Marine Ecosystem (LME) and extends south and east into deeper waters. The LME is considered EFH. Section 3.3.2.1 of NSF/USGS PEIS describes the EFH for the Northwest Atlantic DAA. EFH for various life stages of numerous fish species, including Atlantic cod, Atlantic salmon, Atlantic halibut, flounder, hake, herring and other pelagic species, occurs in or proximate to the analysis area extending out to the limit of the U.S. EEZ. Table 4.20 in the BOEM PEIS (2012) lists the soft bottom species and life stages with EFH identified within the area of interest. The Study Area is overlain by sand/silt/clay surficial sediments (Figure 17) – a soft bottom. The demersal species identified with EFH include scallop, golden crab, red crab, royal red shrimp, offshore hake and witch flounder. *Sargassum*,(an abundant brown algae that occurs on the surface in the warm waters of the western North Atlantic) is also considered an EFH because of the mutually beneficial relationship between fishes and algae. Juvenile loggerhead turtles also utilize floating *Sargassum* as habitat.

Habitat Areas of Particular Concern (HAPC) are subsets of EFH that provide important ecological functions and/or are especially vulnerable to degradation. HAPC are described in the NSF ENAM Draft EA and are incorporated by reference into this Final EA.

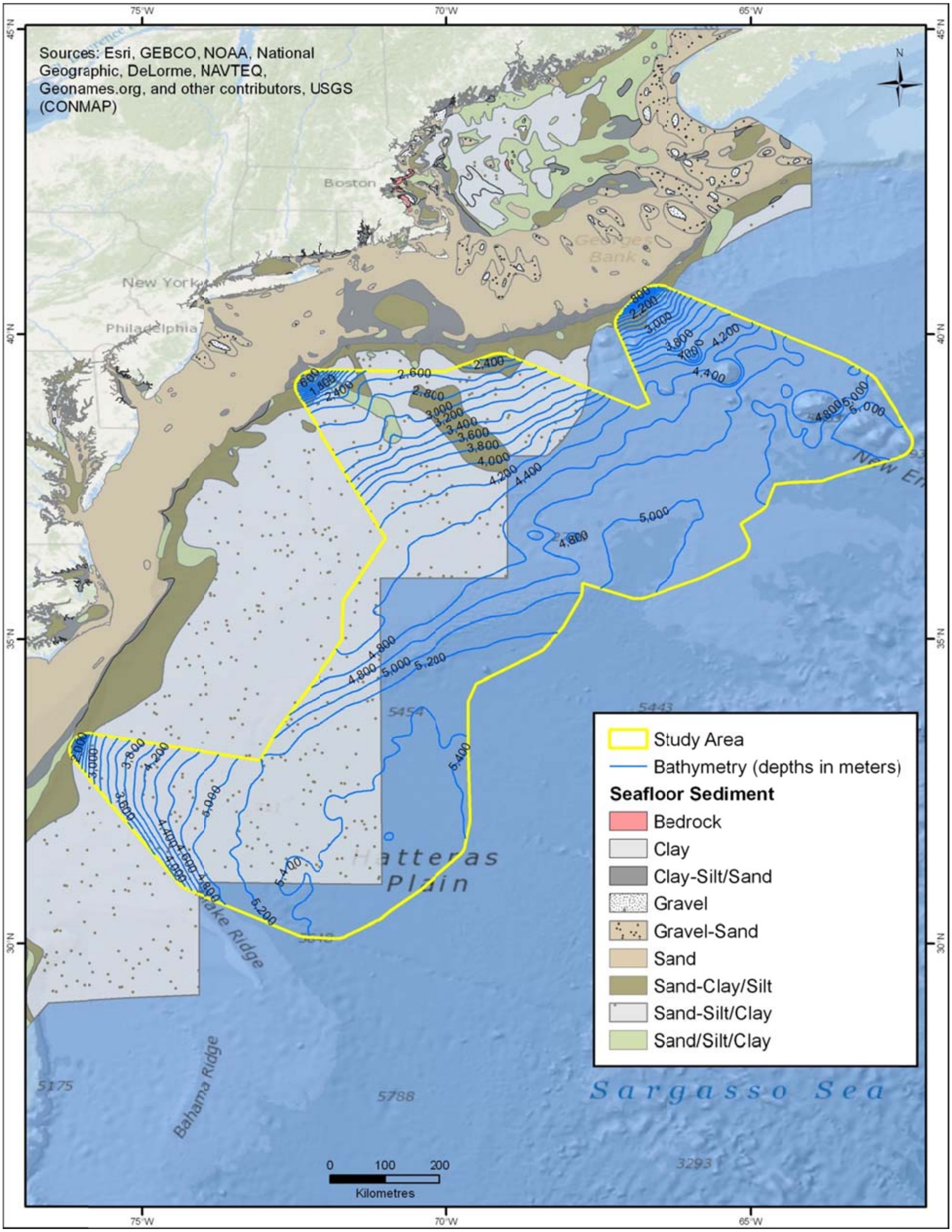

Figure 17: Seafloor Sediment

3.9 SEA TURTLES

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of sea turtles are given in Section 3.4 of the NSF/USGS PEIS (2011). In addition, Section 3.2 of BOEM's Final PEIS (2014) Biological Assessment reviews similar information for all species of sea turtles which may occur within the proposed Study Area. Figure 18, Figure 19, Figure 20, Figure 21 and Figure 22 show the location based on OBIS sighting data of each of the five species relative to the Study Area.

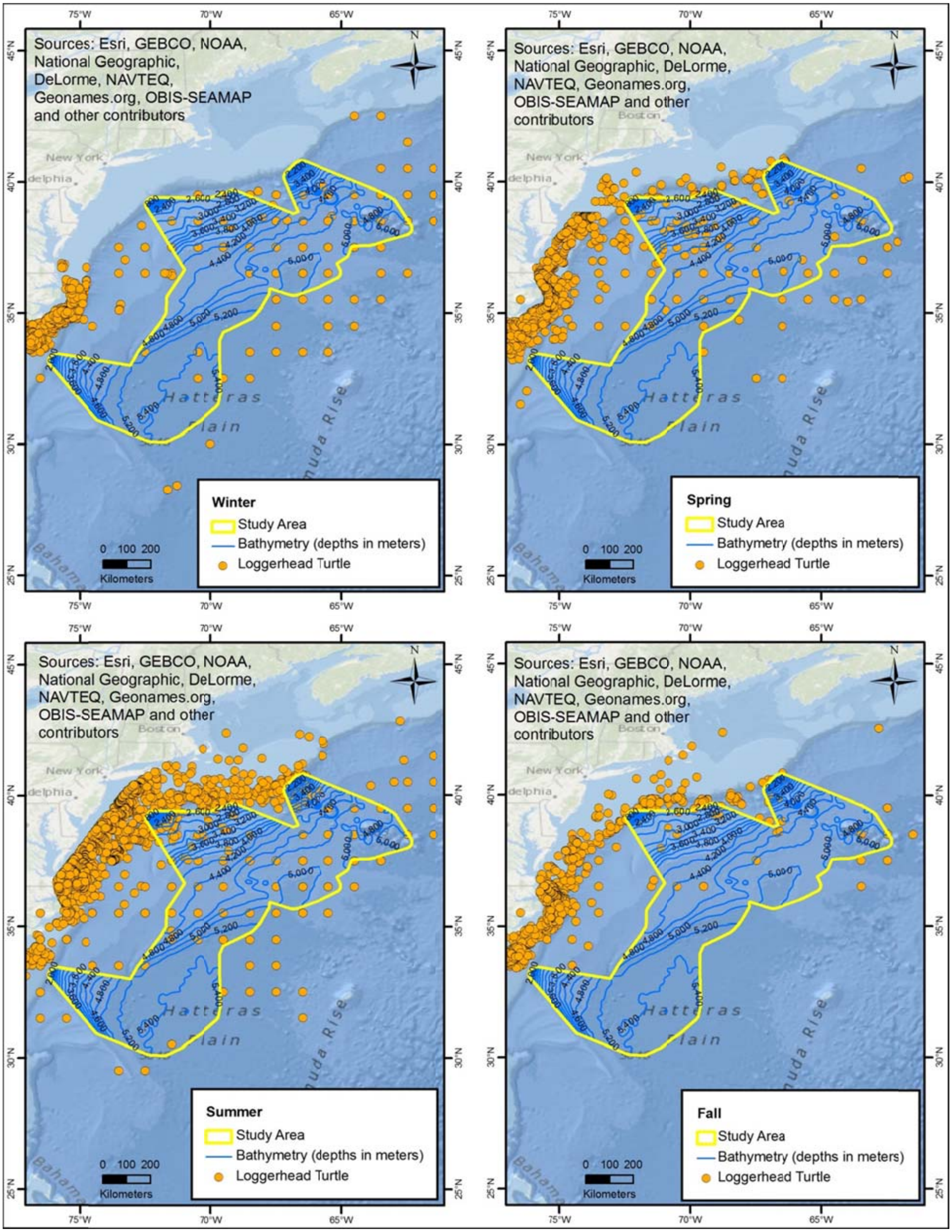

Figure 18: Seasonal Distribution of Loggerhead Turtles (multiyear observations)

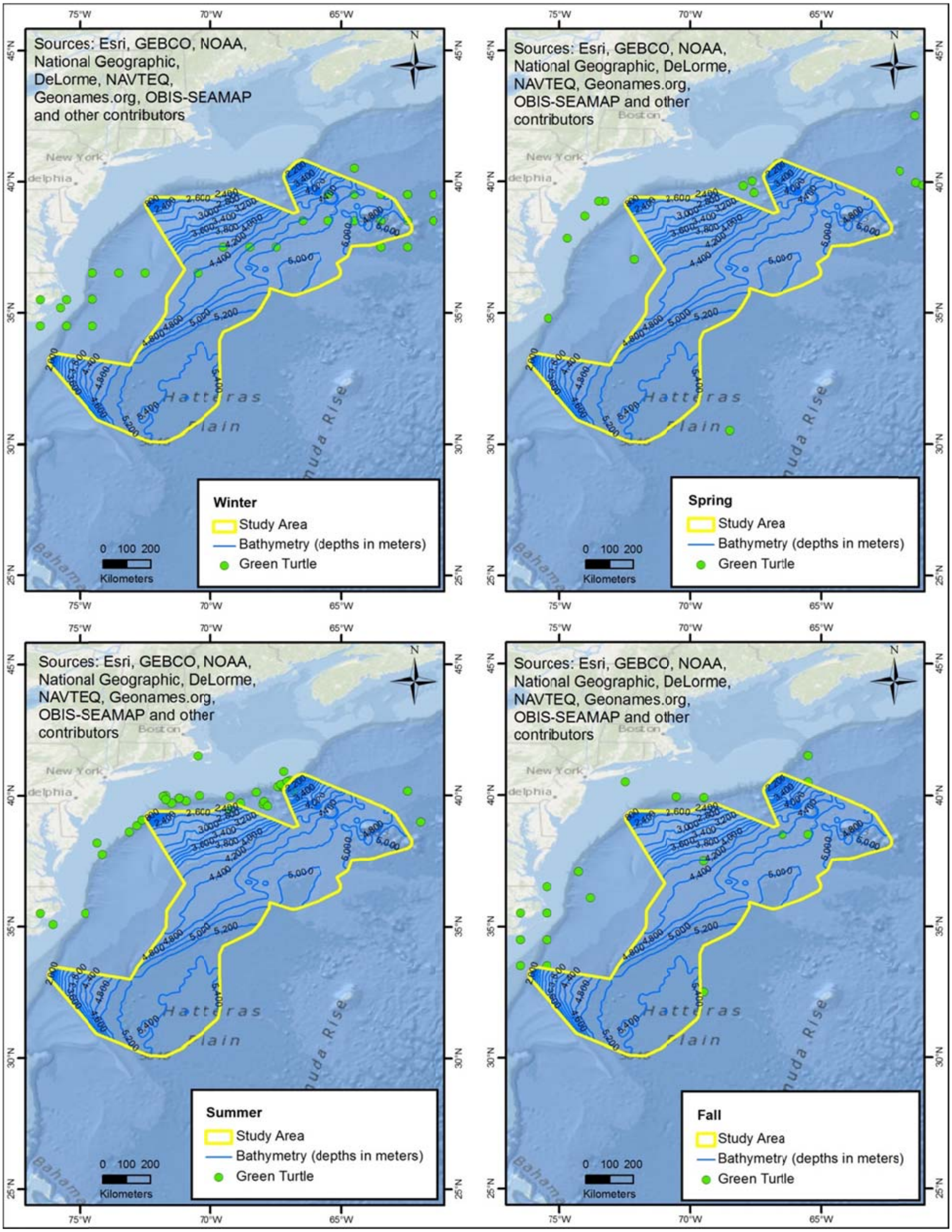

Figure 19: Seasonal Distribution of Green Turtles (multiyear observations)

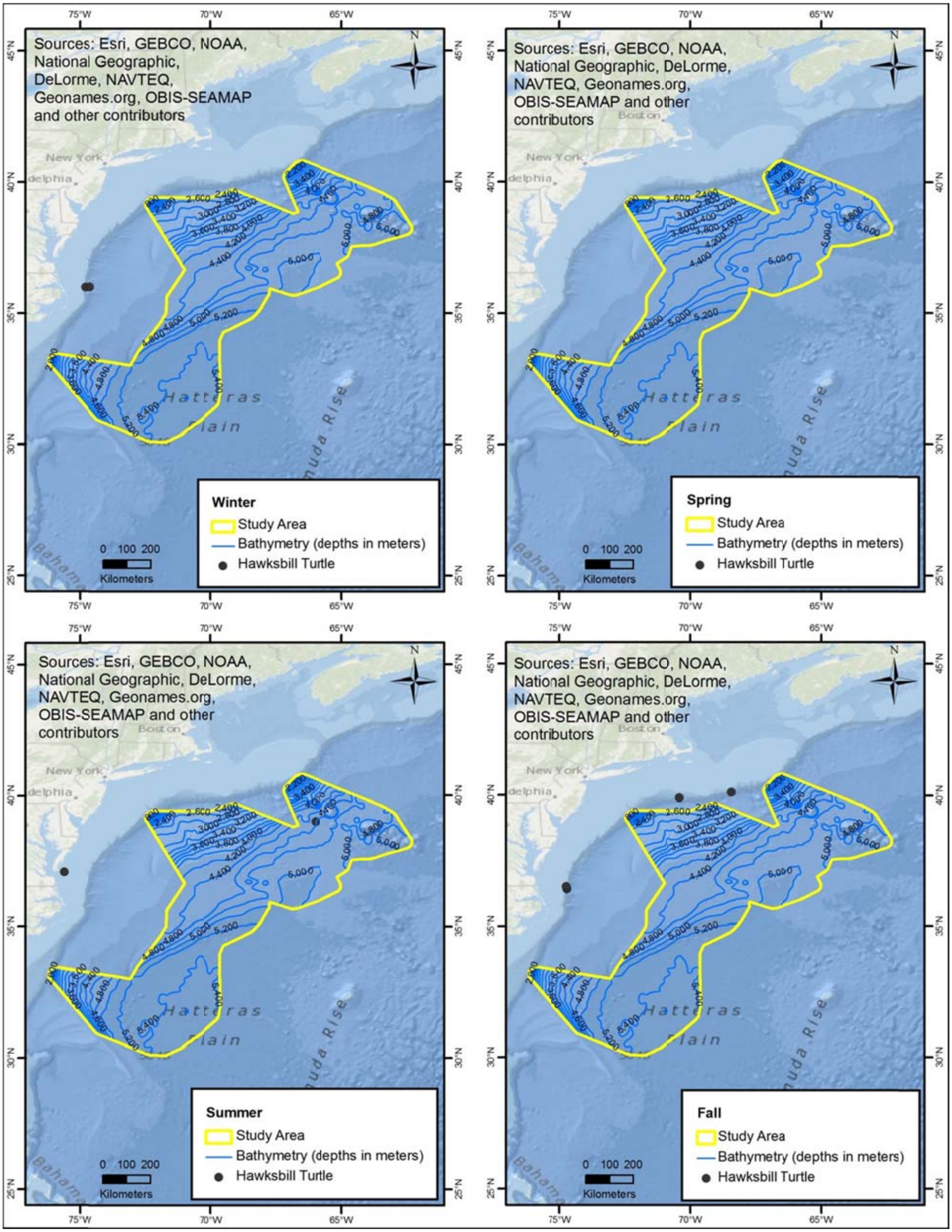

Figure 20: Seasonal Distribution of Hawksbill Turtles (multiyear observations)

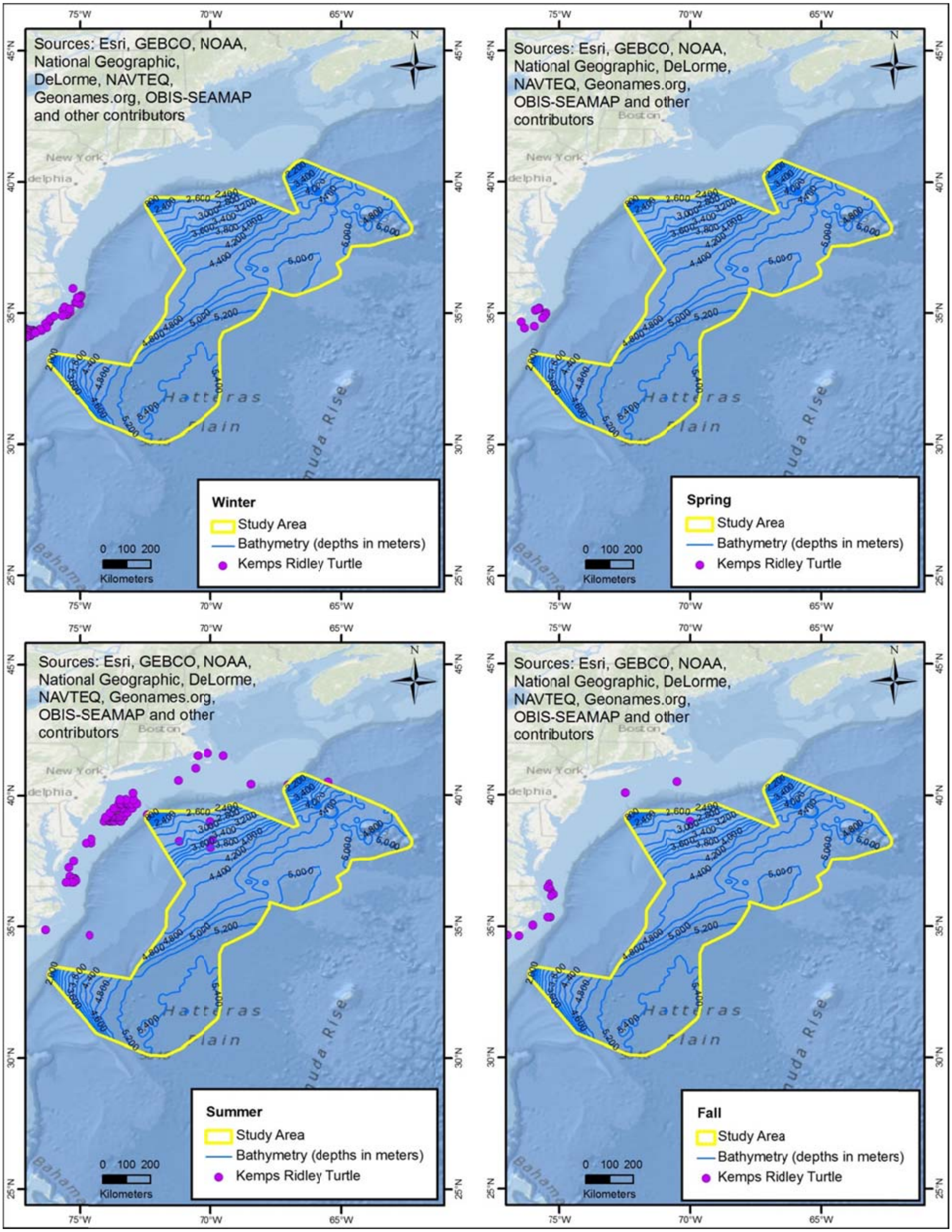

Figure 21: Seasonal Distribution of Kemp's Ridley Turtles (multiyear observations)

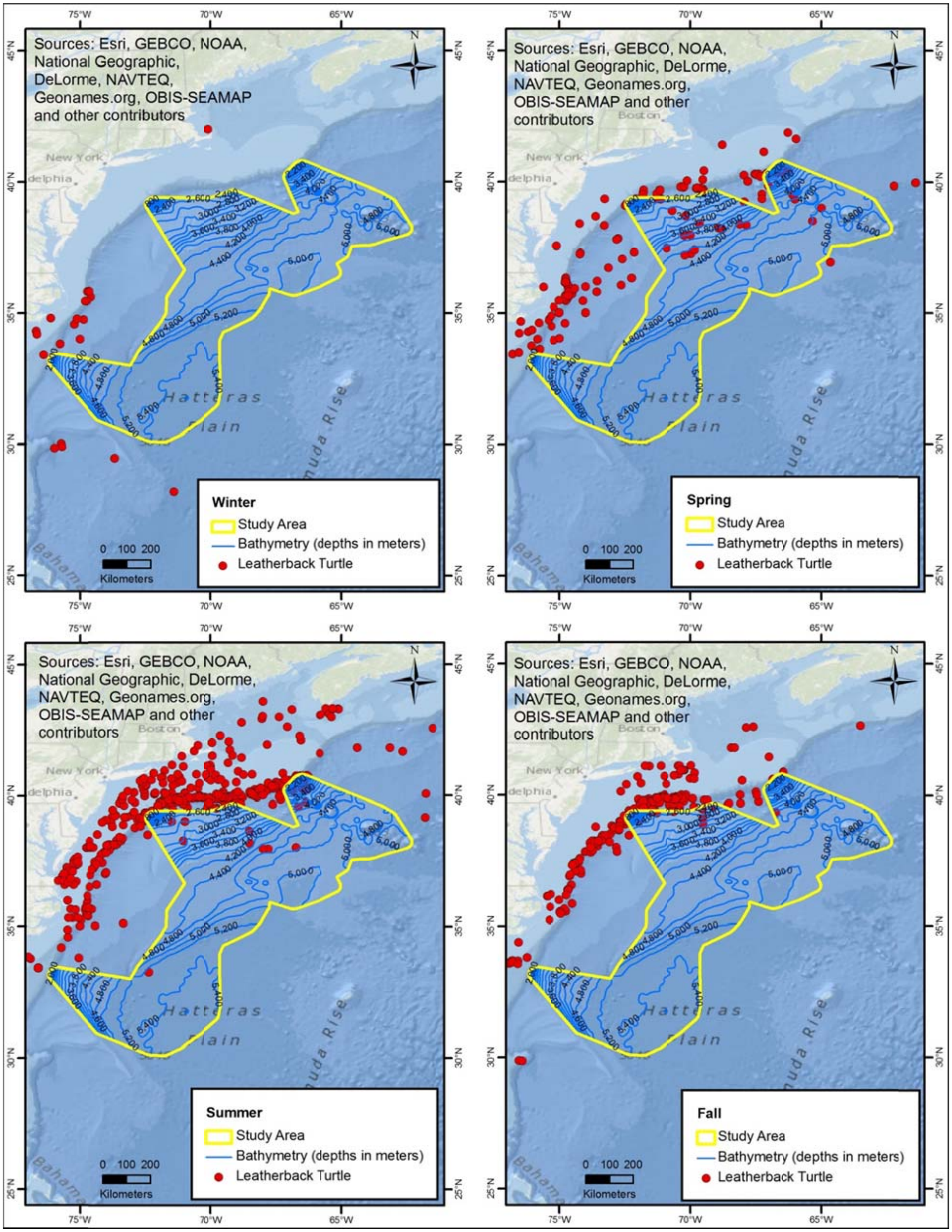

Figure 22: Seasonal Distribution of Leatherback Turtles (multiyear observations)

Table 12 summarizes the habitat, regional abundance, and conservation status of these reptiles. This section describes their distribution near the proposed Study Area. The main source of information is the OBIS database (Read et al,. 2009).

Table 12: ESA-listed Sea Turtles That May Occur the Proposed Study Area

Species (Common Name)	Occurrence near Study Area	Habitat	Estimated Annual Total Nesting Population	Status		
				ESA1	IUCN2	CITES3
Loggerhead	Regular	Oceanic, Coastal, Estuaries	38,334[4]; 68,000-90,000[5;] 9,000-50,000[6]	EN[7], TR[8]	EN	I
Green	Rare	Coastal, seagrass beds	200-1,100[5]	EN[9], TR[10]	EN	I
Hawksbill	Rare	Coral reefs, oceanic, hard bottom habitats	500-1,150[5]	EN	CR	I
Kemps ridley	Rare	Temperate and tropical coastal	5,000[11]	EN	CR	N/A
Leatherback	Regular	Ocean, continental shelf, nearshore	5,215[12]; 906[13]; 26,000-43,000[14]	EN	CR	NA

N/A – Not available or not assessed
U.S. Endangered Species Act: EN = Endangered; TR= Threatened; NL = Not listed (ECOS 2013)
[2] Codes for IUCN classification: EN = Endangered; CR = Critically Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient. Classifications are from the IUCN Red List Threatened Species (IUCN 2012).
[3] 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 by may become so unless trade is closely controlled.
[4] Richards et al. (2011) (Western North Atlantic stock)
[5] NOAA (2013) – In the U.S.
[6] Ernst et al. (1994) – North American Population
[7] Northeast Atlantic Ocean stock
[8] Northwest Atlantic Ocean stock
[9] Breeding population in Florida and on the Pacific coast of Mexico
[10] All other populations
[11] NOAA & FWS (1991)
[12] NMFS and FWS (2008) - Nesting beaches from Florida-Georgia border through southern Virginia
[13] NMFS and FWS (2008) - Nesting beaches from Franklin County on the northwest Gulf coast of Florida through Texas
[14] Dutton et al. (1999) - Worldwide Population

Loggerhead Turtle (*Caretta caretta*)

Loggerhead turtles are likely to be the most present species in the proposed Study Area. OBIS has several thousands of sightings for this species in the waters adjacent to the proposed Study Area. The majority of sightings occurring near the Study Area are off the western extent of its boundaries in the coastal and shelf waters. None the less, there are still hundreds of sightings in the deeper oceanic waters as well. Within the Study Area boundaries, OBIS sightings are ~ 200, with the majority occurring in the northwest. Recent sightings include a 2010 record by the North Carolina Long-Term Sea Turtle Monitoring Project, and a 2010 record by the Casey Key Loggerheads survey. The majority of the sightings within the Study Area were made between the months of June and August. However, several winter and spring sightings from NOAA'sSoutheast Fishery Science Center (SEFSC) Fisheries Log Book System (FLS) Commercial Pelagic Logbook Data suggest that Loggerheads use this area year-round.

Green Turtle (*Chelonia mydas*)

Although not considered common within the proposed Study Area, the green turtle has been observed within its boundaries. According to OBIS there were 24 sightings of this species, with the majority occurring in the northeast. Eighteen of these sightings were made between November and January, and a majority was reported in January 2004, all within a week of each other by Duke North Atlantic Turtle Tracking. This may indicate that the same specimen was seen time and time again during the study. The other sightings occurred between June and August.

Hawksbill Turtle (*Eretmochelys imbricata*)

The hawksbill turtle is considered rare within the proposed Study Area, with only two reported OBIS sightings. In the adjacent water west of the Study Area, only seven sightings exist in the OBIS database. The two sightings within the Study Area occurred in October, 1992 and June, 1993. Both were logged from SEFSC FLS Commercial Pelagic Logbook Data.

Kemp's Ridley Turtle (*Lepidochelys kempii*)

Within adjacent waters to the proposed Study Area, the Kemp's Ridley turtle is primarily observed in coastal and shelf waters. Within the Study Area, this species has been observed in shelf and slope waters at its northern extent twice, and northwestern extent five times. All observations were made between May and August with the most recent being in 1998.

Leatherback Turtle (*Dermochelys coriacea*)

The OBIS database reports that there are several hundreds of sightings of the leatherback in the vicinity of the proposed Study Area. Within its boundaries there are ~ 100 sightings of these species in the shelf and slope waters in the north and northwest. The majority of the sightings occurred between May and August. However, the SEFSC FLS Commercial Pelagic Logbook Data has recorded sightings between September and January.

3.10 OCEAN RESOURCE USERS

3.10.1 Navy Operation Areas

Military range complexes and civilian space program use is covered in Appendix A, Section 4.1.3 of BOEM Final PEIS (2014). The Study Area overlaps spatially with the Narragansett Operation Area (Figure 23). Military activities could include various air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and antisubmarine training, and Air Force exercises.

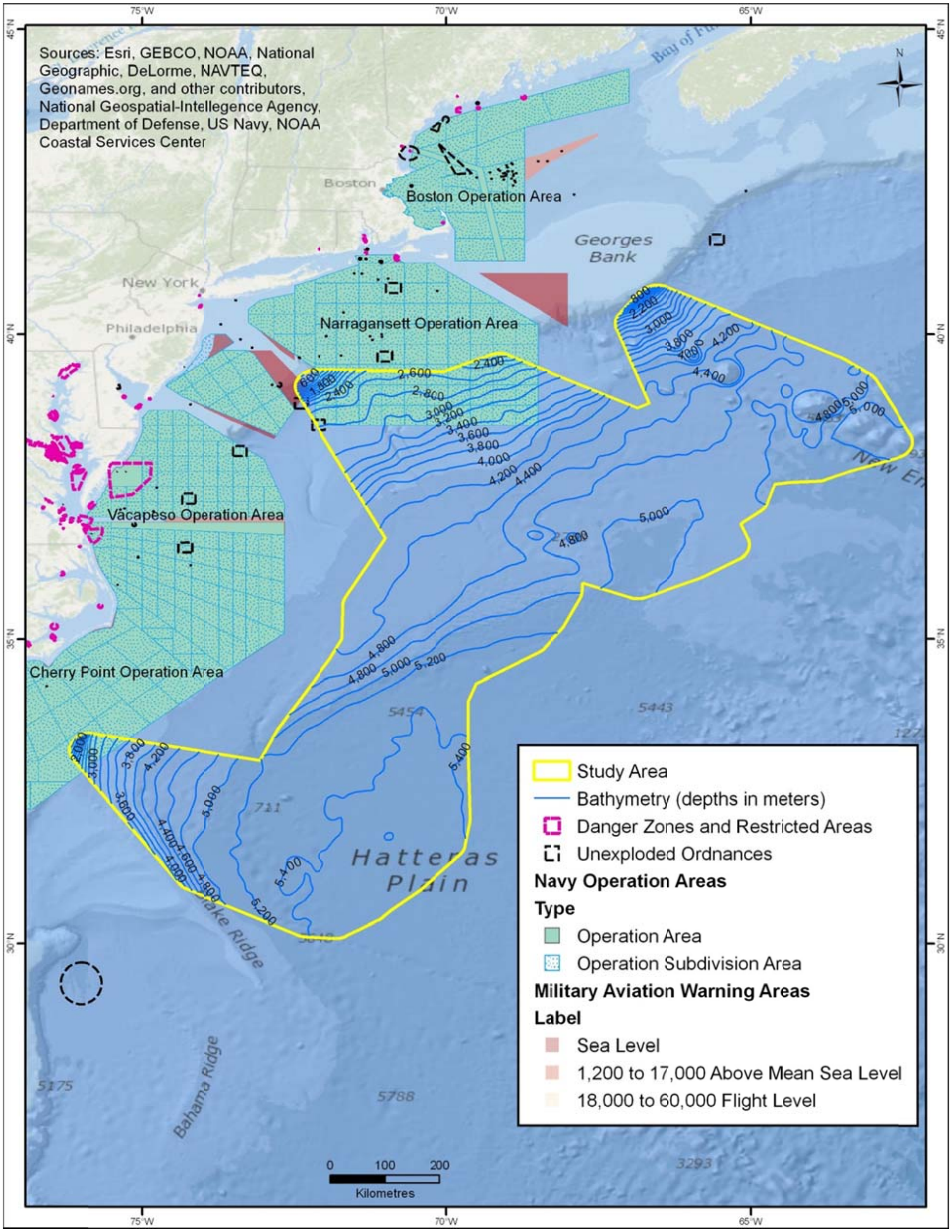

Figure 23: Navy Operation Areas

Unexploded Ordnances

Unexploded ordnance (or UXOs/UXBs, sometimes identified as UO) are explosive weapons (bombs, bullets, shells, grenades, land mines, naval mines, etc.) that did not explode when they were employed and still pose a risk of detonation, potentially many decades after they were used or discarded (DOC, NOAA, NOS, and CSC 2012). As shown in Figure 24 two UOs may exist within the proposed Study Area, and one lies only ~12.4mi (~20-km) of the northern boundary line. This is not a complete collection of unexploded ordnance on the seafloor, nor are the locations to be considered exact (DOC et al., 2012). The presence and locations of the unexploded ordnance have been derived from graphical representations recorded on NOAA Raster Navigation Charts (DOC et al., 2012).

Given that there is no bottom-founded activity associated with the proposed seismic surveying there would be no anticipated interaction with the potential UO sites.

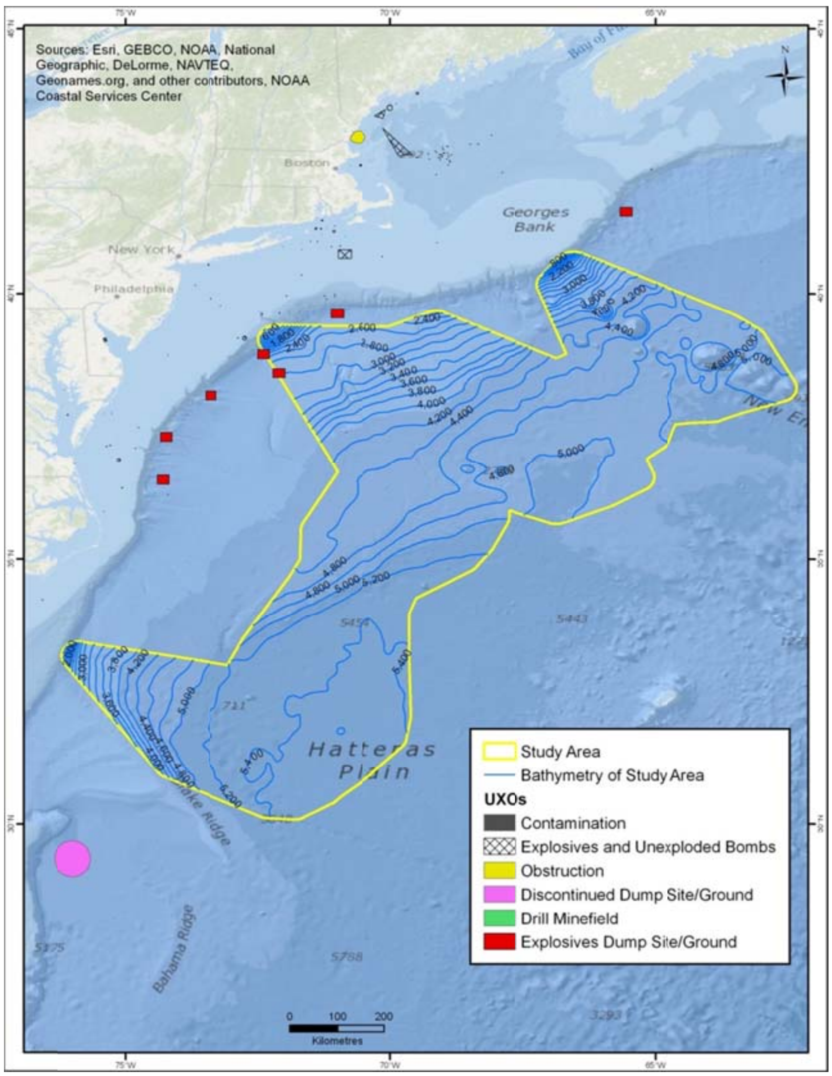

Figure 24: Unexploded Ordnance

3.10.2 Marine Traffic

Shipping and marine transportation is covered in Sections 4.1.1 and 5.10.1.1 of BOEM, 2012 Biological Assessment.

Marine traffic within the proposed Study Area and in adjacent waters includes commercial, military, and recreational shipping and marine transportation. Large commercial ships have designated shipping fairways and navigation channels along the inner shelf (Figure 25).

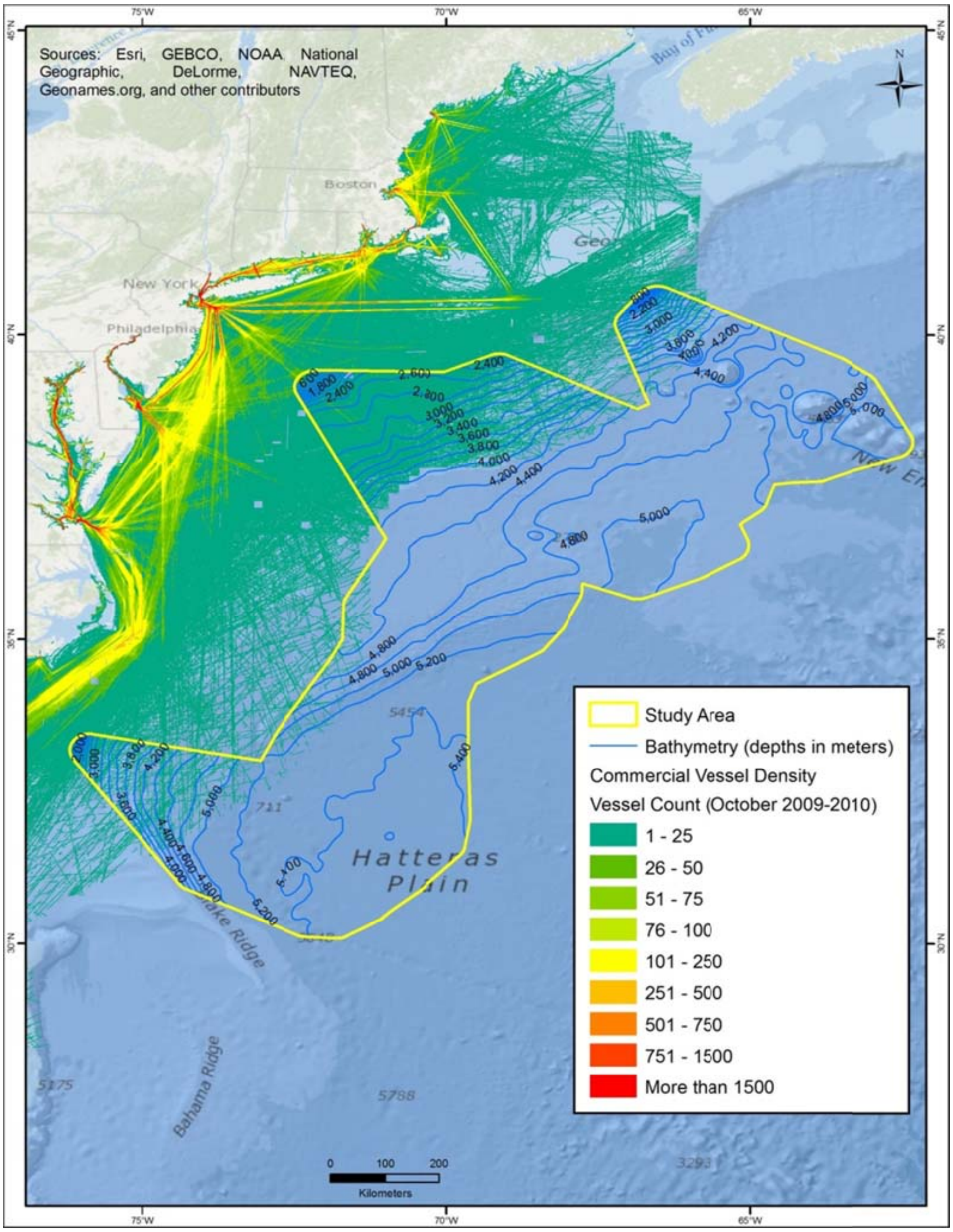

Figure 25: Marine Traffic

The proposed Study Area's western boundary is 808 mi (1300 km) long and runs somewhat parallel to the Atlantic Seaboard and six large, commercial ports: New York/New Jersey, Boston, Baltimore, Norfolk, Virginia (Port of Virginia), Wilmington (North Carolina), and Charleston. As noted previously, however, the proposed tracks are generally greater than 99 miles (159 km) from the coast, where port traffic is expected to be heaviest.

The smaller ports and terminals (Figure 26) located in the Delaware River include Wilmington, DE, and Philadelphia, which are accessed via the Delaware Bay. Delaware Bay is about 140 mi (225 km) west of the northwestern extent of the Study Area. Chesapeake Bay, 252 mi (405 km) west of the Study Area boundary, provides access to the Port of Baltimore, including numerous smaller ports in Maryland and Virginia.

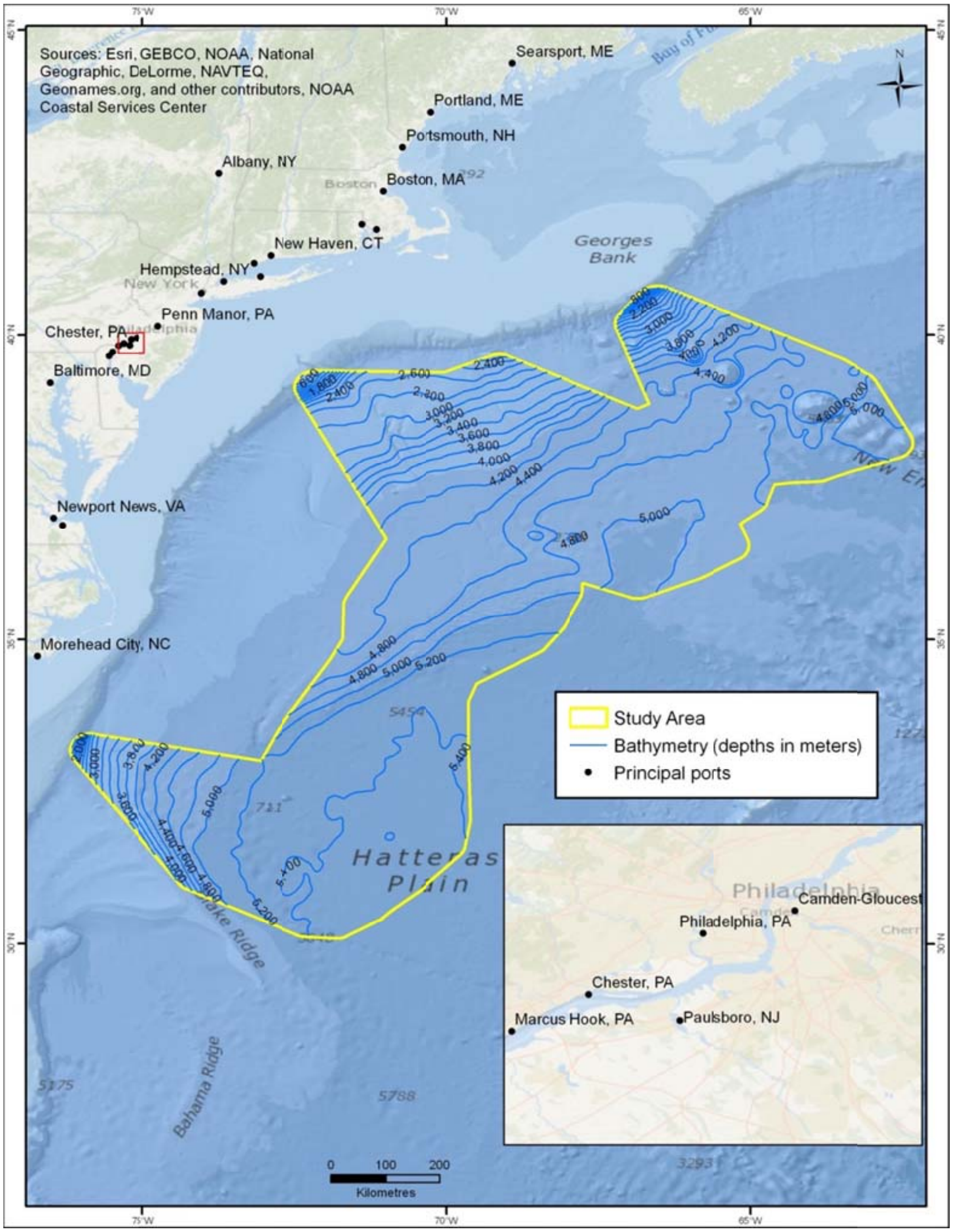

Figure 26: Ports and Terminals

3.10.3 Petroleum

Oil and Gas

Oil and gas exploration and development is covered in Section 4.1.6 of BOEM (2012) Biological Assessment. There are currently no active oil and gas leases or oil and gas exploration, development or production activities on the Atlantic OCS. This lack of activity is expected to be the status quo for the duration of this project. On July 23, 2014, BOEM issued a Record of Decision (ROD) for the Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement (PEIS).

Liquefied Natural Gas

Liquefied Natural Gas (LNG) is covered in Section 4.1.7 and Section 5.10.1.3 of BOEM (2012) Biological Assessment. Since BOEM (2012), an application from Liberty Natural Gas LLC was received by the Maritime Administration (MARAD) for all Federal authorization required for a license to construct, own, and operate an LNG deepwater port, known as Port Ambrose (Figure 27). This application was received on September 28, 2012. The port would be situated in Federal waters approximately 17 nm (31.4 km) southeast of Jones Beach, New York, approximately 24 nm (44.4 km) east of Long Branch, New Jersey, and about 27 nm (50 km) from the entrance to New York Harbor, in a water depth of approximately 103-ft (31.4 m). The application was deemed complete in June 2013 and public scoping meetings were held during the summer of 2013.

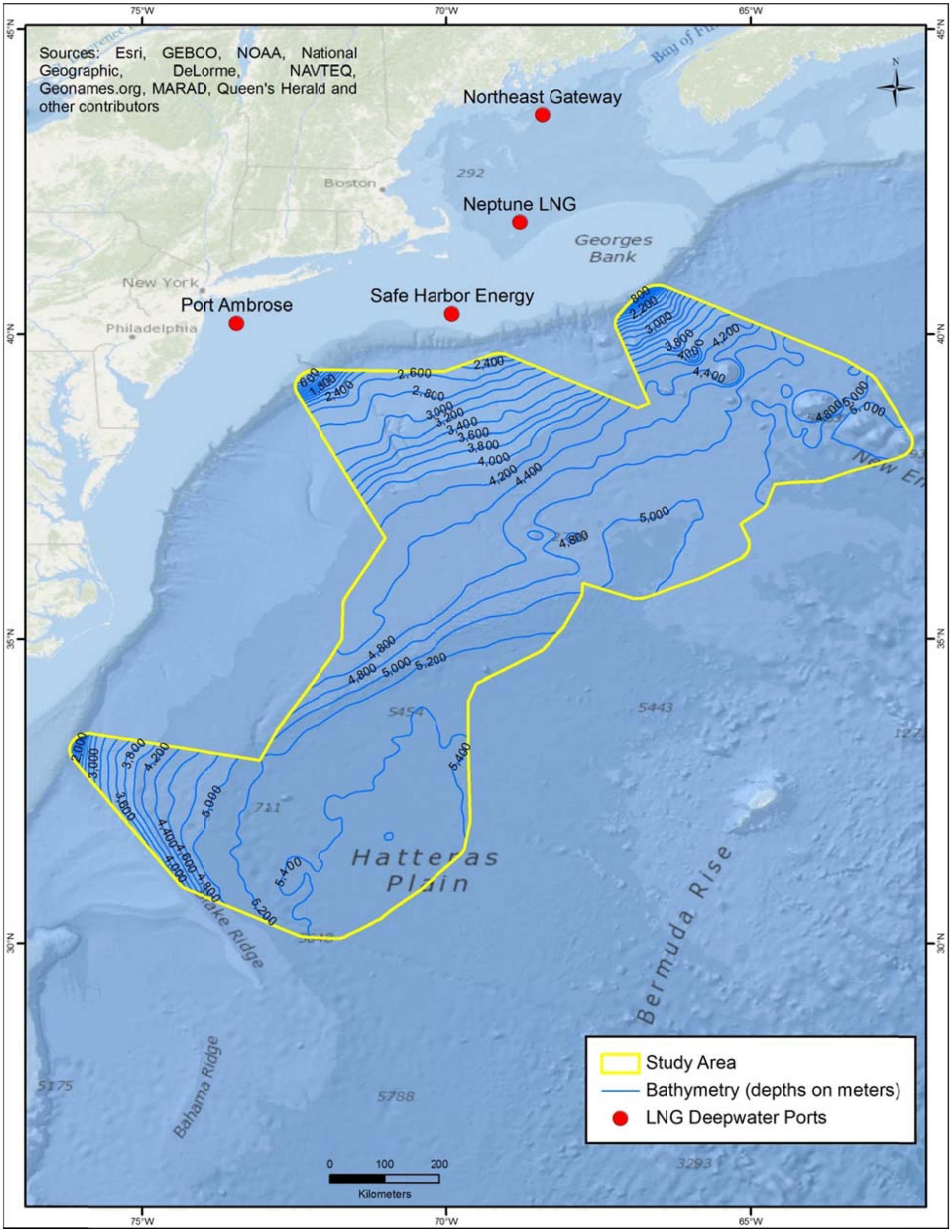

Figure 27: LNG Deepwater Ports

Also since BOEM (2012) PEIS was published, the operational LNG deepwater port, Neptune requested by letter dated May 24, 2012, that the MARAD allow a temporary five-year suspension of operations at the Deepwater Port. The MARAD issued an amended deepwater port license to allow the five-year suspension of operations.

Therefore, for this project's operation period of 2014 and 2015, it is expected that only one LNG deepwater port (Northeast Gateway) would be in operation. Figure 27 delineates the three LNG deepwater ports relative to the Study Area.

3.10.4 Submarine Cables

The submarine cable industry has been around for approximately 150 years and includes copper telegraph cables, telephone cables and fiber-optic cables. Figure 28 depicts the locations of these submarine cables in and around U.S. navigable waters, including in the Proposed Study Area. The interactive map indicates that there are at least 12 active submarine cables within the proposed Study Area. The majority of the cables are found in the northern extent of the Study Area.

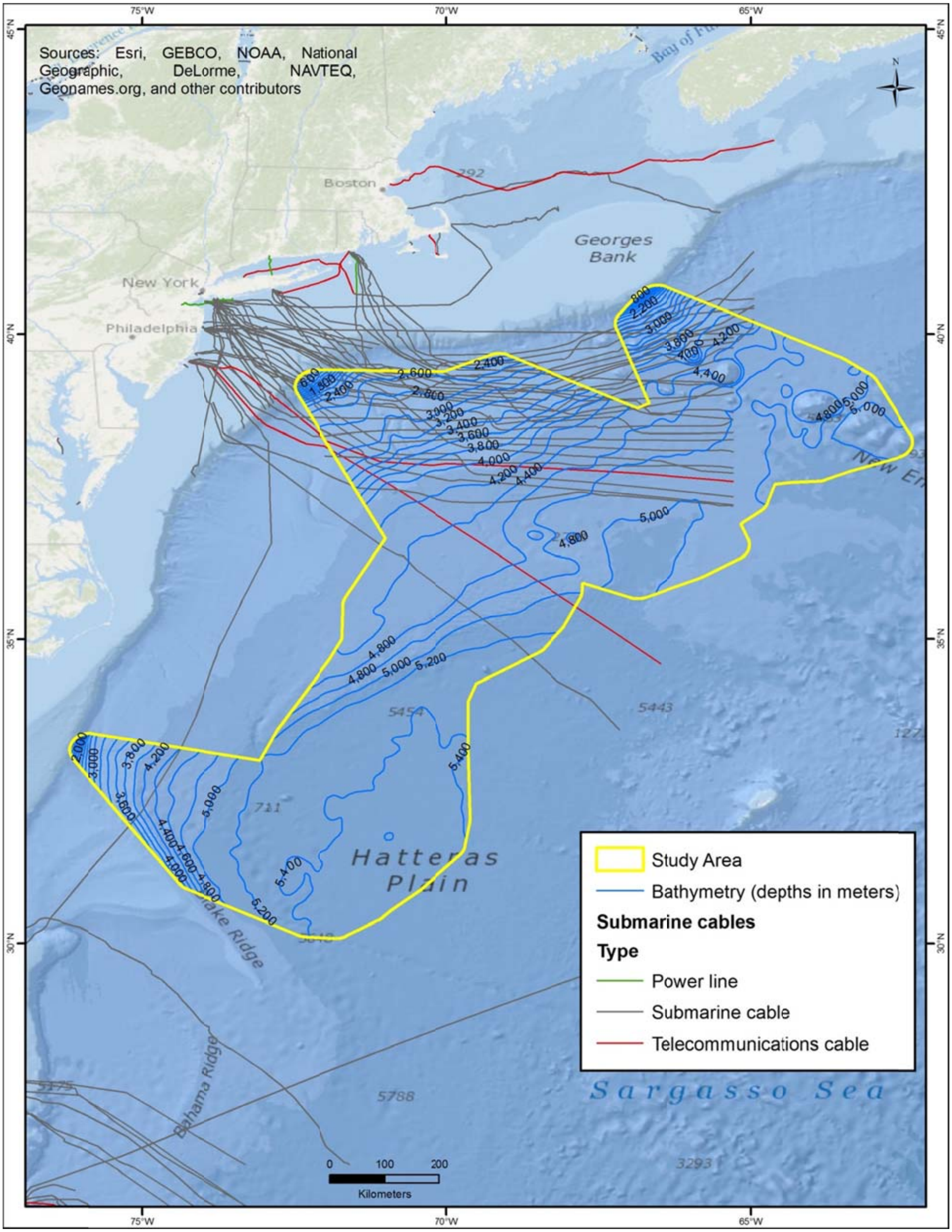

Figure 28: Submarine Cables

According to the interactive map found at (http://www.submarinecablemap.com/) and maintained by TeleGeography, the 6,524 mi (10,500 km) cable with a ready-for-service date of 2015 is planned between Brazil and New York by Seaborn Networks. The cable route intersects the proposed Study Area, therefore, there is a very remote possibility of interaction between the seismic vessel and the cable laying vessel.

Given that there is no bottom-founded activity associated with seismic surveying, the project would neither impact existing cable operations, nor be impacted by existing submarine cables.

3.10.5 Commercial and Recreational Fisheries

The Project area supports nationally and internationally important commercial fisheries. Because of the distance from shore, recreational fishing effort and landings for the Project area are extremely limited. As a result, some of the information provided in this section includes recreational catch data as reported by U.S. (NOAA) and international organizations, such as the 2012 Stock Assessment and Fishery Evaluation (SAFE) Report for Atlantic Highly Migratory Species. From 2008-2012, commercial fishermen, using multiple gear types, recorded over 1.2 million hours fishing, landing approximately 114,000 metric tons (252 million pounds) of fish from the 14 NMFS Statistical Areas that are associated with the Project area (NOAA 2013a). In further offshore portions of the Project area, the primary commercial species sought are classified as highly migratory species (HMS), i.e., species that are generally found in the offshore pelagic environment beyond the continental shelf. HMS are characterized as having vast geographical distributions, with extensive individual migrations often spanning entire oceans (Lynch et al,. 2011). The National Marine Fisheries Service (NMFS) works with other nations through the International Commission for the Conservation of Atlantic Tuna (ICCAT) to manage these globally distributed species through a catch quota system for each member country. In the U.S., tuna and billfish recommendations from ICCAT are implemented by the NMFS division of HMS under the Atlantic Tuna Convention Act and Magnuson-Stevens Act. The Fishery Conservation Amendments of 1990 classified tuna and billfish to be highly migratory species. In 1996, the Sustainable Fisheries Act modified the Magnuson Fishery Conservation and Management Act to create advisory panels that aid in creating fishery management plans to manage billfishes and HMS. Responsibilities of the panels include lowering bycatch and mortality related to bycatch, and stopping overfishing (NOAA 2009).

Another commercial species sought just within the Project area is the deep-sea red crab (*Chaceon quinquedens*). The red crab occurs in a patchy distribution from Nova Scotia to Florida and is found primarily within a 200 to1,800-meter depth band along the continental shelf and slope, but the highest densities and biomass occur between 320 and 910 meters (Figure 29) (New England Fishery Management Council [NEFMC], 2011). The species is also reported to occur in the deep-water canyons along the coast, including Norfolk, Hudson, Hydrographer, and Oceanographer Canyons. In 2002, the NEFMC implemented the Deep Sea Red Crab Fishery Management Plan (NEFMC, 2002). Under the plan, a limited access fishery was implemented, with the fishery authorized to operate with a target total allowable catch (TAC) of 2,688 mt (5.928 million pounds), a 780 days-at-sea allocation, and a trip limit of 34 mt (75,000 pounds). The red crab population in U.S. North Atlantic waters, between Georges Bank and Cape Hatteras, is managed as a single stock.

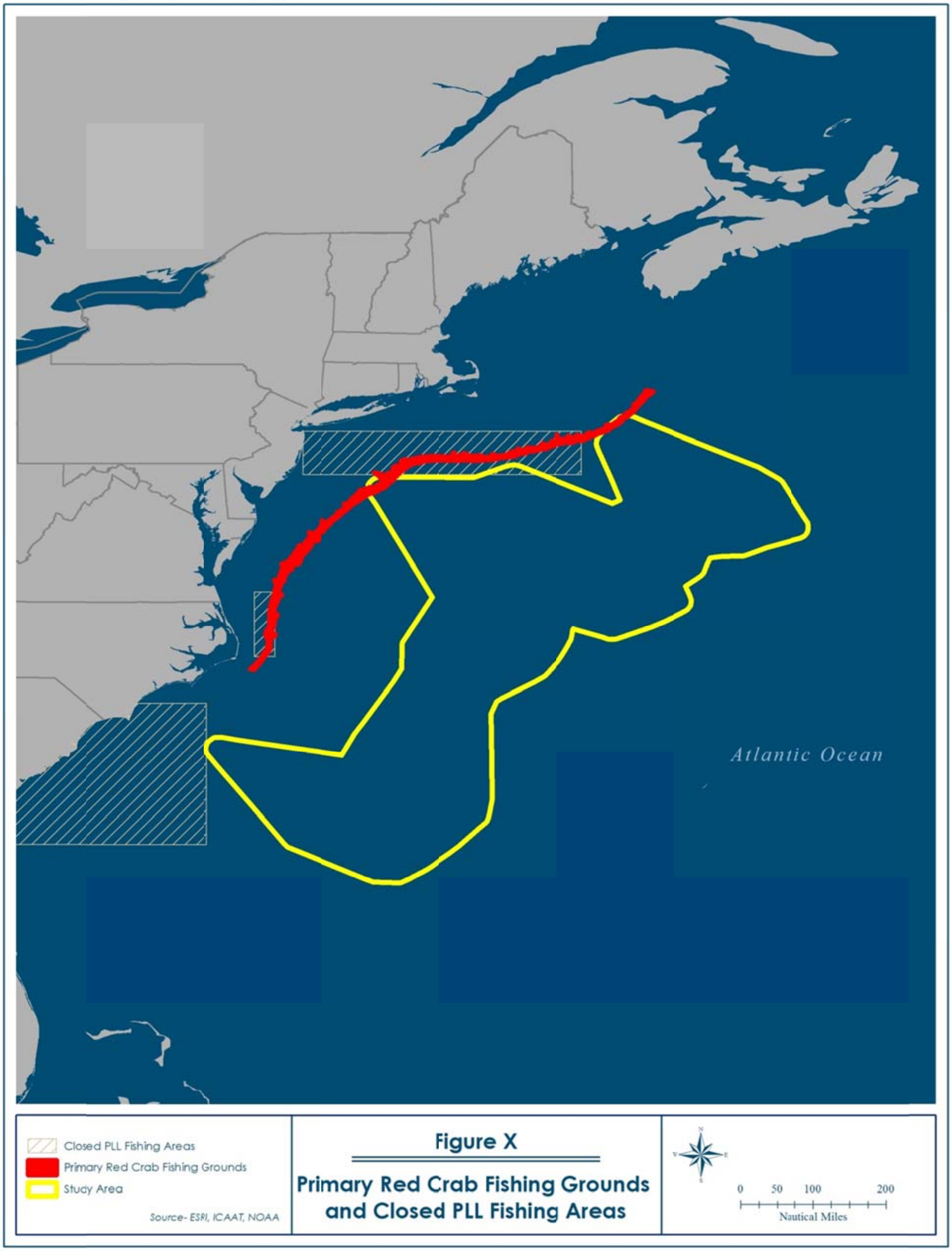

Figure 29: Primary Red Crab Fishing Grounds and Closed PLL Areas

3.10.5.1 Highly Migratory Species

Commercial HMS fisheries in the Project area primarily use pelagic long line (PLL) fishing gear, but other fishing gears include purse seines, handgear (handlines and harpoons), and gillnets (i.e., for sharks). Traps were historically used for HMS, but this method is not employed currently. The list of authorized fishing gear used in HMS fisheries became effective December 1, 1999 (64 FR 67511) and has been modified several times in subsequent final rules. As stated in the rule, "no person or vessel may employ fishing gear or participate in a fishery in the exclusive economic zone (EEZ) not included in this List of Fisheries without giving 90 days' advance notice to the appropriate Fishery Management Council (Council) or, with respect to Atlantic HMS, the Secretary of Commerce (Secretary)." The greatest cumulative percentage of landings within the Project area is associated with PLL, purse seining, and hand gear. As such, only these three fishing methods are discussed in detail in later sections.

The primary species taken in HMS fisheries include swordfish, wahoo, dolphin, eight tuna species (albacore [*Thunnus alalunga*], Atlantic bluefin tuna [*Thunnus thynnus*], bigeye tuna [*Thunnus obesus*], blackfin tuna [*Thunnus atlanticus*], bonito [*Sarda sarda*], little tunny (*Euthynnus alletteratus*), skipjack tuna [*Katsuwonus pelamis*], and yellowfin tuna [*Thunnus albacares*]), and various species of pelagic sharks (e.g., shortfin mako shark [*Isurus oxyrinchus*]).

In order to minimize bycatch and bycatch mortality in the domestic PLL fishery, NMFS implemented regulations to close certain areas of the Atlantic to this gear type (see Figure 29). Historic (1950's-2010) catch levels for predominant species by gear type within portions of the Project area are presented in Figure 30, Figure 31 and Figure 32.

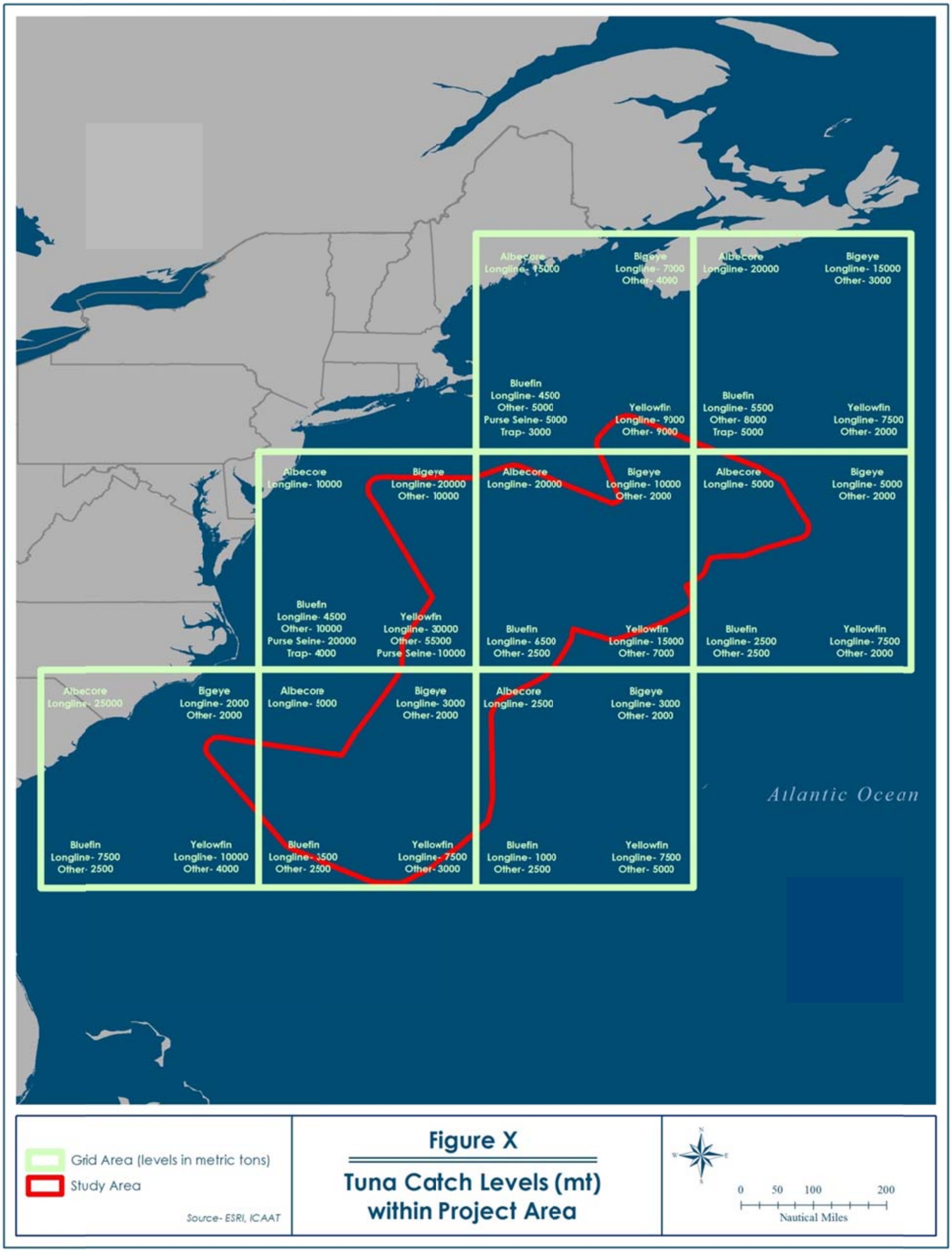

Figure 30: Tuna Catch Levels (mt) within the Project Area

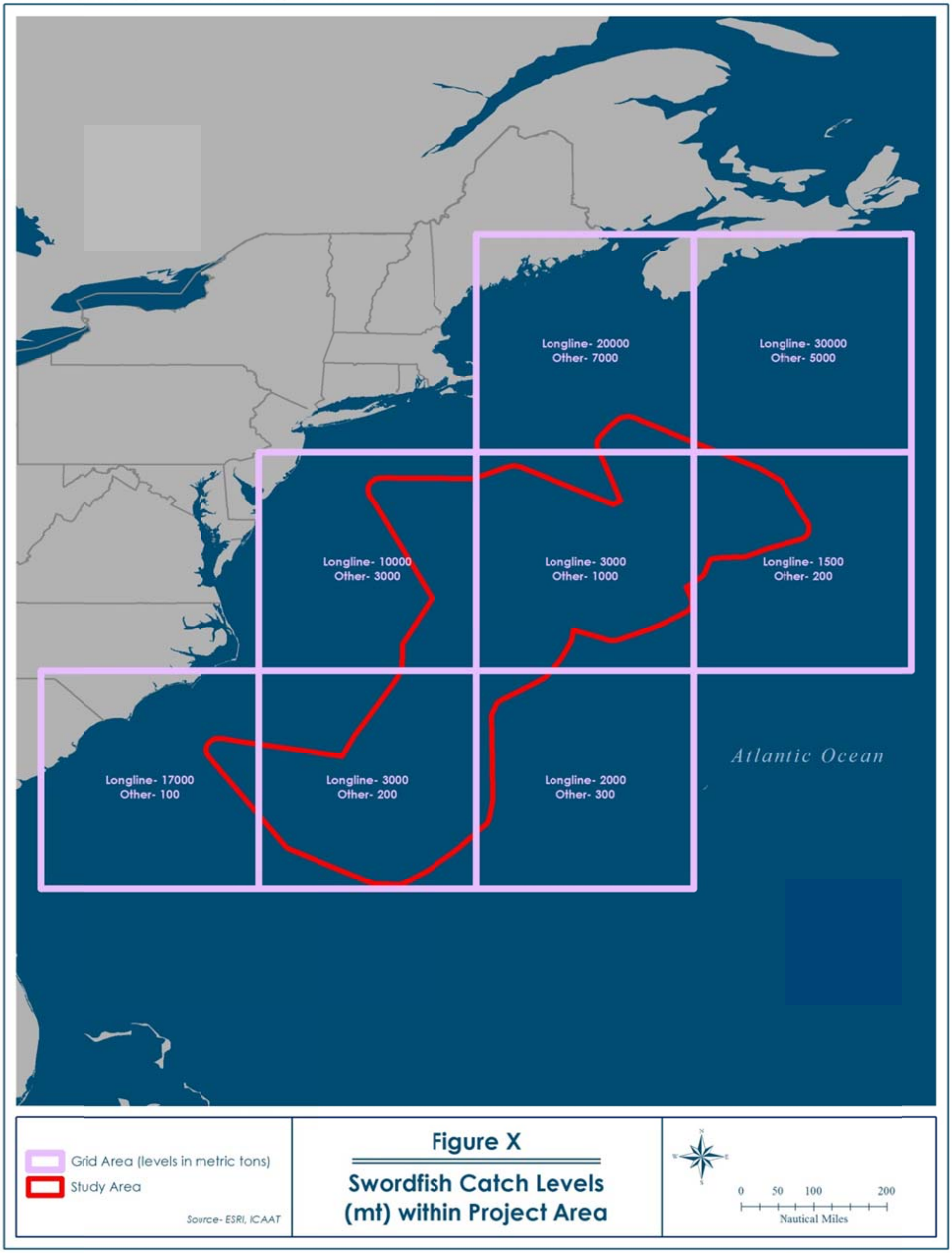

Figure 31: Swordfish Catch Levels (mt) within the Project Area

Figure 32: Marlin Catch Levels (mt) within the Project Area

3.10.5.2 Pelagic Longlines (PLL)

The PLL fishery for Atlantic HMS primarily targets swordfish, blue fin tuna, yellowfin tuna, and bigeye tuna in various areas and seasons. Secondary target species include dolphin, albacore tuna, and, to a lesser degree, sharks. Although this gear can be modified (e.g., depth of set, hook type, hook size, bait, etc.) to target swordfish, tunas, or sharks, it is generally a multi-species fishery. PLL vessel operators are opportunistic, switching gear style and making subtle changes to target the best available economic opportunity on each individual trip. PLL gear sometimes attracts and hooks non-target finfish with little or no commercial value as well as regulated species, e.g., billfish, which cannot be retained by commercial fishermen. PLL gear may also interact with protected species such as marine mammals, sea turtles, and seabirds. Thus, this gear has been classified as a Category I fishery with respect to the MMPA. Any species that cannot be landed due to fishery regulations (or undersized catch of permitted species) is required to be released, regardless of whether the catch is dead or alive.

Commercial fishing vessels set PLL gear to target swordfish at sunset and retrieve gear around sunrise, while the opposite pattern is followed for tuna; gear is set at sunrise and retrieved in the afternoon before sunset. The longline fishery for tuna and swordfish is active year-round in the Project area, but most of the commercial fishing effort is in the spring through fall, when the weather is better. Commercial fishermen targeting HMS fisheries with pelagic longline gear generally set their gear in association with the Gulf Stream; PLL sets can be made on the east or west side of the Gulf Stream current, which varies daily. PLL fishing vessels are mobile, so commercial fishing activity can occur far away (370 to 555 km [200 to 300 nm]) from their respective ports of call.

The U.S. PLL fleet represents a small fraction of the international PLL fleet that competes on the high seas for catches of tuna and swordfish. In recent years, the proportion of U.S. PLL landings of HMS, for the fisheries in which the U.S. participates, has remained relatively stable in proportion to international landings (NOAA 2012). Historically, the U.S. fleet has accounted for less than 0.5% of the landings of swordfish and tuna from the Atlantic Ocean south of 5° N. Lat. U.S. Atlantic PLL catch is primarily associated with vessel characteristics and gear configuration. Table 13: provides a summary of U.S. Atlantic PLL landings, as reported to the ICCAT. Catch levels using PLL for predominant species in portions of the Project area are presented in Figure 30, Figure 31 and Figure 32.

Within the area where the U.S. PLL fleet operates, longline landings still represent a limited fraction of total landings. In recent years (2002 to 2011), U.S. landings have averaged only 5% of total Atlantic longline landings. In 1998, U.S. fishermen accounted for only 1% to 3% of the Atlantic billfish fishing mortality (depending on species). The U.S. fishery accounts for variable proportions of the Atlantic-wide tuna mortality: 47% for West Atlantic bluefin tuna, almost 4% for yellowfin tuna, and a much smaller proportion of skipjack, bigeye tuna, and albacore tuna mortality. The U.S. accounts for approximately 25% of the North Atlantic swordfish catch as described below in Table 13: .

Table 13: Reported Landings (mt) in the U.S. Atlantic Pelagic Longline Fishery (2002-2011)

Species	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Yellowfin tuna	2,573.0	2,164.0	2492.2	1,746.2	2,009.9	2,394.5	1,324.5	1,700.1	1,188.8	1,468.6
Skipjack tuna	2.5	1.4	0.7	0.6	0.2	0.02	1.45	0.5	1.4	0.7
Bigeye tuna	535.8	283.9	310.1	311.9	520.6	380.7	407.7	430.1	443.2	627.1
Bluefin tuna*	49.9	133.9	180.1	211.5	204.6	164.3	232.6	335.0	238.7	220.4
Albacore tuna	155.0	107.6	120.4	108.5	102.9	126.8	126.5	158.3	159.9	267.6
Swordfish North Atlantic.*	2,598.8	2,756.3	2,518.5	2,272.8	1,960.8	2,474.0	2,353.6	2,691.3	2,206.2	2,681.2
Swordfish South Atlantic.*	199.9	20.5	15.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0

*Includes landings and estimated discards from scientific observer and logbook sample programs.
As reported in NOAA 2012.

The U.S. percentage of regional and total catch of HMS species is presented here to provide a basis for comparison of the U.S. catch relative to other nations/entities (Table 14:). International catch levels and U.S. reported catches for HMS (other than sharks) are taken from the 2012 Standing Report for ICCAT's Standing Committee for Research and Science (SCRS 2012). Because the SCRS data collection is reported by species, Table 14: represents a summary of U.S. and international HMS catches by species rather than gear type. Catch of billfish includes both recreational landings and dead discards from commercial fisheries; bluefin tuna includes commercial landings and dead discards and recreational landings; and swordfish includes recreational landings and commercial landings and dead discards. Data necessary to compare the U.S. regional and total percentage of international catch levels for most Atlantic shark species are currently unavailable.

Table 14: U.S. vs. International Catch of HMS Reported to ICCAT in 2011

Species	Total International Reported Catch (mt ww)	Region	Total Regional Catch (mt ww)	U.S. Catch (mt ww)	U.S. Percentage of Regional Catch	U.S. Percentage of Total Atlantic Catch
Atlantic swordfish	25,599	North Atlantic South Atlantic	12,836 12,763	2,887 0	22.5 0.0	11.20
Atlantic bluefin tuna	11,765	West Atlantic East Atlantic/Med.	1,986 9,779	883 0	44.4 0.0	7.50
Atlantic bigeye tuna	77,795	Atlantic/Med.	77,795	746	0.95	0.95
Atlantic yellowfin tuna	100,277	West Atlantic East Atlantic/Med.	19,408 80,869	3,015 0	15.5 0.0	3.00
Atlantic albacore tuna	48,733	North Atlantic South Atlantic/Med.	19,995 28,738	449 0	2.24 0.0	0.92
Atlantic skipjack tuna	212,668	West Atlantic East Atlantic/Med.	39,324 173,344	84 0	0.2 0.0	0.03
Atlantic blue marlin	1,918	North Atlantic South Atlantic	927 991	56 0	6.0 0.0	2.90
Atlantic white marlin	346	North Atlantic South Atlantic	165 181	25 0	15.1 0.0	7.20
Atlantic sailfish	1,623	West Atlantic East Atlantic	566 1,057	14 0	2.5 0.0	0.90
Blue sharks	29,362	North Atlantic South Atlantic/Med.	11,548 17,814	1,183 0	10.2 0.0	4.00
Porbeagle sharks	94	North Atlantic South Atlantic/Med.	72 21	12 0	16.6 0.0	12.80
Shortfin mako sharks	3,855	North Atlantic South Atlantic/Med.	2,154 1,701	408 0	19.0 0.0	10.60

Source: SCRS 2012.

3.10.5.3 Purse Seine

Purse seine gear consists of a floated and weighted encircling net that is closed by means of a drawstring, known as a purseline, threaded through rings attached to the bottom of the net. The efficiency of this gear can be enhanced by the assistance of spotter planes used to locate schools of tuna. The bluefin tuna baseline percentage quota share for the purse seine category is 18.6% of the U.S. quota. The purse seine fishery is managed under a limited entry system with non-transferable individual vessel quotas (IVQ), excluding any new entrants into this category. Vessels participating in the Atlantic tunas purse seine fishery are required to target the larger size class bluefin tuna—more specifically—the giant size class (≥ 81 inches) and are granted a tolerance limit for large medium size class bluefin tuna (73 to < 81 inches) (i.e., large medium catch may not exceed 15% by weight of the total amount of giant bluefin tuna landed during a season). These vessels may begin fishing on July 15 of each year and may continue through December 31, provided the vessel has not fully attained its IVQ. Over the last few years the purse seine category has not fully harvested its allocated bluefin tuna quota. In 2008, 2010, and 2011, the purse seine category did not harvest any Atlantic tunas (Table 15). The U.S. purse seine fleet has historically accounted for a small percentage of the total international Atlantic tuna landings. Table 15 shows that since 2004, the U.S. purse seine fishery has contributed to less than 0.10% of the total purse seine landings reported to ICCAT. Historic (1950s to 2010) catch levels of predominant species using purse seines in portions of the Project Area are presented in Figure 30, Figure 31 and Figure 32.

Table 15: Estimated International Atlantic Tuna Landings (mt ww) for the Purse Seine Fishery in the Atlantic and Mediterranean (2004-2011)

Species	2004	2005	2006	2007	2008	2009	2010	2011
Bluefin tuna	19,895	23,524	20,356	22,980	12,641	9,479	4,985	4,293
Yellowfin tuna	62,228	61,410	62,761	52,733	70,047	77,757	74,172	69,802
Skipjack tuna	93,284	89,704	71,215	81,335	73,080	84,494	125,467	149,307
Bigeye tuna	18,417	18,595	16,457	17,553	15,536	22,658	23,769	27,544
Albacore	717	949	3,432	1,289	169	259	213	192
Total	**194,541**	**194,182**	**174,221**	**175,890**	**171,473**	**194,659**	**228,606**	**251,138**
U.S. total	32	178	4	28	0	11	0	0
U.S. percentage	0.02	0.09	<0.01	0.02	0	<0.01	0	0

Source: SCRS 2012

3.10.5.4 Commercial Handgears

Commercial handgears, including handline, harpoon, rod and reel, buoy gear and bandit gear, are used to fish for Atlantic HMS on private vessels, charter vessels, and headboat vessels. Rod and reel gear may be deployed from a vessel that is anchored, drifting, or under way (trolling). In general, trolling consists of dragging baits or lures through, on top of, or even above the water's surface. While trolling, vessels often use outriggers to assist in spreading out or elevating baits or lures and to prevent fishing lines from tangling. In the Project area, handgear fisheries for all HMS are typically most active during the summer and early fall. The availability of Atlantic tunas at a specific location and time is highly dependent on environmental variables that fluctuate from year to year.

Fishing usually takes place outside of the proposed Study Area, generally between 8 and 200 km from shore, and for those vessels using bait, the baitfish typically includes herring, mackerel, whiting, mullet, menhaden, ballyhoo, butterfish, and squid. The commercial handgear fishery for bluefin tuna has historically occurred mainly in New England, but more recently off the coast of southern Atlantic states, such as Virginia, North Carolina, and South Carolina. The majority of U.S. commercial handgear fishing activities for bigeye, albacore, yellowfin, and skipjack tunas take place in the northwest Atlantic.

The proportion of domestic HMS landings harvested with handgear varies by species, but Atlantic tunas comprise the majority of the commercial landings. In 2011, bluefin tuna commercial handgear landings accounted for approximately 66% of the total U.S. bluefin tuna landings, and 87% of commercial bluefin tuna landings. Historic (1950s-2010) catch levels using hand gear (designated as other), for predominant species, within portions of the Project area are presented in Figure 30, Figure 31 and Figure 32.

3.10.5.5 Pot and Trap Gear

Commercial fishing for deep-sea red crab uses pots or traps. These are rectangular, square, or cylindrical enclosed devices with one or more gates or entrances set on the bottom to target benthic invertebrates such as the deep-sea red crab. Pots/traps are usually marked at the surface with a buoy (float) that is attached to the pot or trap by a rope. This type of gear is usually set in string near natural or artificial structure or hard bottom. Pots are connected by "mainlines" that either float off the bottom or sink to the bottom (Stevenson et al., 2004).

Annual U.S. commercial landings of deep sea red crab during 1982 to 2005 ranged from 466 mt (1996) to 4,000 mt (2001); no fishing took place in 1994, as there was no targeted fishery for the species that year. Since 2002, when the fishery management plan was implemented, landings have been stable at about 2000 mt per year. A small portion of red crab landings are taken as bycatch in the offshore lobster fishery. There is no recreational fishery for red crabs. Discards consist of female crabs (which cannot be landed by regulation) and male crabs too small to sell. Discards have not been well quantified, but are likely substantial for both males and females in the red crab fishery. Since 2002, U.S. landings for deepsea red crabs have been almost exclusively (99%) at ports in Massachusetts. Landings for 2002 to 2012 totaled 7,132 mt, with a value of almost $15 million (NOAA, 2013a).

The red crab fishing grounds lie almost entirely outside of the Study Area and therefore interaction with proposed activities are highly unlikely.

4 ENVIRONMENTAL CONSEQUENCES

4.1 PROPOSED ACTION

The proposed action to conduct a seismic survey program using the *Langseth* airgun array would introduce pulsed sounds into the ocean and could produce incidental takes of marine mammals and endangered species. The bulk of the analysis in this section covers the anticipated impacts of this seismic source.

Although the NSF/USGS PEIS presents general environmental consequences for airgun sounds from actions similar to the one proposed in this EA, there are new scientific studies and publications since that document was finalized. These new studies update the background information and environmental consequences for mysticetes, odontocetes, fish, and habitats (for example, Cato, 2013; Castellote et al., 2012; Ellison et al., 2012; Finneran, 2013; Hawkins, 2013; Ketten, 2013; Kight and Swaddle, 2011; Lokkeborg et al., 2012; Nowacek, 2013; Nowacek et al., 2013; Richardson, 2013; Southall et al., 2013a; Southall et al., 2013b). Much of the recent scientific literature and the importance of these studies to environmental consequences are presented in the ENAM Draft EA (NSF, 2014), and are incorporated by reference into this EA as if fully set forth herein. Additionally the NMFS EA (NMFS 2014) also addresses recent scientific literature published since the PEIS and addresses the importance of these studies to environmental consequences and are incorporated by reference into this Final EA as if fully set forth herein.

The ENAM survey is in the same geographic region as the survey proposed in this EA (see NSF ENAM Draft EA, figure 6), uses similar size airgun source and receiver, and is scheduled to take place immediately following the USGS survey proposed here. Many of the effects described and updated in the NSF ENAM Draft EA are generic with respect to acoustic effects on the environment and are applicable to our EA. However, the specific location of the proposed USGS tracklines are further offshore and cover a larger region of deep water along the U.S. margin than the ENAM survey (see NSF ENAM Draft EA, figure 6). Hence, the environmental consequences of the proposed actions may differ between the two surveys (e.g., types and numbers of marine species potentially impacted).

The new studies do not fundamentally change the way the airgun modeling is performed (Appendix A) or how the incidental takes are estimated (Appendix B). The acoustic modeling has been done to be consistent with modeling used for other EAs and has been deemed to be acceptable for estimating takes under MMPA and defining exclusion zones associated with the 160 dB re 1 μPa_{rms} and 180 dB re 1 μPA_{rms} isopleths used to estimate Level B and Level A takes respectively.

4.2 NOISE EMISSIONS

The majority of noise emitted during the proposed action would be due to the seismic airgun array. The Langseth airgun array is a tuned acoustic source that emits sound energy primarily below 200 Hz at frequencies useful for identifying the base of the sediments in the deep waters off the U.S. Atlantic continental margin, but which also overlaps with the hearing ranges of some marine species (further described below). The airgun array produces an impulsive sound one to three times per minute, and is not a continuous noise.

Additional noise emissions could come from operation of the Kongsberg EM122 MBES and the Knudsen Chirp 3260 SBP, which would be operated simultaneously with the airgun array. These acoustic systems are described in the NSF/USGS PEIS (§ 2.2.3.1) and a summary of new scientific studies and their potential significance has been updated in the NSF ENAM Draft EA and the NMFS EA (NMFS 2014) and are incorporated by reference as if fully set forth herein. These more recent studies do not change the basic conclusions of the NSF/USGS PEIS that operation of this equipment might produce localized, temporary, or minor behavior changes in some marine species, but is unlikely to be geographically extensive or long lasting.

The survey vessel itself contributes very little to the overall noise field. This noise is also described in the NSF/USGS PEIS (§ 2.2.3.1) with a summary of new scientific studies on vessel noise and their potential significance given in the NSF ENAM Draft EA. These more recent studies do not change the basic conclusions of the NSF/USGS PEIS that vessel noise would not be at levels that would cause anything more than localized and temporary behavioral changes in marine mammals. Further, large vessel traffic is so common in the oceans of the world that it is considered a usual source of background (i.e., ambient) noise.

4.2.1 Sound Effect Criteria

The potential for anthropogenic underwater noise to affect marine species depends on the species' ability to hear the sounds produced (Ireland et al., 2007). Noises are less likely to disturb animals if they are at frequencies outside the animal's range of hearing. An exception is when the sound pressure is so high that it can cause physical injury. For non-injurious sound levels, frequency weighting curves based on audiograms may be applied to weight the importance of sound levels at particular frequencies in a manner reflective of the receiver's sensitivity to those frequencies (Nedwell and Turnpenny, 1998).

The NMFS/NOAA considers two levels of harassment to the marine mammals: Level A (auditory injury by way of the onset of permanent threshold shift, or PTS) and Level B (disturbance by way of temporary threshold shift, TTS, and/or behavior impacts). According to the 1994 Amendments to the Marine Mammal Protection Act (MMPA) of 1972, Level A Harassment is defined as "any act that injures or has the potential to injure a marine mammal or marine mammal stock in the wild." Level B Harassment is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or altered."

NMFS (2000) specified that Level A Harassment for pulsed sources occurs when an animal is exposed to sound pressure levels of 180 dB re 1 μPa rms (for cetaceans) or 190 dB re 1 μPa rms (for pinnipeds). The criterion of 160 dB re 1 μPa rms is considered to induce Level B Harassment for both mammal groups for pulsed sources. More recently, the Noise Criteria Group was established, sponsored by NMFS, resulting in new recommendations for updated exposure criteria using the best available science (Southall et al,. 2007). In December 2013, NOAA issued revised draft Acoustic Guidance for public comment. However, these recommendations have not been made final. These guidelines propose to update the acoustic threshold levels for which TTS and PTS are predicted to occur in marine mammal species, incorporating the dual metrics of cumulative sound exposure level (SEL_{cum}) and peak sound pressure level (SPL). Frequency weighting functions are also incorporated to account for differences between various hearing groups: low- mid and high-frequency cetaceans, otarid and phocid pinnipeds.

USGS would be prepared to revise its operational mitigation protocols outlined by new guidance from NMFS.

The current NOAA/NMFS acoustic threshold levels for Level A and Level B harassment and behavior sound effects for cetaceans are shown in Table 16.

Table 16: Injury and Behavior Exposure Criteria for Cetaceans

Group	Level A (Injury) Pressure (dB re 1 µPa rms)	Level B (Behavior) Pressure (dB re 1 µPa rms)
Cetaceans	180	160

The SBP and MBES systems would be operated only in conjunction with the seismic source (i.e. not during transits). An EZ or FMZ for those instruments would lie within the limits for those defined for the seismic source. Therefore, no further modeling or analysis of those systems was required.

4.2.2 Exclusion Zone

The proposed survey would use an array volume of 6,600 in^3. Project site-specific modeling has not been completed for that array; however, received sound levels recorded during calibration in the Gulf of Mexico have been predicted by L-DEO's model (included here as Appendix A) as a function of distance from the airguns, for the 36-airgun array at any tow depth. Although the study provides caveats on its applicability (water temperature, salinity, sound speed, and sediment not taken into account), the Gulf of Mexico calibration measurements demonstrate that, although simple, the L-DEO model is a robust tool for estimating mitigation radii. The energy output (zero to peak) for the 6,600 in^3 array is 258.5 dB re 1 µPa at 1m.

Table 17: summarizes the L-DEO model (Appendix A) predicted distance in water depth >1000 m relative to sound level criteria (≥190, 180 and 160 dB re 1 μPa_{rms}) that are expected to be received during the proposed survey on the East Coast margin in 2014 and 2015.

Table 17: Predicted radii distances to the NMFS >190, 180 and 160 dB SPL (rms) Criteria for single 40 in^3 airgun and 6,600 in^3 Airgun Array at 9 m tow depth

Array	Predicted Safety Radii (m)		
	190 dB	180 dB	160 dB
Single Bolt 40 in3 airgun	100[1]	100	338
36 air gun array, total volume 6,600 cu. in.	286	927	5780

[1] Exclusion Zone for the small airgun is 100 m per NSF/USGS PEIS

The sound exposure levels for mitigation radii were calculated using the transmission loss modeling results and corresponding source level for each modeled source expressed in SPL (rms) units of dB re: 1 .µPascal m. As a result of consultation with NMFS, the 166 dB re 1 µPa RMS limit (for sea turtles) was estimated to be 3740 m for water depths greater than 1000 m, i.e., for water depths for the proposed USGS survey.

Mitigation procedures would require a power-down of the airgun array should a marine mammal or sea turtle approach or appear within the airgun EZ. During these power-downs, a single 40 in^3 airgun would continue to be operated as a mitigation gun, unless the animal proceeded to approach the EZ for the mitigation airgun, in which case all airguns would be shut down until the EZ were cleared and the power-up (e.g., ramp up) procedure initiated. The mitigation airgun would also be used for maintenance of the airgun array that might last up to 3 hours. For longer, maintenance of the seismic equipment, the mitigation gun would not be used and the entire system would be shut down.

4.2.3 Direct Effects on Mysticetes, Odontocetes, and Pinnipeds

Because the studies that describe direct effects of noise, including airgun sounds, on marine mammals are given for species in the NSF/USGS PEIS and the NSF ENAM Draft EA, this section identifies some of the direct effects, proposed mitigation, and estimated takes associated with this proposed action. Appendix 2 (Request for Incidental Harassment Authorization under the Marine Mammal Protection Act) gives the detailed analyses that support estimates of the marine mammals that could be taken by the proposed action of this Final EA, together with the number of requested takes.

4.2.3.1 Mysticetes

The seven species of mysticetes that occur in the proposed study area have been observed infrequently to rarely compared to their coastal presence (Figures 9 and 10), and when they have been observed, are generally along the western (continental slope and upper continental rise) regions of the survey. Although the distribution observations have large uncertainties, the low densities of animals suggest that much of the survey area occurs in a region where mysticetes are not widespread and encounters would be minimal.

Hearing (temporary and permanent effects) - The mysticete auditory system is sensitive to low frequencies. Section 3.6.4.2 and Appendix B and E of the NSF/USGS PEIS (2011) provides details of potential effects on mysticete cetaceans from the predominantly low-frequency energy produced by the proposed airgun source of 6,600 in^3.

There has been no specific documentation that temporary hearing impairment (temporary threshold shift, TTS) occurs for marine mammals exposed to sequences of airgun pulses during operational seismic surveys (NSF/USGS PEIS 2011 Appendix E) and in the newer scientific studies discussed in the NSF ENAM Draft EA and NMFS EA (NMFS, 2014). Mysticetes tend to avoid operating airguns, and these deviations reduce or eliminate the risk of temporary hearing effects. However, the low distribution of mysticetes in the survey area means it is possible that small numbers of mysticetes would be exposed to the Langseth airgun pulses that theoretically could cause TTS. These exposures are discussed in Appendix B.

NMFS's policy regarding exposure of marine mammals to high-level sounds is designed to eliminate the risk of permanent hearing damage (permanent threshold shift, PTS). This policy has been that cetaceans should not be exposed to impulsive sounds ≥180 dB re 1 μPa_{rms} (NMFS, 2000). This criterion has been used in defining the exclusion zone (shut-down radii) - which was modeled at 927 m for these water depths in the Study Area - for cetaceans. Monitoring and mitigation measures are designed to detect marine mammals occurring near the seismic source array to avoid exposing them to sound pulses that might cause permanent threshold shifts. Hence the proposed action is designed to make it highly unlikely that mysticetes would have permanent injury from the airgun operations. Hence, Level A effects would be highly unlikely with appropriate mitigation measures (described in section 6, Summary of Mitigation).

The potential sensitivity of mysticetes to the mid- to high-frequency Knudsen SBP and the higher frequency EM122 MBES is believed to be more variable and generally less sensitive among species, as described in the NSF/USGS PEIS and the more recent scientific studies in the NSF ENAM Draft EA and NMFS EA (NMFS, 2014). Because of the lower exposure relative to the airgun array, and the intermittent, and downward directed nature of these sounds, individuals would not be expected to be exposed to more than one or two pings from the moving vessel should they be in the ensonified area.

Masking - Studies of how anthropogenic sound, particularly seismic sounds, masks cetacean sounds, are limited and results are variable (summarized in Table 3.6-5 and Appendix E of the NSF/USGS PEIS 2011 together with more recent studies in the NSF ENAM Draft EA and NMFS EA (NMFS, 2014)). The airgun signal is intermittent (one to three pulses per minute) and the amplitude of the signal falls rapidly with distance and time, making the "noise" intervals relatively small time periods during the survey. Masking of marine mammal calls and other natural sounds by the pulsed sounds of the Langseth airgun would be limited, particularly with proposed mitigation of ramp up, shut down, PSVO observing, and PAM (see section 6, Summary of Mitigation).

Marine mammal communications would not be significantly masked by MBES signals given their low duty cycle and the brief period when an individual mammal would potentially be within the MBES or SBP beam from a moving vessel. Both of these signal types are predominantly or entirely at frequencies >11 kHz, i.e., higher than the predominant frequencies in mysticete calls, reducing any potential for masking. Similarly, mysticete communications would not be masked appreciably by the SBP signals given their downward directionality and the brief period when an individual mammal could be within the SBP beam.

Behavior - Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable among species, locations, whale activities, oceanographic conditions affecting sound propagation, etc. (Appendices B and E in the NSF/USGS PEIS 2011 and the more recent studies described in the NSF ENAM Draft EA and NMFS EA (NMFS, 2014)). For the proposed Langseth airgun array, behavior changes are possible and takes are estimated appropriately (Appendix B).

Herding of mysticetes is a behavior that could occur in canyon regions if the ship were to proceed onshore from deep water. For 2014, the ship track would depart from Brooklyn, NY so the northern line on the margin would be going from onshore to offshore. Note that this is opposite to the numbering scheme shown in Figure 3, which implies the cruise starts in the south (line 1) and ends in the north. The southern line going from offshore to onshore is in a region of no canyons (the closest canyon is ~200 km further north). The order of ship tracks for the 2015 cruise is not decided, but consideration of herding behavior would be taken into account when and if the cruise occurs and ports are determined.

4.2.3.2 Odontocetes

The distribution of the 27 species of odontocetes that could occur is irregular and infrequent throughout the survey area, with concentrations more common along the continental slope and upper rise of the Atlantic margin (Figures 12-15). Hence odontocetes are expected to be more commonly found in the area than mysticetes, although still not abundantly.

Hearing (temporary and permanent effects) – The Langseth airgun array would likely be audible to odontocetes, although odontocetes in general have hearing and vocalization frequencies that are much higher than the predominant 200 Hz (or lower) frequencies of the Langseth airgun array. Odontocetes are considered less sensitive to the predominant low frequencies produced by low frequency airgun arrays similar to that of the Langseth, as described in the NSF/USGS PEIS and from more recent studies described in the NSF ENAM Draft EA and NMFS EA (NMFS, 2014).

Some odontocetes show avoidance of the area where received levels of airgun sounds are high enough such that TTS could potentially occur. In those cases, the avoidance responses of the animals themselves reduce or (most likely) eliminate any possibility of TTS. If some odontocetes did experience temporary hearing impairment, the TTS effects would (by definition) be fully recoverable.

NMFS's policy regarding exposure of marine mammals to high-level sounds has been that cetaceans should not be exposed to impulsive sounds ≥180 dB re 1 μPa (rms) (NMFS 2000). This policy is designed to avoid permanent hearing effects (PTS) for cetaceans, including odontocetes. This criterion has been used in defining the exclusion zone (shut-down radii), which was modeled at 927 m for these water depths in the Study Area, for all cetaceans. Monitoring and mitigation measures are designed to detect marine mammals occurring near airguns to avoid exposing them to sound pulses that might cause PTS. Hence the proposed action is designed to avoid a situation in which the odontocetes would have permanent hearing injury.

Sound frequencies produced by the EM 122 MBES and Knudsen SBP overlap the range of most sensitive hearing of many odontocetes, and all odontocetes can presumably hear these sounds based on what is known about their hearing, sound production, and ear structure. However, because of the low duty cycle and downward directed orientation of these sound sources, the anticipated effects should be limited to one to two pings from the moving vessel, i.e., of limited temporal and geographic range.

Masking – As described in the NSF/USGS PEIS and the updated information in the NSF ENAM Draft EA, Odontocetes are considered less sensitive to masking by low-frequency sounds than are mysticetes. Potential effects are considered minimal because the dominant low-frequency components of the airgun sounds do not overlap dominant frequencies produced by odontocetes and because vessels movement would be transient.

Odontocete communications would not be masked appreciably by the EM 122 MBES or Knudsen SBP signals given their low duty cycles, the brief period (i.e., seconds) when an individual mammal would potentially be within the downward-directed MBES or SBP beam from a transiting vessel. Temporary localized masking of odontocete calls by project vessel sound is possible although it would be short lived and of geographically limited extent.

Behavior – Odontocetes, and particularly delphinids show some limited avoidance of seismic vessels operating large airgun arrays (Appendix E in NSF/USGS PEIS 2011 and the more recent scientific studies summarized in NSF ENAM Draft EA and NMFS EA (NMFS, 2014)). Results for porpoises appear to vary by species. In most cases, the animals do not show strong avoidance (i.e., they do not leave the area) and they continue to call. Controlled exposure experiments in the Gulf of Mexico indicate that foraging effort is apparently somewhat reduced upon exposure to airgun pulses from a seismic vessel operating in the area, and there may be a delay in diving to foraging depth. Odontocete reactions to large arrays of airguns are variable and, at least for delphinids and some porpoises, seem to be confined to a shorter distance than has been observed for mysticetes.

Behavioral responses of marine mammals, including odontocetes, to MBES sounds is treated in the NSF/USGS PEIS and updated in the NSF ENAM Draft EA and NMFS EA (NMFS, 2014). No information exists on the disturbance of odontocetes from operation of the MBES (Southall et al., 2013). The short ping duration of the MBES, its narrow fore-and-aft beam width, its generally downward directed beam orientation, and the forward movement of the vessel would reduce the sound energy received by any individual animals that might be within the ensonified zone. The newer information does not alter the findings of the NSF/USGS PEIS (§3.4.7., §3.6.7, and §3.7.7) that operation of MBES and SBP is not likely to impact either mysticetes or odontocetes. Exposure of individual odontocetes is likely brief in duration (<1 sec; 1 or at most 2 pings) given that these devices are located on a moving seismic vessel and the pings are intermittent and directed downward.

Herding of odontocetes is a behavior that could occur in canyon regions if the ship were to proceed onshore from deep water. For 2014, the ship track would depart from Brooklyn, NY, so the northern line on the margin would be going from onshore to offshore. Note that this is opposite to the numbering scheme shown in Figure 3, which implies the cruise starts in the south (line 1) and ends in the north. The southern line going from offshore to onshore is in a region of no canyons (the closest canyon is ~200 km further north). The order of ship tracks for the 2015 cruise is not decided, but consideration of herding behavior would be taken into account when and if the cruise occurs and ports are determined.

4.2.3.3 Pinnipeds

Pinnipeds have not been observed in the survey area (see §3.5). Because they are coastal inhabitants, they are not expected to be effected by the operation of the Langseth airgun array in the deep-water continental margin areas of the study area. In the unlikely event pinnipeds are observed during the survey, appropriate mitigation would be undertaken as per NMFS guidance for pinnipeds.

4.2.3.4 Summary of Direct Effects on Mysticetes, Odontocetes, and Pinnipeds

The proposed seismic project (involving the use of a 6,600 in^3 airgun array, a Kongsberg EM 122 MBES and a Knudsen 3260 SBP) would introduce pulsed sounds into the ocean that, with the proposed mitigation measures, could result in a small number of animals coming within the areas identified where temporary hearing changes, masking of vocalizations/communications, and minor behavioral changes could occur. Hence a small number of Level B harassment effects could occur. Level A effects, using the proposed mitigation procedures, would be highly unlikely.

As part of the IHA consultation process, NMFS reviewed the take estimates proposed in Table 18 of the Final EA. NMFS reestimated the take calculations for five Mysticete species and nine Odontocete species for which density model outputs within the SERDP/NASA/NOAA and OBIS-SEAMAP database were not available, or for those species with density outputs that did not extend into the planned study area at all (i.e., all four pinniped species and sei whale), but for which OBIS sightings data within or adjacent to the study area exist. Mean group sizes were determined based on data reported from the Cetacean and Turtle Assessment Program (CeTAP) surveys (CeTAP, 1982) as well as reports from the Atlantic Marine Assessment Program for Protected Species (AMAPPS, 2010, 2011, 2012, 2013). The mean group size is weighted by effort and rounded up.

The Mysticete species for which NMFS reestimated takes were: Humpback Whale, North Atlantic Right Whale, Blue Whale, Bryde's Whale, and Sei Whale. The Odontocete species are: the Atlantic White-sided Dophin, Killer Whale, Spinner Dolphin, Fraser's Dolphin, Harbor Porpoise, False Killer Whale, Pygmy Whale, Melon-headed Whale, and Northern Bottlenose Whale. One Mysticete species (Blue Whale) and three Odontocete species (Atlantic White-sided Dolphin, Killer Whale, and Clymene Dolphin) had smaller take estimates as a result of this recalculation. USGS Estimated takes and NMFS proposed takes for the remaining species were identical. The proposed take estimates by NMFS use the smaller of the take estimates using the mean group sizes, rather than the larger estimates from USGS.

Final proposed take estimates proposed by NMFS use the smaller of the take estimated from mean group size, or which ever USGS requested take is higher for the summer (Table 18 of the Final EA) or spring (Table 19 of the Final EA).

Table 18, reproduced from Appendix B and modified by consultation with NMFS, presents the estimated takes by USGS, revised estimated takes by NMFS using mean group sizes for species for which density estimates were not initially available, and NMFS proposed takes for mysticetes and odontocetes species for the full (i.e., 2014 and 2015) proposed action.

Table 19 presents the estimated takes and requests for takes for mysticetes and odontocetes species that could be encountered during a 2015 program that was scheduled in the spring (March, April, May). Two species show increased estimated takes in the spring as opposed to the summer (the potential take of humpback whales increases by 38 and the possible take of Bottlenose dolphin increases by 11). Ten species show decreased estimate of takes in the spring, and all other species show no change in estimated takes. The larger of the take numbers from this table or the mean group size numbers in Table 18 are used for the proposed estimate of 2015 take by NMFS.

NMFS does not provide specific guidance or requirements for IHA applicants or for Section 7 consultation for the development of take estimates and multiple exposure analysis; therefore, variation in methodologies and calculations are likely to occur. During the consultation, USGS, NSF, and NMFS also discussed using the Navy Marine Species Density Database maps (Department of Navy, 2012) to estimate densities of species for takes. However, after further discussion with the Navy, they advised that “The maps in the technical report are a classified image, a representation of the underlying data, not the actual data. Digitizing these images is a misrepresentation of the actual data and in my opinion would not represent best available science.” (Andrew DiMatteo, Personal Communication, July 23, 2014).

USGS, NSF, and LDEO would adhere to the requirements of the Incidental Take Statement (ITS) and the IHA and associated take levels issued.

Table 18: Densities and Estimates of Possible Numbers of Individuals That Could be Exposed to 160 dB re 1 μPA_{RMS} During Each of Proposed Summer (June, July, August) 2014 and 2015 2-D Seismic Surveys

Species	Mean Density (#/km²)[a]	Ensonified Area (km²)	Calcu-lated Take[b]	% of Regional Population[c]	Mean Group Size[d]	Level B Proposed Take[e] USGS	NMFS
Mysticetes							
Fin Whale	0.0000610	36,600	3	0.0113		3	3+3=6
Humpback Whale	N/A	36,600	0	0.0259	1.7	3[f]	3+38=41
Minke Whale	0.0000360	36,600	2	0.0014		2	2+2=4
North Atlantic Right Whale	N/A	36,600	0	0.6593	2.3	3[f]	3+3=6
Blue Whale	N/A	36,600	0	0.2339	1.3	2[f]	1+1=2
Bryde's Whale	N/A	36,600	0	N/A	3	3[f]	3+3=6
Sei Whale	N/A	36,600	0	0.0291	1.7	3[f]	3+3=6
Odontocetes							
Atlantic White-sided Dolphin	N/A	36,600	0	0.1106	32.40	54[f]	33+33=66
Atlantic Spotted Dolphin	0.0288400	36,600	1056	2.3616		1056	1056+1056=2112
Bottlenose Dolphin	0.0066470	36,600	244	0.3147		244	244+255=499
Long-Finned Pilot Whale	0.0190400	36,600	697	0.0894		697	697+697=1394
Short-Finned Pilot Whale	0.0190400	36,600	697	0.0894		697	697+697=1394
Pantropical Spotted Dolphin	0.0197600	36,600	724	21.7222		724	724+724=1448
Risso's Dolphin	0.0093180	36,600	342	1.8740		342	342+342=684
Shorted-beaked Common Dolphin	0.0055320	36,600	203	0.1170		203	203+203=406
Striped Dolphin	0.1343000	36,600	4,916	8.9697		4,916	4916+4916=9832
Sperm Whale	0.0022510	36,600	83	0.6293		83	83/83=166
Killer whale	N/A	36,600	0	N/A	5.40	7[f]	6+6=12
Clymene Dolphin	0.0093110	36,600	0	N/A	51.26	346	52+341=393
Spinner Dolphin	N/A	36,600	0	N/A	65	65[f]	65+65=130
Rough-Toothed Dolphin	0.0004260	36,600	16	5.5351		16	16+16=32
Fraser's Dolphin	N/A	36,600	0	N/A	100	100[f]	100+100=200
Harbor Porpoise	N/A	36,600	0	0.0010	3.19	5[f]	4+4=8
False Killer Whale	N/A	36,600	0	N/A	15	15[f]	15+15=30
Pygmy Killer Whale	N/A	36,600	0	N/A	25	25[f]	25+25=50
Dwarf Sperm Whale	0.0008970	36,600	33	0.8719		33	33+33=66
Pygmy Sperm Whale	0.0008970	36,600	33	0.8719		33	33+33=66
Melon-Headed Whale	N/A	36,600	0	N/A	100	100[f]	100+100=200
Sowerby's Beaked Whale	0.0022870	36,600	84	1.1844		84+84=168	
Blainville's Beaked Whale	0.0022870	36,600					
Gervais' Beaked Whale	0.0022870	36,600					
True's Beaked Whale	0.0022870	36,600					
Cuvier's Beaked Whale	0.0022870	36,600		1.2860			
Northern Bottlenose Whale	N/A	36,600	0	N/A	1.91	2[f]	2+2=4
Pinnipeds							
Harbor seal	0	36,600	0	N/A		0	
Gray seal	0	36,600	0	N/A		0	
Harp seal	0	36,600	0	N/A		0	
Hooded Seal	0	36,600	0	N/A		0	

[a] Source: OBIS-SERDP-Navy NODE 2007a and 2007b (for those species where density data were available).
[b] Calculated take is estimated density multiplied by the 160-db ensonified area. These calculations do not include any contingency as the survey will be conducted as one continuous line.
[c] Requested takes expressed as percentages of the larger regional populations, where available; where not available (most odontocetes–see Table 2), Draft 2013 SAR population estimates were used; N/A means not available
[d] Mean Group Size provided by NMFS during consultation for those speicies for which density model outputs were not available or for which density model outputs did not extend into the study area in both spring and summer.
[e] Proposed (i.e., requested) take authorization by USGS (Final EA) and NMFS (during consultation).
[f] USGS - Average group size from CeTAP 1984. NMFS - Take size recommended by NMFS based on summer and spring proposed takes by USGS or by NMFS revised group sized (see comment d).

Table 19: Densities and Estimates of Possible Numbers of Individuals That Could be Exposed to 160 dB re 1 µPA$_{RMS}$ During Spring (March, April, May) 2015 2-D Seismic Survey

Species	Mean Density (#/km^2)[a]	Ensonified Area (km^2)	Calculated Take[b]	% of Regional Population[c]	Requested Level B Take Authorization
Mysticetes					
Fin Whale	0.0000600	36,600	3	0.113	3
Humpback Whale	0.0010170	36,600	38	0.3276	38
Minke Whale	0.0000350	36,600	2	0.0014	2
North Atlantic Right Whale	N/A	36,600	0	0.6593	3[d]
Blue Whale	N/A	36,600	0	0.2339	2[d]
Bryde's Whale	N/A	36,600	0	N/A	3[d]
Sei Whale	N/A	36,600	0	0.0291	3[d]
Odontocetes					
Atlantic White-sided Dolphin	N/A	36,600	0	0.1106	54[d]
Atlantic Spotted Dolphin	0.0285700	36,600	1046	2.3393	1046
Bottlenose Dolphin	0.0069560	36,600	255	0.3289	255
Long-Finned Pilot Whale	0.0108000	36,600	396	0.0408	396
Short-Finned Pilot Whale	0.0108000	36,600	396	0.0508	396
Pantropical Spotted Dolphin	0.0194900	36,600	714	21.422	714
Risso's Dolphin	0.0092150	36,600	338	1.8520	338
Shorted-beaked Common Dolphin	0.0053940	36,600	198	0.1141	198
Striped Dolphin	0.1330000	36,600	4,868	8.8817	4,868
Sperm Whale	0.0019050	36,600	70	0.5307	70
Killer whale	N/A	36,600	0	N/A	7[d]
Clymene Dolphin	0.0093110	36,600	341	N/A	341
Spinner Dolphin	N/A	36,600	0	N/A	65[d]
Rough-Toothed Dolphin	0.0004200	36,600	16	5.9041	16
Fraser's Dolphin	N/A	36,600	0	N/A	100[d]
Harbor Porpoise	N/A	36,600	0	0.00010	5[d]
False Killer Whale	N/A	36,600	0	N/A	15[d]
Pygmy Killer Whale	N/A	36,600	0	N/A	25[d]
Dwarf Sperm Whale	0.0008850	36,600	33	0.8719	33
Pygmy Sperm Whale	0.0008850	36,600	33	0.8719	33
Melon-Headed Whale	N/A	36,600	0	N/A	100[d]
Sowerby's Beaked Whale		36,600			
Blainville's Beaked Whale		36,600			
Gervais' Beaked Whale	0.0021370	36,600	79	1.1139	79
True's Beaked Whale		36,600			
Cuvier's Beaked Whale		36,600		1.2094	
Northern Bottlenose Whale	N/A	36,600	0	N/A	2[d]
Pinnipeds					
Harbor seal	0	36,600	0	N/A	0
Gray seal	0	36,600	0	N/A	0
Harp seal	0	36,600	0	N/A	0
Hooded Seal	0	36,600	0	N/A	0

[a] Source: OBIS-SERDP-Navy NODE 2007a and 2007b (for those species where density data were available).
[b] Calculated take is estimated density multiplied by the 160-db ensonified area. These calculations do not include any contingency as the survey will be conducted as one continuous line.
[c] Requested takes expressed as percentages of the larger regional populations, where available; where not available (most odontocetes–see Table 2), Draft 2013 SAR population estimates were used; N/A means not available
[d] Requested take authorization was increased to average group size for species for which densities were not available but have been sighted near or have the potential to be observed within the Study Area. Average group size from CeTAP 1984.

4.2.4 Direct Effects on Marine Birds

Of the seabirds, waterfowl, and shorebirds identified that could be in the study area (§3.6), a subset of seabirds have been sighted regularly in the survey area. It is not possible to use quantitative sound-energy criteria to assess impacts of these sources on seabirds because there are no measured or predicted underwater audiograms for any seabird species, published or otherwise, or quantitative noise criteria used to characterize effects of airgun noise on seabirds, such as auditory thresholds corresponding to TTS or PTS levels caused by underwater noise. There are no documented adverse effects directly or indirectly on seabirds as reported by offshore observers or research. The NSF/USGS PEIS (Section 3.5.4) and the more recent NSF ENAM Draft EA addressed the effects of seismic surveys on seabirds and indicated that there are no scientific data indicating or suggesting that seabirds are adversely affected by seismic airguns or other sound sources used during the proposed seismic surveys.

During the proposed seismic surveys, dedicated PSVO's would monitor and record marine birds observed in the study area. Seismic activities would shut down for any ESA seabirds observed diving and/or foraging within the EZ. . In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, PSOs and other crew members have seen no seismic sound-related seabird injuries or mortality. Furthermore, USGS and NSF received concurrence from USFWS that the proposed activities "may affect" but "are not likely to adversely affect" species under their jurisdiction (Appendix E).

4.2.5 Direct Effects on Marine Fish, Marine Shellfish, and Essential Fish Habitat

Approximately 600 species of demersal and pelagic fish could occur in the survey area (§3.7). The NSF/USGS PEIS and the updated studies summarized in the NSF ENAM Draft EA (incorporated by reference as if set forth herein) concluded that the effects of marine sound on marine fish and their fisheries could result in non-lethal, temporary impacts, including short-term changes in behavior, and that there could be injury or mortal impact to a small number of individuals within several (10) meters of the Langseth airgun array (Appendix D, Section D.2.2). It further concluded that there would be no long-term effects on populations of fish.

The hearing capability of fish is not known well and varies with species (NSF/USGS PEIS, Appendix D, Section D.2.2, and the updated information in NSF ENAM Draft EA. McCauley et al. (2000) conducted trials with captive fish and found that increases in swimming behavior occurred when seismic sound levels reached 156 dB re 1 μPa_{rms}. During the activity proposed by USGS, noise levels should attenuate to 160 dB about 5780 m from the survey vessel. The hearing capability of Atlantic salmon indicates a rather low sensitivity to sound (Hawkins and Johnstone, 1978). Laboratory experiments yielded responses only to 0.58 kHz and only at high sound levels. Poor hearing by salmon is likely due to the lack of a link between the swim bladder and inner ear (Jorgensen et al., 2004). Sturgeon (*Acipenser fulvescens*) were found to be responsive to sounds with frequencies from 100 to 500 Hz, generally at the higher end of the frequencies produced by the *Langseth* airgun array. Based on the known or presumed hearing ranges of ESA-listed salmonids and sturgeon, airgun arrays could contribute to localized, transitory masking of sound detection by these species. However, in general, the potential for masking effects would be limited and localized in extent given the brief, pulsed nature of the seismic survey sounds and the transiting seismic vessel relative to individual fish; related effects would not be measureable at the population scale.

The use of the *Langseth* MBES is extremely unlikely to result in population-level effects on any marine fish species as it operates at 10.5-13 kHz, frequencies that are above the known hearing ranges of most marine fish species (Table 3.3-3 in the NSF/USGS PEIS) and above the known hearing ranges of ESA-listed salmonids and sturgeon. Alosidae fishes can detect ultrasonic (>20 kHz) signals (Mann et al. 2001), but exposures of individual fish (those not very close to the MBES) would be very brief (less than one minute). The frequencies of the SBP are within the hearing range of some species in the order Clupeiformes. The exposures of most individual fish (those not very close to the SBP) would be brief. No other marine fish are currently known to hear as high as 2.5 kHz (Table 3.3-3). The narrower along-track beam of the Langseth MBES and SBP would affect a much smaller area than the broader areas affected by the airguns and arrays; as a result, a given fish location near the transiting source would be ensonified for only one to several brief pings at most, lasting less than a minute in duration.

Direct effects on essential fish habitats (see §3.8.2), either the substrate or the water column, would not be expected, because the seismic signals do not physically change the substrate or the water column. Potential indirect effects from the vessel and proposed survey are described in §4.2.8.

Sargassum mats, which are floating algae that serve as nurseries for sea turtles and habitat for some marine fish and birds, occurs primarily to the south and east of the survey area in the Sargasso Sea, but could be found in the survey area. The main potential impact associated with the proposed seismic survey would be the direct effects on the animals (marine mammals and sea turtles, as discussed above), rather than on the habitat.

In summary, the direct effects of the seismic survey and its associated sound may have minor effects on marine fisheries that are generally reversible, of limited duration, magnitude, and geographic extent when considering individual fish, and not measureable at the population level. There would be no anticipated negative impacts on Essential Fish Habitat (EFH). No mitigation would be needed for marine fish or EFH.

4.2.6 Direct Effects on Sea Turtles

Five species of sea turtle — the leatherback, loggerhead, green, hawksbill, and Kemp's Ridley — could be encountered in the proposed Study Area. Only foraging or migrating individuals would occur. Their occurrence in the study area is relatively small compared to their distribution and many observations on the shelf or near the upwelling of the shelf-slope break (see figures 18-22).

Based on what is known regarding sea turtle hearing (Section 3.4.4.2 NSF/USGS PEIS 2011) and more recent studies summarized in the NSF ENAM Draft EA, sound from the Langseth airguns would be detectable but the MBES and SBP signals would not be detectable by sea turtles. Sounds from an airgun array such as the *Langseth* array might cause temporary hearing impairment in sea turtles if they do not avoid the (uncertain) radius where TTS occurs. Research (Section 3.4.4.3 NSF/USGS PEIS, 2011) generally suggests that sea turtles showed localized avoidance during large and small-source surveys when the airgun arrays were operating. Sea turtles generally respond to seismic survey sound with behavioral changes such as startling, increasing swimming speed, swimming away from, and/or locally avoiding the source. Studies indicate that exposure to seismic sounds results in short-term behavioral changes and localized avoidance by sea turtles. Available evidence suggests that the zone of avoidance around seismic sources is a few kilometers or less (McCauley et al., 2000a, b; Holst et al,. 2006; Weir, 2007).

Potential interactions between sea turtles and the project could be adverse in the study area. However, tendency of sea turtles to avoid seismic operations suggest it is unlikely that sea turtles would be exposed to sound levels of sufficient strength and for sufficient duration to cause physiological effects. Section 3.4.7 of the NSF/USGS PEIS concluded that with implementation of the proposed monitoring and mitigation measures, 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. Ramp up procedures would also serve to further minimize direct effects on marine turtles.

4.2.7 Direct Effects on Fisheries

The survey area is within national and international commercial fisheries (§3.10.5). Potential impacts on commercial fisheries are more likely to be behavioral effects from the *Langseth* airgun array that could cause a small reduction in fish catch or temporary changes in distribution, migration, and reproduction due to behavioral effects on fish from seismic survey operations. For some fish species, behavioral changes from seismic survey operations may result in changes in vertical or horizontal distribution. These short-term behavioral effects would be localized.

Preclusion of fishermen from productive fishing grounds constitutes a space-use conflict. The size of the Study Area precluded to fishing would be limited to the area immediately surrounding the seismic vessel and gear. Seismic vessels such as *Langseth* operate under a 'restricted ability to maneuver' designation, which means other vessels in the path of the survey vessel must give way.

The degree of impact from the proposed action would depend upon the relative mobility of the fishing operation (MMS 2004). Fixed gear (e.g., traps) is most vulnerable, and mobile gear such as hook-and-line fishing from drifting (or trolling) boats is least vulnerable. Because of the large water depths, non-fixed gear would be the more prevalent equipment used within the proposed survey area. Many gear types require considerable time to deploy and retrieve, decreasing the mobility of larger and deeper ocean fishing vessels. Surface currents and wind greatly influence the movement of longlines and other drifting gear (e.g., purse seines) but these natural impacts could also affect the Langseth receiver array. A longline deployed upstream of a geophysical survey grid could drift into the path of the survey vessel and become entangled in either the airgun array or the streamer receiver. Surface longlines are generally allowed to drift for 4 to 5 hours before a 10- to 12-hour retrieval period (MMS 2004). Minimizing potential adverse effects on fisheries may be accomplished by adjusting tracklines and communicating with fisherman about respective locations of vessels, equipment, and rater of travel or drift.

Although it is expected that recreational fishing would be extremely limited in the Study Area, impacts on recreational fishing would typically be similar to those described for commercial fishing. However, since most recreational fishing uses mobile gear such as hook-and-line fishing from drifting (or trolling) boats, the potential for impacts would generally be less than those described for commercial fishing operations.

In summary, potential adverse environmental effects on commercial and recreational fisheries would be mitigated through the implementation of various standard mitigation measures, including: communications with fishing vessels in the survey area during seismic operations, monitoring of fishing gear locations, and possible slight trackline adjustments that maintain safety and avoid entanglement.

4.2.8 Indirect Effects on Marine Mammals and Sea Turtles

The primary impact that could be expected for habitats or the food sources used by marine mammals and sea turtles would be temporarily elevated noise levels from the Langseth airgun array, MBES, and SBP. These impacts are expected to be short-term and of limited geographic extent. At any one time, only a very small area of available habitat or food supply would be ensonified at any one time. The proposed survey would have negligible impact on the ability of marine mammals and sea turtles to feed.

A special case exists for sargassum habitat (which has been proposed as a critical habitat for juvenile loggerhead sea turtles (FR 78(138) 18 July 2013). The proposed survey area is at the northern extent of the Sargasso Sea, and no observations exist for determining the likelihood of sargassum in the study area. Because sargassum occurs in patchy clumps, it is possible that the ship transiting across a clump would break it apart, but multiple clumps are how sargassum occurs. Hence the ship's transit would create an effect that is identical to currents, which also separate and combine these clumps. The way the tracks are laid out in single long lines means that any sargassum in the ship track would not be affected by more than the single traverse.

4.2.9 Conclusions for Marine Mammals and Sea Turtles

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 proposed to issue 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 Draft Biological Opinion reviewed by USGS and NSF, NMFS has proposed 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 proposed issuances of the IHA and the Biological Opinion further verifies that significant impacts would not be anticipated from the proposed activities.

4.2.10 Conclusions for Invertebrates, Fish and Fisheries

In decades of seismic surveys carried out by Langseth and its predecessor, R/V Ewing, Protected Species Observers (PSOs) and other crew members have not seen seismic sound-related fish or invertebrate injuries or mortality.

4.2.11 Conclusions for Seabirds

In decades of seismic surveys carried out by Langseth and its predecessor, R/V Ewing, Protected Species Observers (PSOs) and other crew members have not seen seismic sound-related seabird injuries or mortality. Furthermore, USGS received concurrence from USFWS that the proposed activities “may affect” but “are not likely to adversely affect” species under their jurisdiction (Appendix D).

4.2.12 Conclusions for Essential Fish Habitat

Although adverse impacts to EFH were not anticipated, USGS consulted with the NMFS Southeast and Northeast offices of the Greater Atlantic Region under the Magnuson-Stevens Act for EFH. The NMFS Greater Atlantic Regional Fisheries Office concluded that the proposed activities may at some level adversely affect EFH. NMFS also noted, however, “Upon considering the design and nature of the survey we have no EFH conservation recommendations to provide pursuant to Section 305(b)(2) of the Magnuson-Stevens Act at this time.”(Appendix D).

4.3 NON-ACOUSTIC DIRECT EFFECTS

Although the noise from the airguns is expected to be the primary direct effect on the environment, operating a large ship at sea could result in other effects. This section summarizes those effects.

4.3.1 Disturbance by Vessel Presence

Ocean going vessels, such as *R/V Langseth,* are common on nearly all of the world’s oceans. Noise or lights from a large vessel such as *Langseth* could affect marine animals in the proposed study area. At survey speed (approximately 4.2 knots), the vessel would cover about 200 km per day, and would not be in one area long enough for the effects to be lasting. The NSF/USGS PEIS concluded that the normal vessel sounds and lights could not be expected to cause more than localized, short-term, or temporary changes in behavior of marine animals, similar to the effects that any large commercial vessel might have.

4.3.2 Collisions

The risk of collision of seismic vessels or towed/deployed equipment with marine mammals exists but is extremely unlikely. This is based on the relatively slow operating speed (typically 4-5 kt or 7-9 km/h) of the vessel during seismic operations, and the generally straight-line movement of the seismic vessel. Collisions between cetaceans and seismic gear have not been reported during previous seismic vessel activities.A seismic vessel would travel faster during transits to and from seismic survey sites (approximately 10 kt or 18 km/h), and movement would be predominantly in a straight line, with typically gradual changes in orientation. As noted in the NSF/USGS PEIS (§3.4.4.4 and (§3.6.4.4), collisions between vessels and/or their towed gear with marine mammals or sea turtles is extremely unlikely.

The planned monitoring and mitigation procedures are designed to minimize, if not eliminate, risk of collision.

4.3.3 Entanglement with Towed/Deployed Gear

The NSF/USGS PEIS (§3.4.4.4 and §3.6.4.4) concluded that the risk of entanglement of towed/deployed equipment with marine mammals and sea turtles could occur but would be extremely unlikely. Entanglement of marine mammals in seismic equipment is not likely since streamers are equipped with no tangle gear and marine mammals and sea turtles are expected to avoid the vessel during operations. Rare incidents have been reported of a turtle becoming entangled in tail-buoys off Africa (Weir, 2007), and a single incident occurred when an olive ridely turtle was found in a deflector foil of the seismic equipment during *Langseth* operations off Costa Rica in 2011 (in a region of abundant turtles). Deflector foils are deployed for 3D seismic surveys, and will not be deployed for these 2D surveys. No other incidents of entanglement have occurred in more than a decade of seismic surveys of *Langseth* operations or those of its predecessor NSF vessel *R/V Maurice Ewing*.

The planned monitoring and mitigation procedures are designed to minimize, if not eliminate, risk of and entanglement.

4.3.4 Waste Discharges

R/V Langseth could produce a variety of discharges and emissions, as described in Table 20 below, together with the regulations and actions that would minimize or eliminate their effects.

Table 20: Summary of Seismic Vessel Related Emissions and Discharges

Discharge/ Emission	Description and Handling/Disposal Procedures
Grey and Black Water	There may be up to 55 persons on the seismic vessel at any one time. Grey water discharge (showers, dishwashing, deck drains, etc.) could be 40 m^3/d and that black water discharge (sanitary waste) would be 19 m^3/day. All liquid discharges would be treated in accordance with the IMO standards prior to ocean discharge.
Ballast Water	On survey vessel, ballast water is stored in dedicated ballast tanks to improve vessel stability. No oil would be present in ballast/preload tanks or in the discharged ballast/preload water. If oil is suspected to be in water, it would be tested and, if necessary, treated to ensure that oil concentrations in the discharge do not exceed 15 mg/L, as required by MARPOL 73/78 (International Convention for the Prevention of Pollution from Ships, 1973, and the Protocol of 1978 related thereto), IMO.

Bilge Water	Bilge water often contains oil and grease that originate in the engine room and machinery spaces. Before discharge, bilge water is treated in accordance with MARPOL 73/78, IMO using an oil/water separator. The extracted water is tested to ensure that the discharges contain no more than 15 mg/L of oil.
Discharges from Machinery Spaces	Machinery spaces would be equipped with drip trays, curbs and gutters, and other devices to prevent spilled or leaked materials from entering the water. Waste material from drip pans and work spaces would be collected in a closed system designed for that purpose and would be returned to the process cycle, recycled, or transferred ashore.
Solid Waste	Most solid waste is transferred to shore for disposal at an approved disposal facility. Compliance with vessel waste management plan, Clean Water Act, and MARPOL 73/78 for all solid waste discharges. Combustible materials (e.g., oily rags, paint cans) are handled separately in hazardous materials containers. Recycling programs would comply with local state regulatory requirements.
Chemicals and Hazardous Materials	Chemicals and hazardous materials that would be stored on the survey vessel and consumed during the project include industrial cleaners, paints, lubricants, *etc*. All hazardous materials would be managed according to applicable guidelines and regulations to prevent environmental and human health impacts. Material Safety Data Sheets (MSDS) and worker training records would be made available according to applicable regulations. All hazardous waste would be brought to shore for treatment and/or disposal. The seismic vessel is equipped with solid-streamer technology, as this type of streamer is not reliant on flotation fluid to achieve a neutral ballast state, thus eliminating the risk of an accidental spill.
Lights	The survey vessel would carry operational, navigation and warning lights. Working areas would be illuminated with floodlights as required for compliance with occupational health and safety standards and would be fully equipped with emergency lighting.

Atmospheric Emissions	The major emission source from the proposed surveys is the seismic vessel. Operational atmospheric emissions may include vessel exhaust, exhaust fumes from diesel generators and operational emission of halons during firefighting or maintenance of air conditioning and refrigeration systems. These emissions would be minimized through best vessel management practices and preventative maintenance procedures. Survey emissions would not exceed any applicable air quality standards or guidelines. There are limited emission sources and few receptors likely to be affected. To ensure that air emissions are minimized, L-DEO would implement the following mitigation measures: • properly maintaining and routinely inspecting ship equipment • minimizing vapor loss from fuel tanks • minimizing idling of equipment when not in use • complying with the air quality regulations (Clean Air Act) • adhere to MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships

With proper attention to regulations governing these emissions, development of appropriate action plans, and safe operation of the vessel, which is normal operating procedure the risk from these waste emissions should be minimized or eliminated.

4.3.5 Potential Malfunctions and Accidental Events

There are unplanned situations that may be encountered during the proposed action. Potential hazards such as fuel spills, loss of seismic gear, or vessel collisions are addressed during site-specific planning as part of emergency response planning. Procedures are developed by L-DEO to ensure that such events are managed in a safe and environmentally sound manner. L-DEO has policies, plans, and procedures to prevent or mitigate effects of malfunctions and accidents. These policies, plans, and procedures would be located on the seismic vessel, and in the L-DEO shore office. During the proposed action, there would be limited amounts of marine fuel and lube oil onboard that could potentially be accidentally spilled to the ocean. The *Langseth* operates on diesel fuel. The fuel (marine gas oil) capacity of the *Langseth* is 1,340 m^3 (353,760 gal). Any accidental spill would be reported to the US Coast Guard immediately.

The *Langseth* would be equipped with solid-streamer technology, as this type of streamer does not rely on flotation fluid to achieve a neutral ballast state, thus eliminating the risk of an accidental spill from a damaged streamer.

Other accidental events could include damage or loss of seismic equipment, entanglement of seismic equipment with fishing gear, and vessel collisions. Best management practices and communications would be used on the survey vessel to avoid equipment loss or damage. Gear would be retrieved from the water if wave heights reach or exceed unacceptable limits. In case of severe weather, the vessel may return to shore until conditions improve.

4.3.6 Additional Safety concerns for *R/V Langseth*

In the Northwest Atlantic, marine operations are affected primarily by wind, waves, currents, visibility, and to a lesser extent, air and sea temperatures. The time of year is a factor in determining the level of risk or impact any of these environmental parameters may have on operational efficiency or success. Planning and executing activities safely requires due consideration of the seasonally variable hazards which may be encountered.

Project activities are planned to take place between in August and September, 2014 and between April and August, 2015. This section characterizes the range of conditions likely to be encountered within this time frame, and some of the potential associated adverse effects. Vessels, equipment and materials used by the project must be rated to function within the expected conditions and adhere to all standards and codes for safety and data quality.

Wind and waves have the potential to increase stress on vessels, disrupt operations and scheduling, and to affect survey data quality. Vessels such as *R/V Langseth* and its equipment must be able to withstand the range of normal and extreme wind and wave conditions expected. Seismic survey operations are typically limited by wind or sea conditions due to loss of data quality in high seas and potential damage to equipment.

Thunderstorms and major storm systems occur in the region most often during summer and fall as hot, humid air masses collide with passing fronts (Joyce, 1987). Tropical cyclones, which occur during summer and fall, are severe but infrequent. Extratropical cyclones occur frequently during winter and may produce unfavorable conditions during winter and spring. Most major storms, including hurricanes, occur during the North Atlantic hurricane season from June through November. The *Langseth* is built as a global ocean vessel able to withstand the stresses that could occur in high winds and heavy seas.

While the summer to early fall period generally favors calm seas, visibility may be reduced due to formation of fog and could affect operations because of limited visibility. Limited visibility is accounted for in the mitigation procedures.

Warm and cold core rings are features of the Gulf Stream and described in detail in Appendix F of the NSF/USGS PEIS (2011). Upwellings occur in the western part of the study area from wind driven water current from slopes along the shelf break. Both oceanography features can create strong currents that increase the potential for entanglement on the streamers trailing behind the *Langseth*. These circumstances occur in all oceanographic environments that seismic surveys must accommodate and present no greater risk to this Langseth cruise than other seismic cruises utilizing long streamers.

4.4 ANALYSIS OF ALTERNATIVES – 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 first cruise (21 days in August to September, 2014, the dates for the 2015 survey are yet to be scheduled) are the dates when the personnel and equipment essential to meet the overall project objectives are available.

Additionally, the U.S. Interagency Task Force on the Extended Continental Shelf (ECS), under leadership of the Department of State, has established a Project Office to complete work on delineating the outer limits of the U.S. ECS in 5 years from 2014-2019. Delineating the Atlantic margin ECS takes two field surveys (as proposed in this action), at least two years of analysis and interpretation following data acquisition, as well as one year to develop the appropriate technical documentation for Article 76 of the Law of the Sea Convention. Delaying the proposed 2014 field program by a year jeopardizes completing the necessary steps to meet the 5-year Project Office deadline.

Marine mammals and sea turtles are expected to be found throughout the proposed Study Area and throughout the time period during which the project may occur. Most marine mammal species are year-round residents in the North Atlantic, based on the number of OBIS sightings in the Study Area and adjacent waters, so altering the timing of the proposed project likely would result in no net benefits for those species.

Scheduling ship time is challenging, in which the demands of the various scheduled and funded activities require compromises. The proposed dates for the 2014 survey are the dates when the equipment and personnel essential to meet the overall project objectives are available. The 2014 survey is also scheduled so that the subsequent proposed *Langseth* GeoPRISMS/ENAM cruise (mid-September to early October) does not overlap with Northern Right Whale migrations.

Weather conditions in the Atlantic and ship schedules also constrain the possible survey time window to April through September. Because of generally higher sea states in winter, winter is an unsafe time for conducting experiments when ship maneuverability is limited, as it is towing an 8-km-long streamer. Scheduling the survey in mid-summer when daylight hours are maximized and sea states are generally minimal facilitates observations and identifications of marine wildlife.

4.5 ANALYSIS OF ALTERNATIVES – 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. The U.S would not be able to define the ECS and therefore not be able to exercise its sovereign rights over the seafloor and sub-seafloor because it would lack the data to determine the extent of its sovereign rights. Nor would the USGS have an important data set to contribute to its accurate assessment of submarine landslide and tsunami hazards along the east coast. The No-Action Alternative would not meet the purpose and need for the proposed activities.

5 CUMULATIVE EFFECTS

The Council on Environmental Quality (CEQ) regulations (40 CFR sec. 1500 - 1508) for implementing NEPA define cumulative effects as the impact on the environment that 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). The NSF/USGS PEIS addresses scientific research activities within the 2012-2020 time-frame, and a cumulative activity scenario has been developed for the same period as recommended by the CEQ (1997) guidelines. The reasonably foreseeable future activities described below are part of the cumulative scenario. Individual environmental effects could accumulate and interact to result in cumulative environmental effects. A critical step in the environmental assessment is determining what other projects or activities have reached a level of certainty (e.g., “would be carried out”) such that they must be considered in an environmental assessment. Certain requirements must be met to consider cumulative environmental effects:

- there must be a measurable environmental effect of the project being proposed;
- the environmental effect must be demonstrated to interact cumulatively with the environmental effects from other projects or activities; and
- it must be known that the other projects or activities have been, or would be, carried out and are not hypothetical.

5.1 CUMULATIVE EFFECTS OF PROPOSED TWO-CRUISE (2014, 2015) SEISMIC PROGRAM

The proposed action would occur in two parts. The two parts would occur at least seven months apart and may be closer to one year apart. The nature of each survey is that the vessel would be continuously moving, covering different parts of the seafloor, except for occasionally crossing tracklines, which is a required component of the seismic cruise plan. The seismic tracks are laid out to satisfy the requirements of Article 76 of the United Nations Convention on the Law of the Sea for substantiating the sediment thickness formula line. Because the sounds generated by seismic surveys are transient and do not "accumulate" in the environment, the most likely cumulative effects would be associated with other concurrent activities (e.g., cargo ships, tankers, other seismic surveys, or fishing vessels). The cumulative effects of the proposed two-part seismic program would be short term, intermittent and localized, with respect to effects on marine mammal species and sea turtles.

The individual seismic survey vessel activity and noise would constitute a temporary and minor contribution to the overall noise generated by other such sources and and would be of short duration in local areas. Based on current knowledge, and especially with the proposed mitigation procedures in place, the proposed project is not expected to result in, or contribute to, cumulative impacts on marine mammals or sea turtles, including threatened or endangered species.

5.2 METHODOLOGY FOR THE CUMULATIVE EFFECTS ANALYSIS

- The scoping exercise was undertaken to identify past, ongoing, and reasonably-foreseeable human activities that are likely to interact cumulatively with environmental effects from exploration activities. The next step was to assess the potential impact of cumulative effects on each environmental factor.
- The other projects and activities considered in this assessment include those that are likely to proceed (such as those listed in the Federal Register), and those which have been issued permits, licenses, leases or other forms of approval. Past, present, and future activities that may impact cumulatively with the project are outlined in Table 21.

Table 21: Scoping of Offshore Activities and Interactions with the Survey Project

Activity	Description	Temporal Interaction with Project	Spatial Interaction
Offshore Petroleum	Exploration Drilling, Development Drilling or Production	Future	No Interaction. Anticipated leasing within the Mid-Atlantic and Southern Atlantic OCS planning areas is not anticipated until well after the 2016 time frame (USDOI, BOEM, 2011c). Nine applications for Geological and Geophysical (G&G) activities by geophysical companies are registered on the BOEM website; all applications have expired on exploration survey schedule. It is not anticipated that any of these permits would be issued before 2015. Given the separation in time with the proposed

Activity	Description	Temporal Interaction with Project	Spatial Interaction
			activities (and perhaps survey overlap), no cumulative effects would be anticipated.
ECS Bathymetric and Geophysical Research	The U.S. Interagency Task Force on the Extended Continental Shelf (ECS) has a multiyear strategy for acquiring data along the U.S. margins in order to define the outer limits of the U.S. ECS beyond 200 nm. Multibeam bathymetry (most margins, led by NOAA and University of New Hampshire) and multichannel seismic reflection and refraction data (selected margins, including the Atlantic, led by USGS)	Present, Future	No spatial overlap with additional ECS surveys is forecast
NSF-sponsored seismic research	In 2014, the *Langseth* is scheduled to conduct two NSF-supported seismic surveys off the Atlantic seaboard to study sea-level changes and geologic framework. These are described in Appendix C: 1. The proposed NJ Margin survey area is located between ~39.3–39.7°N and ~73.2–73.8°W in the Atlantic Ocean, ~25–85 km off the coast of New Jersey. Water depths in the survey area are 30–75 m. The seismic survey would be conducted outside of state waters and within the U.S. EEZ, and is scheduled to occur for ~30 days during 3 June–9 July 2014. Some minor deviation from these dates is possible, depending on logistics and weather.	Present	No spatial overlap as survey programs would be consecutive using the same vessel of opportunity, *R/V Langseth*

Activity	Description	Temporal Interaction with Project	Spatial Interaction
	2. The proposed East North America Margin (ENAM) survey area is located between ~32–37°N and ~72–76.5°W in the Atlantic Ocean ~6–430 km off the coast of Cape Hatteras. Water depths in the survey area are 30–4300 m. The seismic surveys 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. Separate EAs are being prepared for those activities. Neither survey would overlap with the proposed USGS ECS Study Area.		
Future Geophysical Research	Other seismic research projects could be proposed in the region in the future, however none are currently planned by the USGS or NSF. Therefore, it is not reasonably foreseeable to assume future research cruises in the region.	Future	The duration of a typical seismic research cruise ranges from 2 to 4 weeks with approx. 1 to 2 weeks of transit and/or preparation between cruises. Seismic operations may last 30-800 hr during a seismic survey. Consecutive cruises may occasionally occur in the same location or the same region, but they would not be expected to occur

Activity	Description	Temporal Interaction with Project	Spatial Interaction
			simultaneously in the same location.
Marine Traffic Shipping (domestic, international, tourism)	Over the 2014 to 2015 time period shipping and marine transportation activities in the Study Area may increase above the present level, due in part to the expansion of the Panama Canal, which is expected to be complete in 2014 and which would double its capacity	Past, Present, Future	Interaction could occur
Commercial Fishing	Fishing effort is diverse and shifting in response to stock locations	Past, Present, Future	Interaction could occur
Military	Over the 2014-2015 time period, there may be increases in military uses of the Study Area above present levels (BOEM PEIS, 2014).	Past, Present, Future	Interaction could occur
Submarine Cables	Seaborn Networks Seabras-1 telecommunication cable installation, with Ready For Service in 2015	Future	Interaction could occur with cable laying vessel

In addition to consideration of these projects and activities, the cumulative effects assessment also considers past biological and/or anthropogenic pressures that may have contributed to existing conditions within the Project Area (i.e., commercial whaling). Where applicable, these pressures and the resulting effects are reflected in the description of existing conditions. Table 22 22 provides an assessment of cumulative effects for those concurrent activities scoped above. Additionally, it is not anticipated that the proposed action would result in any noticeable contributions to climate change. Relevant information about potential effects of climate change in the region is discussed in the Cumulative Effects Section of a site specific NMFS EA for a Maine Geophysical Survey in the Northwest Atlantic Ocean (NMFS 2014) and is incorporated into this Final EA by reference as if fully set forth herein.

Table 22: Assessment of Cumulative Effects

Environmental or Socio-Economic Factor	Cumulative Effects Assessment
Marine Mammals	Because the sounds generated by seismic surveys are transient and do not "accumulate" in the environment, the most likely cumulative effects would be associated with other concurrent activities (e.g., cargo ships, tankers, other seismic surveys and fishing vessels). The cumulative effect is short term (< 1 month), intermittent, and localized, with respect to effects on ESA-listed marine mammal species. The individual seismic survey vessel activity and noise would constitute a minor contribution to the overall noise generated by other such sources and space-user conflict, and would be of short duration in local areas. Based on current knowledge, and especially with the proposed mitigation procedures in place, the proposed project is not expected to result in, or contribute to, cumulative impacts on marine mammals, including threatened or endangered species.
Sea Turtles	Because sea turtles can be visually difficult to detect, the mitigation of visual avoidance may be less effective than for marine mammals. However, the source array would be shut down if a sea turtle is observed within the Exclusion Zone. PSVO's would maintain records of marine turtles sighted. Given the lack of systematic surveys for marine turtles in the Study Area, this opportunity for observation of sea turtles could add to the understanding of their distribution in the area.
Marine Fish	Marine fish populations in the Study Area may be affected by natural factors, such as changes in prey and predator populations in areas within their natural range that may occur outside the Study Area. Certain populations of marine fish are more vulnerable to changes in their environment. This is especially true of species of special concern. The distribution of most fish species varies seasonally in response to physical or chemical changes in the surrounding environment (e.g., depth, substrate, salinity, temperature) and as a result of seasonal habitat requirements (e.g., spawning, feeding). This shift is becoming more apparent to fishers with climate change influence resulting in water temperature and mass changes. Long annual migrations are undertaken by groundfish species, such as cod, halibut, shrimp and crab; and pelagic species such as tunas, swordfish, Atlantic salmon and sharks. The project would not change the physical or chemical requirements that dictate fish presence, and their ability to

Environmental or Socio-Economic Factor	Cumulative Effects Assessment
	reproduce. The residual effects of the project components on fin fish that may be cumulative with the effects of other human activities in the region are expected to be very limited, consisting primarily of short-term avoidance behavior. The predicted cumulative effects of the proposed seismic survey with noise from vessel traffic, and commercial fishing are similar to those discussed in the assessment above. Seismic surveys produce repetitive, localized and short-term increases in ambient noise levels, with the period between potential exposures ranging from hours to days. Beyond the FMZ, sound from a seismic survey is similar to commercial vessels (MMS 2004). With mitigation and monitoring procedures in place, the project components are predicted to have minimal interaction with fish species and are not anticipated to result in any cumulative adverse effects to any marine fish species The main cumulative impact on fish population would be the fishing activities that could occur at the same time as the seismic exploration. Research indicates that adverse seismic related effects are largely of a temporary behavioral level effect. Therefore, seismic surveys would not contribute adversely to cumulative effects to fish and shellfish. In general, the cumulative effect on fish populations would be short-term and localized. The proposed project would not be expected to result in or contribute to cumulative impacts on fish species.
Marine Birds	The *R/V Langseth* would comply with discharge regulations established by IMO and thus would not add to short-term or long-term effects of oil spillage on marine avifauna. Overall, there would be no cumulative adverse effects of this seismic exploration project expected to occur on the distribution, abundance, breeding status and general well-being of marine avifauna in or near the Study Area.
Marine Protected Areas	This seismic program would not encroach on any Marine Protected Areas, and therefore not contribute to any cumulative effects.
Marine Traffic	Effects from vessel traffic under the cumulative scenario are potentially adverse but minimal. With respect to vessel activity levels, the proposed seismic survey would represent a small portion of total vessel activity on the Atlantic OCS. Commercial fishing, commercial shipping and ocean study activities also would contribute to the cumulative vessel activity in the Study Area. The cumulative incremental impact attributed to the project vessel

Environmental or Socio-Economic Factor	Cumulative Effects Assessment
	operations would be negligible.
Commercial Fisheries	Cumulative effects on commercial fisheries would be related to the space-use conflicts and noise associated with other users of the offshore resources. Possible conflicts include the *Langseth*'s streamer entangling with fixed fishing gear and temporary displacement of fishers within the immediate vessel operating area. Little fixed fishing gear would be anticipated in the Study Area; however if encountered during operations, the Langseth would attempt avoidance. Fishing activities could occur within the Study Area, however, a safe distance would need to be kept from the *Langseth* and the towed seismic equipment. Conflicts would be avoided through communication with the fishing community through publication of a Notice to Mariners about operations in the area. No damage would be anticipated to result from the project with proposed mitigation, and the project would thus not increase economic risk to fishing vessels. In general, because the sounds generated by seismic surveys are intermittent and non-stationary, the most likely cumulative effects would be associated with other concurrent activities (e.g., cargo ships, tankers, other seismic surveys, and fishing vessels). The cumulative effect would be expected to be short term, intermittent and localized. In general, the seismic survey vessel activity and noise would constitute a minor incremental contribution to the overall noise generated by other such sources and space-user conflict, and would be of short duration in local areas. Based on current knowledge, and especially with the proposed mitigation procedures in place, the proposed project would not be expected to result in or contribute to cumulative effects on commercial fisheries.

6 SUMMARY OF MITIGATION

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 well as possible the nature and extent of any effects. The planned monitoring and mitigation measures would minimize the possibility of any injurious effects to marine species and reduce the environmental disruption.

Table 23: Environmental Factor-Specific Mitigation Measures and Follow-Up

Environmental Factor	Mitigation Measures	Follow up and Monitoring
Marine Mammals and Turtles	Before start of the operations, vessel operator would review sail lines, scheduling, anticipated fishing vessels and gear types, mitigation measures, expectations of all parties and Emergency Response Plans. PSVO's would be onboard the vessel throughout the duration of the survey and would record sightings of marine mammals and sea turtles per the IHA. Use of Passive Acoustic Monitoring (PAM) to detect possible presence of marine mammals. A 30 minute ramp-up procedure would be undertaken for seismic surveys. Ramp-up would be delayed if a marine mammal were observed in the Exclusion Zone. PSVO's would ensure the delay or shut down of seismic operations if ESA-listed mammals or turtles are present within the Exclusion Zone. Collision avoidance practices, including speed and course adjustment. Ramp-up of seismic data acquisition only when EZ is entirely visible.	PSVO reports would be available to NMFS and USFWS and the public. 90-day report required by NMFS summarizes all PSVO observations and mitigation actions.
Sea Birds	PSVO's would monitor for foraging sea birds within the EZ.	See 90-day report above
Marine Fish and Shellfish	None required	No follow up or monitoring required for routine activities
Marine Protected Areas	None required	No follow up or monitoring required for routine activities
Commercial Fisheries	A Notice to Mariners on the location and scheduling of seismic activities would be issued. The bridge crew on the vessel would monitor fishing activity in the vicinity of the seismic vessel and serve as a liaison between the fishing vessels and the seismic vessel. Commence deployment of seismic system only if deployment area confirmed to be clear of fixed fishing	No follow up or monitoring required for routine activities

Environmental Factor	Mitigation Measures	Follow up and Monitoring
	gear or floating longline gear.	
Marine Traffic/ Military	A Notice to Mariners on the location and scheduling of seismic activities would be issued.	No follow up or monitoring required

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9 APPENDIX A: ACOUSTIC MODELING OF SEISMIC SOURCE

Helene Carton, PhD, L-DEO

The airgun array that would be used for the USGS East coast survey is the full 4-string 6600-in^3 array, which is described and illustrated in § 2.2.3.1 of the NSF/USGS PEIS (hereafter NSF/USGS PEIS). It would be towed at a depth of 9 m. The shot interval would be 50 meters (20 to 22 seconds).

Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010 provided as in the NSF/USGS PEIS Appendix H), 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 ~1600 m water depth (deep water), 50 m depth (shallow water) and a slope site (intermediate water depth) in the Gulf of Mexico in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010), while propagation measurements of pulses from the 18-airgun 2-string array also at a tow depth of 6 m have been reported for the same shallow and deep sites (Diebold et al. 2010).

For deep and intermediate-water cases, these 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 meters. Figures 2 and 3 in the NSF/USGS PEIS Appendix H 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 suited 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 environments, 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 (Figures 12 and 14 in the NSF/USGS PEIS Appendix H). As a consequence, isopleths falling within this domain can be reliably predicted by the L-DEO model, while 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, while the direct arrivals become weak and/or incoherent (Figures 11, 12 and 16 in the NSF/USGS PEIS Appendix H). Aside from local topography effects, the region around the critical distance (~5 km in Figures 11 & 12, and ~4 km in Figure 16 in the NSF/USGS PEIS Appendix H) 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 (Figures 11, 12 and 16 in NSF/USGS PEIS Appendix H). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for estimating mitigation radii.

The proposed survey on the East coast margin would acquire data with the 36-airgun array at a tow depth of 9 m. The survey would take place entirely in deep water (> 1000 m). We use the deep-water radii obtained from 9-m tow depth L-DEO model results down to a maximum water depth of 2000 meters (Figure A1).

Measurements have not been reported for the single 40-in^3 airgun. The 40-in^3 airgun fits under the NSF/USGS PEIS low-energy sources. In § 2.4.2 of the NSF/USGS PEIS, Alternative B (the Preferred Alternative) conservatively applies a 100-m exclusion zone (EZ) 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. In addition, L-DEO model results are used to determine the 160 and 190 dB radii for the 40-in^3 airgun in deep water (Figure A2).

Table A1 shows the distances at which the 160, 180 and 190 dB RMS sound levels are expected to be received for the 36-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. The 180-dB distance would also be used as the exclusion zone for sea turtles, as required by NMFS in most other recent seismic projects (e.g., Smultea et al. 2004; Holst and Beland 2008; Holst and Smultea 2008). If marine mammals or sea turtles are detected within or about to enter the appropriate exclusion zone, the airguns would be immediately powered down (or shut down if necessary).

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. Although USGS is aware that NOAA is revising acoustic guidance for marine mammals, at the time of preparation of this Final EA, NOAA has not issued an official revised version of that policy. As such, this Final EA has been prepared in accordance with the current NOAA acoustic guidance and the procedures are based on best practices noted by Pierson et al. (1998) and Weir and Dolman (2007).

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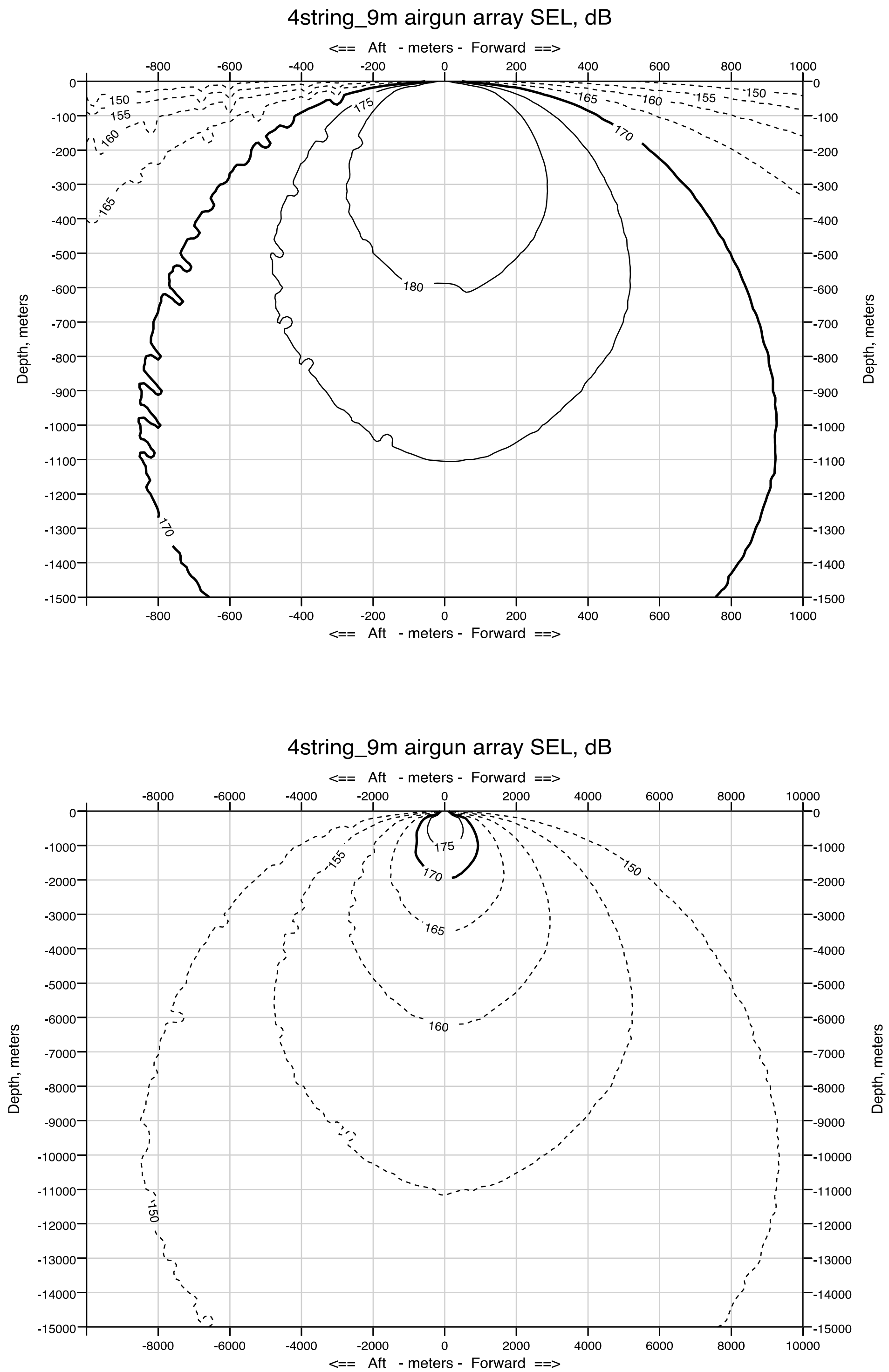
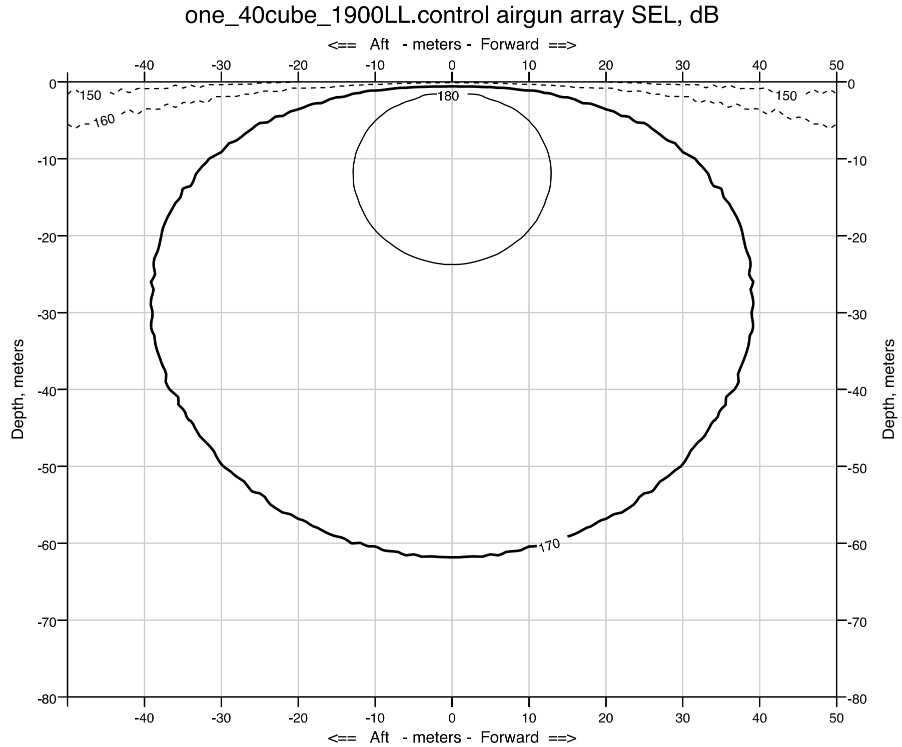


FIGURE A1. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the survey, at a 9-m tow depth. Received RMS levels (SPLs) are expected to be ~10 dB higher. Plot at the top provides radius to the 170 dB SEL isopleths as a proxy for the 180 dB RMS isopleths and plot at the bottom provides radius to the 150 dB SEL isopleth as a proxy for the 160 dB RMS isopleth.



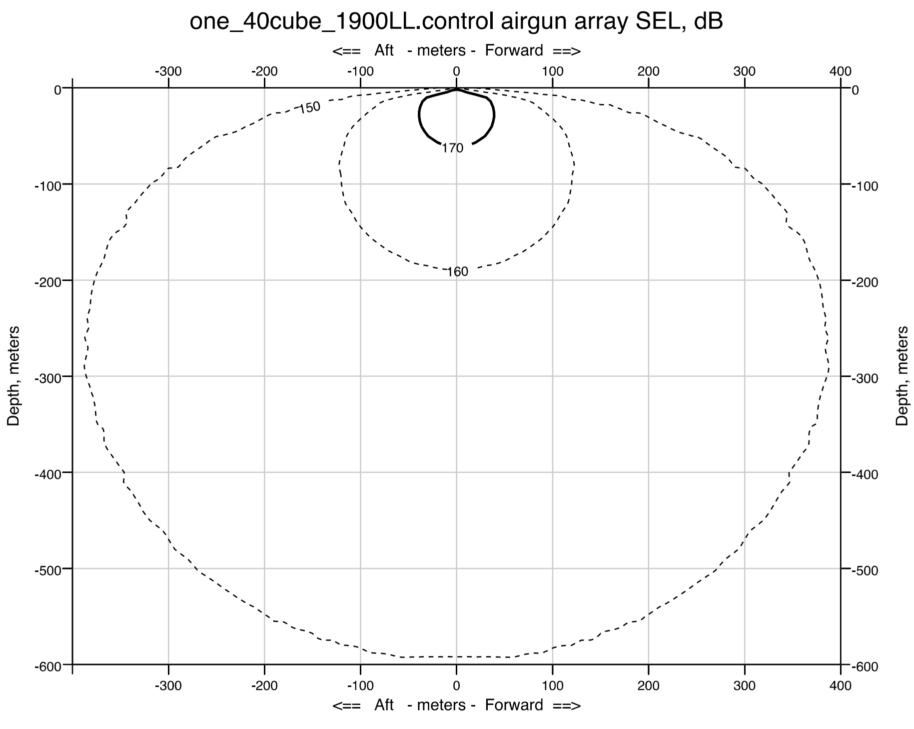


FIGURE A2. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9 m depth, which is planned for use as a mitigation gun during the proposed survey. Received RMS levels (SPLs) are expected to be ~10 dB higher. Plot at the top provides radius to the 170 dB SEL isopleths as a proxy for the 180 dB RMS isopleths and plot at the bottom provides radius to the 150 dB SEL isopleth as a proxy for the 160 dB RMS isopleth.

TABLE A1. Predicted distances to which sound levels ≥190, 180 and 160 dB re 1 μPa_{rms} are expected to be received during the proposed survey on the East coast margin in 2014 and 2015. For the single mitigation airgun, the EZ represents the conservative EZ for all low-energy acoustic sources in water depths >100 m defined in the NSF/USGS PEIS.

Source and Volume	Water Depth (m)	Predicted RMS Radii (m)		
		190 dB	180 dB	160 dB
Single Bolt airgun, 40 in^3	>1000 m	13	100	388
36-gun array totaling 6600 in^3	>1000 m	286	927	5780

10 APPENDIX B: REQUEST FOR AN INCIDENTAL HARASSMENT AUTHORIZATION

Request for an Incidental Harassment Authorization under the Marine Mammal Protection Act

by
U.S. Geological Survey

2-D Seismic Reflection Scientific Research Survey Program: Mapping the U.S. Atlantic Seaboard Extended Continental Shelf Region and Investigating Tsunami Hazards, August-September 2014 and April-August, 2015

Request for an Incidental Harassment Authorization under the Marine Mammal Protection Act

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U.S. Geological Survey

2-D Seismic Reflection Scientific Research Survey Program: Mapping the U.S. Atlantic Seaboard Extended Continental Shelf Region and Investigating Tsunami Hazards, August-September 2014 and April-August, 2015

March 2014

Submitted to:

National Marine Fisheries Service
Office of Protected Resources
1315 East-West Hwy
Silver Spring, MD 20910

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ACRONYMS AND ABBREVIATIONS

µ	micro
2-D	two dimensional
BOEM	Bureau of Ocean Energy Management
CeTAP	Cetaceans and Turtle Assessment Program
dB	decibel
ECS	extended continental shelf
EEZ	Exclusive Ecomonic Zone
EIS	*Environmental Impact Statement*
ESA	Endangered Species Act
EZ	exclusion zone
IHA	Incidental Harassment Authorization
in^3	cubic inch(es)
kHz	kiloHertz
kw	kilowatt(s)
L-DEO	Lamont-Doherty Earth Observatory
MBES	multibeam echosounder
NASA	National Aeronautics and Space Administration
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NODE	(U.S. Department of the) Navy Operating Area (OPAREA) Density Estimates
NSF	National Science Foundation
OBIS	Ocean Biogeographic Information System
OEIS	*Overseas Environmental Impact Statement*
OPAREA	Operating Area
Pa	Pascal
PAM	Passive acoustic monitoring
PEIS	*Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey* (June 2011)
PSAO	Protected Species Acoustic Observer

PSVO	Protected Species Visual Observer
PTS	permanent threshold shift
R/V Langseth	*Research Vessel Marcus G. Langseth*
RMS	root-mean-squared
SAR	Stock Assessment Report
SBP	sub-bottom profiler
SEFSC	Southeast Fisheries Science Center
SEL	sound exposure level
SERDP	Strategic Environmental and Development Program
SPL	sound pressure level
TTS	temporary threshold shift
UME	Unusual Mortality Event
USGS	United States Geological Survey

I. DESCRIPTION OF THE ACTIVITY

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

1.1 Overview of the Activity

The United States Geological Survey (USGS), Coastal and Marine Geology Program (Debbie Hutchinson, Principal Investigator), plans to conduct a regional marine two dimensional (2-D) seismic survey in the northwest Atlantic Ocean within the U.S. Exclusive Economic Zone (EEZ) and extending into International Waters as far as 350 nautical miles from the U.S. coast (Study Area) (**Figure 1**). Water depths in the Study Area range from approximately 1,400 meters to 5,400 meters. The proposed USGS survey is planned to be conducted in two phases; one survey during August and September, 2014, and the second survey is expected to take place between April 1 and August 31, 2015 (specific dates to be determined). The activities for both Phase 1 and Phase 2 are included in this application (**Figure 2**).

USGS plans to use conventional marine seismic methodology to: (1) establish the outer limits of the U.S. continental shelf, also referred to as the Extended Continental Shelf (ECS) as defined by Article 76 of the Convention of the Law of the Sea; and (2) study the sudden mass transport of sediments down the continental shelf as submarine landslides that may pose significant tsunamigenic (i.e., earthquake potential along the subduction zone) hazards to the Atlantic and Caribbean coastal communities.

The proposed survey will use the *Research Vessel Marcus G. Langseth* (*R/V Langseth*) as the sole source vessel. To conduct the proposed survey, the *R/V Langseth* will deploy a 36-airgun array as the energy source and one 8-kilometer multichannel hydrophone cable as the receiving system. The hydrophone cable will receive the returning acoustic signals from the towed airgun array and the data will be processed on-board the *R/V Langseth* as the survey occurs.

Each proposed surveys (2014 and 2015) will each consist of a 17- to 18-day leg (exclusive of transit and equipment deployment and recovery) comprising approximately 1,700 nautical trackline miles (approximately 3,165 kilometers) of 2-D seismic reflection coverage. The airgun array will operate continuously during the survey with shutdowns only for repairs and marine mammal and sea turtle mitigation. Data will continue to be acquired between line changes. The successive track segments can be surveyed as almost one continuous line. Turns of no greater than 120 degrees will be required to move from one line segment to the next. The 2014 proposed survey design consists primarily of the track lines that run along the periphery of the overall Study Area, including several internal track lines (**Figure 2**). The proposed 2014 survey will occur in water depths ranging between 1,450 meters and 5,400 meters. The 2015 proposed survey consists of additional dip and tie lines. (Dip lines are lines that are perpendicular to the north-south trend of the continental margin. Strike lines are parallel to the margin. Tie lines are any line that connects other lines.) The 2015 survey design may be modified based on the 2014 results.

Along with the airgun operations, two additional acoustical data acquisition systems will be operated during the survey. A Kongsberg EM122 multibeam echosounder (MBES) and a Knudsen Model 3260 Chirp sub-bottom profiler (SBP) will be operated continuously during the seismic operations in order to map the ocean floor. MBES and SBP will not operate during transits at the beginning and end of the survey.

The Langseth has been used to conduct research seismic surveys world-wide since 2008. All of the seismic surveys have been operated under incidental harassment authorizations issued by NMFS. Environmental assessments, IHA's and post-cruise reports environmental impact for most of these cruises cruises can be found on the NMFS Protected Resource website. Many of these reports and applications were prepared by LGL Limited, Environmental Research Associates, under contract to Lamont Doherty Earth Observatory or the USGS. Because material from earlier documents is owned by the U.S. Government and in the public domain, some material common to these documents may have been used verbatim herein without attribution. The USGS acknowledges role of LGL in preparing material that has been used.

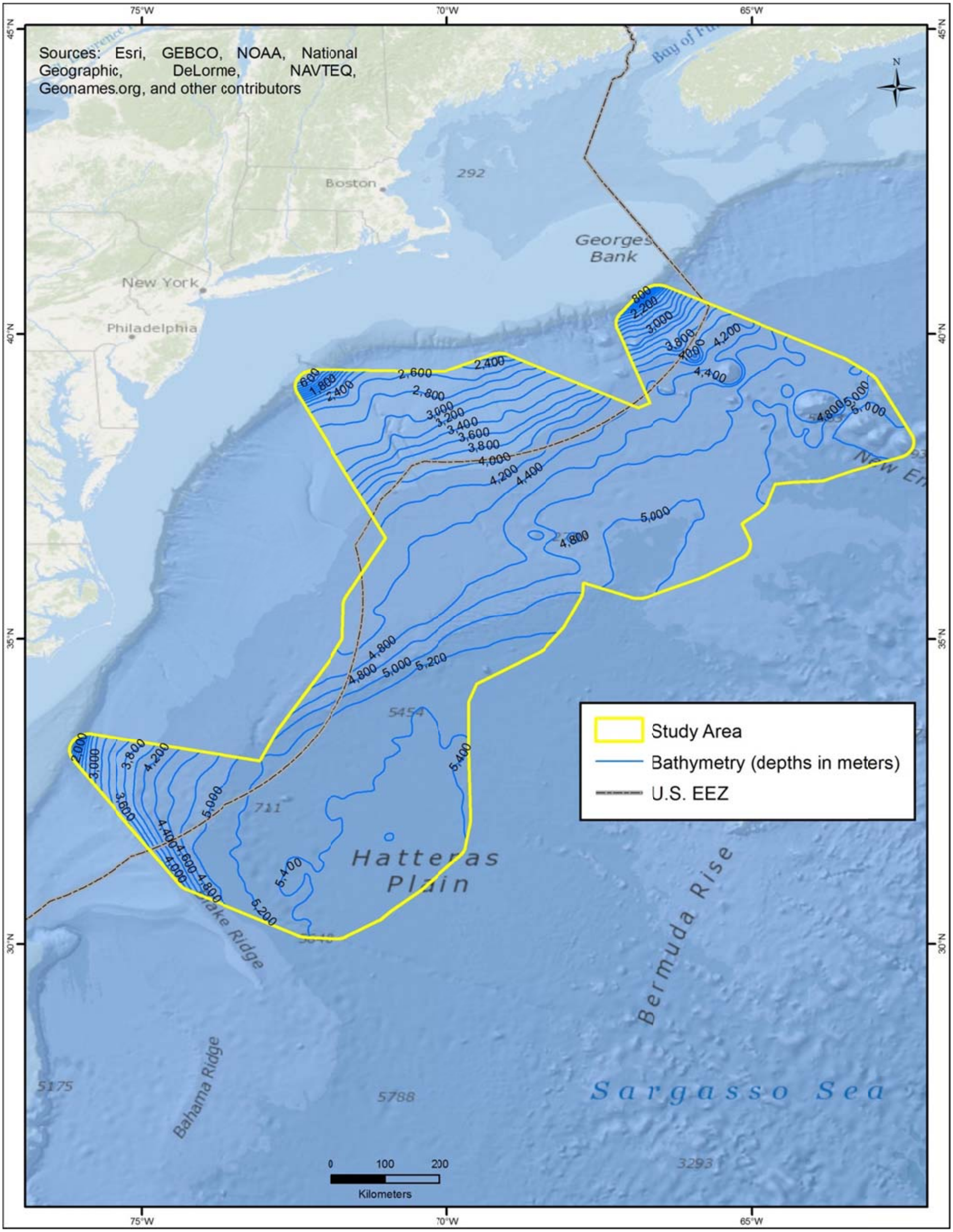


Figure 1 Proposed USGS Study Area

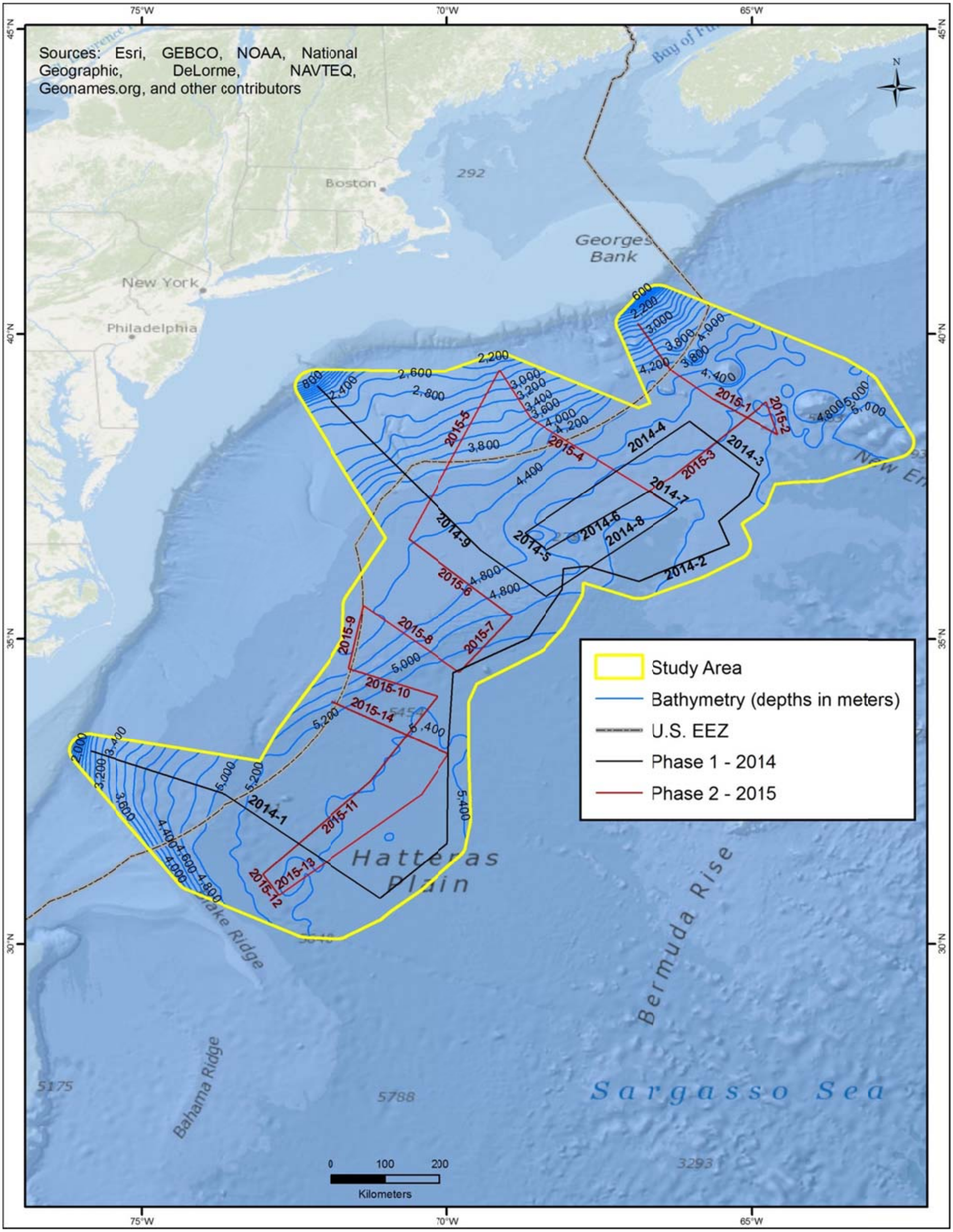


Figure 2 Proposed Seismic Survey Lines, Phases 1 and 2

1.2 Vessel Specifications

The *R/V Marcus G. Langseth* will be used as the source vessel; it is owned by the NSF and operated by Lamont-Doherty Earth Observatory (L-DEO) of Columbia University. The *R/V Langseth* was designed as a seismic research vessel with a quiet propulsion system to avoid interference with the seismic signals. The operation speed during seismic acquisition is typically 7.8 to 8.3 kilometers per hour (4.2 to 4.5 knots). When not towing seismic survey gear, the *R/V Langseth* can cruise at 20 to 24 kilometers per hour (11 to 12 knots). The *R/V Langseth* was further described in Section 2.2.2.1 of the *Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey* (June 2011; referred to herein as the PEIS) and the Record of Decision (June 2012).

1.3 Airgun Description

During the proposed 2-D survey, the airgun array to be used will consist of 36 airguns (plus 4 spare airguns), with a total volume of approximately 6,600 cubic inches (in^3). The airgun array and configuration are described and illustrated in the PEIS in Section 2.2.3.1 and on Figure 2.11, respectively. For the 2014 and 2015 proposed survey, the airgun array will be towed at a depth of 9 meters and shot intervals will be 50 meters (approximately 20 to 24 seconds). The firing pressure of the array is 2,000 pounds per square inch.

1.4 **Predicted Sound Levels**

The airgun array that will be used for the USGS East Coast survey is the full 4-string 6,600-in^3 array, which is described and illustrated in the PEIS in Section 2.2.3.1.

Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010, provided as Appendix H of 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 (i.e., the mitigation gun), which will 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 meters have been reported in approximately 1,600 meters water depth (deep water), 50 meters depth (shallow water) and a slope site (intermediate water depth) in the Gulf of Mexico in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010), while propagation measurements of pulses from the 18-airgun 2-string array also at a tow depth of 6 meters have been reported for the same shallow and deep sites (Diebold et al. 2010).

For deep water and intermediate water depth cases, these field measurements cannot be used readily to derive mitigation radii because at those sites, the calibration hydrophone was located at a roughly constant depth of 350 to 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 approximately 2,000 meters. 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 suited 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.

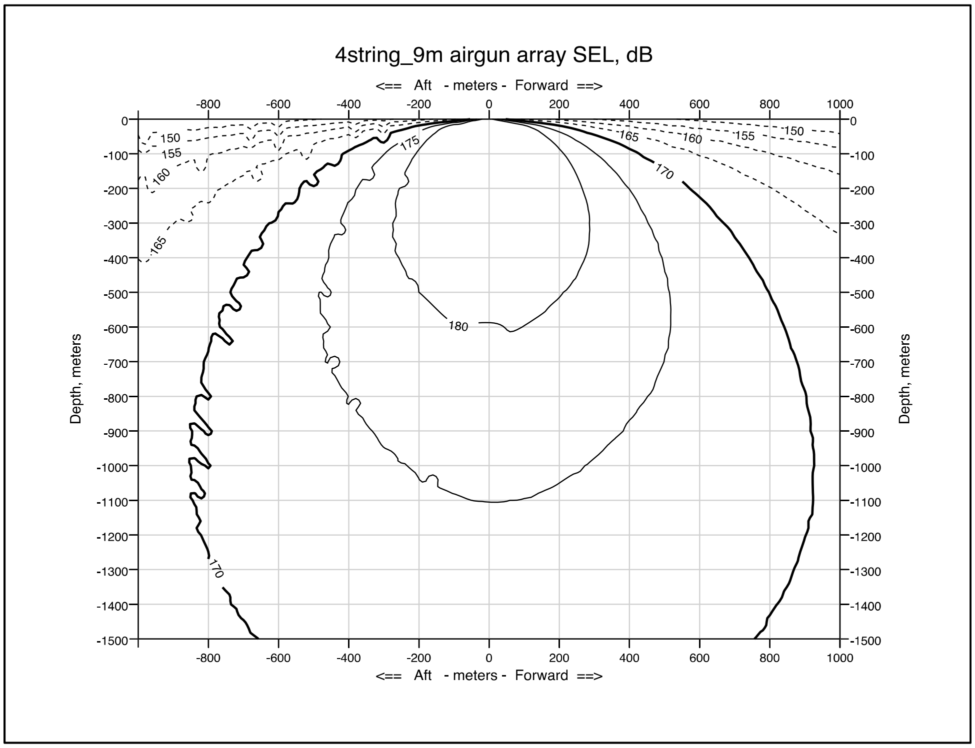
In deep water and intermediate depth water environments, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are consistent (Figures 12 and 14 in Appendix H of the PEIS). Consequently, isopleths falling within this domain can be reliably predicted by the L-DEO model, while 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, while the direct arrivals become weak and/or incoherent (Figures 11, 12 and 16 in Appendix H of the PEIS). Aside from local topography effects, the region around the critical distance (approximately 5 kilometers in Figures 11 and 12, and approximately 4 kilometers in Figure 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 fall almost entirely below the mitigation model curve (Figures 11, 12 and 16 in Appendix H of the PEIS). Thus, analysis of the Gulf of Mexico calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for estimating mitigation radii.

The proposed survey on the East Coast margin will acquire data with the 36-airgun array at a tow depth of 9 meters. The survey will take place entirely in deep water (greater than 1,000 meters). The deep-water radii obtained from 9-meter tow depth L-DEO model results will be used down to a maximum water depth of 2,000 meters (**Figure 3**).

Measurements have not been reported for the single 40-in^3 airgun. The 40-in^3 airgun would be considered under the low-energy sources category in the PEIS. In Section 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applies a 100-meter exclusion zone (EZ) for all low-energy acoustic sources in water depths greater than 100 meters. This approach is adopted here for the single Bolt 1900LL 40-in^3 airgun that will be used during power-downs. In addition, L-DEO model results are used to determine the 160- and the 190-decibel (dB) radii for the 40-in^3 airgun in deep water (**Figure 4**).

Table 1 shows the distances at which the 160-dB, 180-dB, and 190-dB root-mean-squared (RMS) sound levels are expected to be received for the 36-airgun array and the single (mitigation) airgun.

The 180-dB re 1 micro (µ) pascal (Pa) $_{RMS}$ distance is the safety criterion as specified by the National Marine Fisheries Service (NMFS) (2000) for cetaceans. If marine mammals or sea turtles are detected within or about to enter the appropriate exclusion zone, the airguns would be immediately powered down (or shut down if necessary).



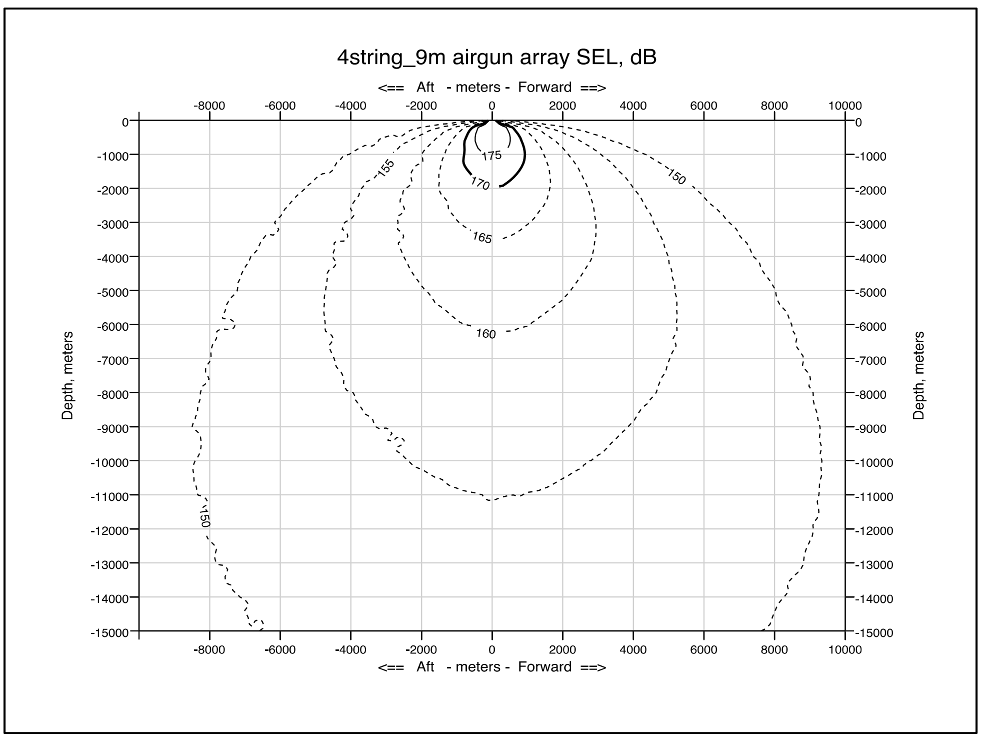


Figure 3 Modeled Deep-Water Received Sound Exposure Levels (SELs) from the 36-Airgun Array Towed at 9 Meters Depth

Modeled deep-water received sound exposure levels (SELs) from the 36-airgun array planned for use during the survey, at a 9-meter tow depth. Received RMS levels (SPLs) are expected to be ~10 dB higher. Plot at the top provides radius to the 170 dB SEL isopleths as a proxy for the 180 dB RMS isopleths and plot at the bottom provides radius to the 150 dB SEL isopleth as a proxy for the 160 dB RMS isopleth.

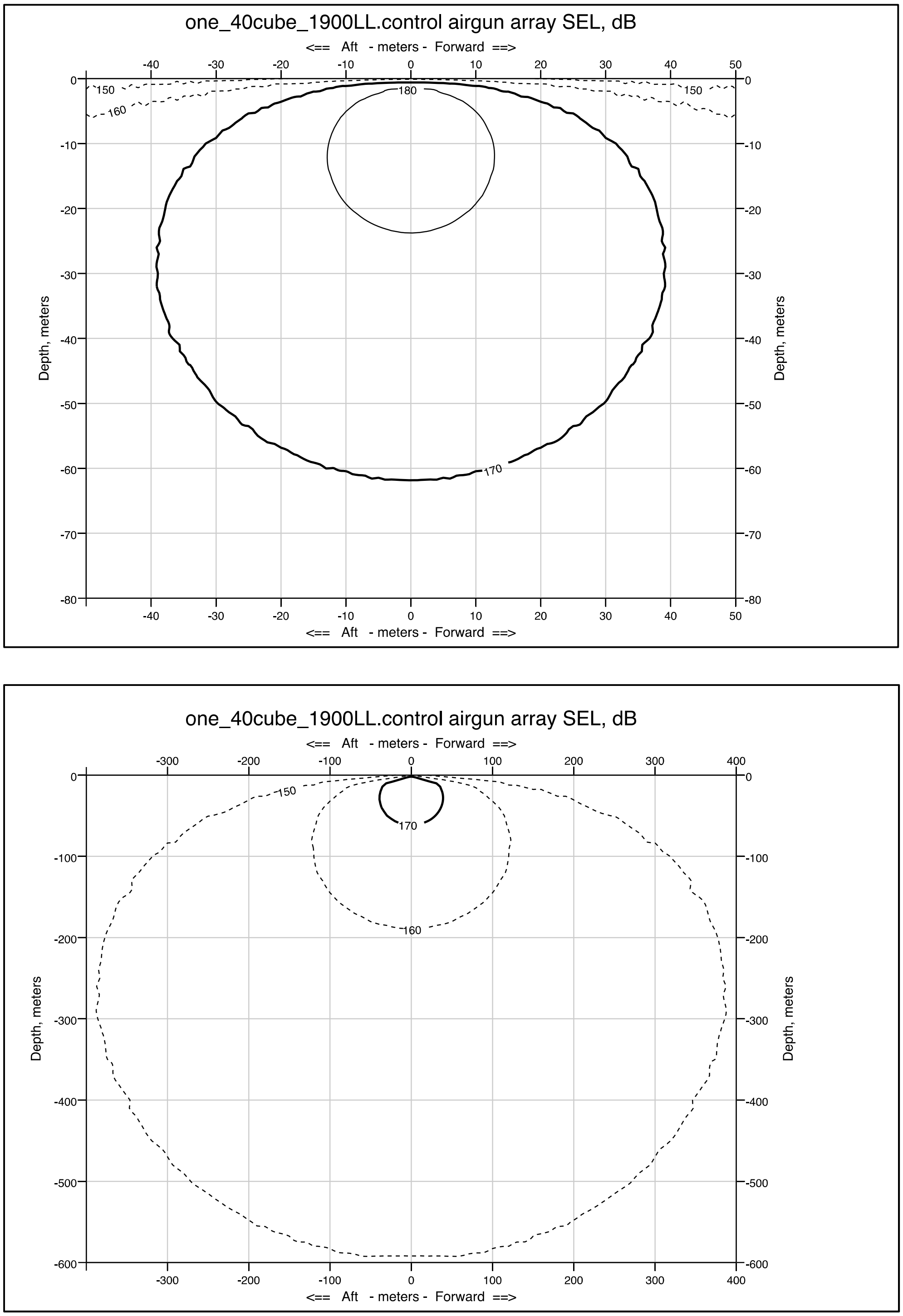


Figure 4 Modeled Deep-Water Received Sound Exposure Levels (SELs) from a Single 40-in^3 Airgun Towed at 9 Meters Depth

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

Table 1 Predicted Distances to Sound Levels ≥ 190, 180 and 160 dB re 1 μPa_{RMS}

Predicted distances to which sound levels ≥190, 180 and 160 dB re 1 μPa_{RMS} are expected to be received during the proposed survey on the East Coast margin in 2014 and 2015. For the single mitigation airgun, the EZ is the conservative EZ for all low-energy acoustic sources in water depths >100 meter defined in the PEIS.

Source and Volume	Water Depth (meters)	Predicted RMS Radii (meters)		
		190 dB	180 dB	160 dB
Single Bolt airgun, 40 cubic-inch	>1,000	13	100	388
36-gun array totaling 6,600 cubic inches	>1,000	286	927	5,780

Southall et al. (2007) provided detailed recommendations for new science-based noise exposure criteria. Although the NSF is aware that the National Oceanic and Atmospheric Administration (NOAA) is revising acoustic guidance for marine mammals, at the time of preparation of this Incidental Harassment Authorization (IHA) application, NOAA has not issued an official revised version of that policy. As such, this IHA application has been prepared in accordance with the current NOAA acoustic guidance and the procedures are based on best practices noted by Pierson et al. (1998) and Weir and Dolman (2007).

1.5 Description of Operations

During the survey, the source vessel, the R/V *Marcus G. Langseth,* will tow a standard 36-airgun array at a depth of 9 meters. The *R/V Langseth* also will tow one 8-kilometer long hydrophone streamer cable. As the airgun array is towed along the survey lines, the hydrophone streamer cable will receive and record the returning acoustic signals from the towed airgun array and the data will be processed on-board the *R/V Langseth* as the survey occurs.

During the 2014 survey, 1,700 nautical track line miles (approximately 3,165 kilometers) of 2-D survey lines will be shot (**Figure 2**). All water depths will be greater than 1,000 meters. Due to the almost continuous nature of the 2014 and 2015 survey track line segments (**Figure 2**), full turns will not be required. Only 90 to 120-degree turns will be conducted with 2-D seismic data being collected continuously during the turns. In addition to the operations of the airgun array during the 2-D survey, a MBES and a SBP also will run continuously. The plan for the 2015 (**Figure 2**) survey is similar in all respects to the 2014.

1.6 Multibeam Echosounder and Sub-bottom Profiler

Along with the airgun operations, two additional acoustical data acquisition systems will be operated during the survey. The ocean floor will be mapped with the Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. These sound sources will be operated from the *R/V Langseth* continuously throughout the survey.

The Kongsberg EM 122 MBES operates at 10.5 to 13 (usually 12) kiloHertz (kHz) and is hull-mounted on the *R/V Langseth*. The maximum source level is 242 dB re 1 μPa_{RMS}. The Knudsen Chirp 3260 SBP normally is 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 water depths of 10,000 meters and penetrating tens of meters into the sediments. The nominal power output is 10 kilowatts (kw), but the actual maximum radiated power is 3 kW or 222 dB re 1 μPa m.

II. DATES, DURATION, AND REGION OF ACTIVITY

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

The proposed survey area would be bounded by the following geographic coordinates:

40.5694° N / -66.5324° W
38.5808° N / -61.7105° W
29.2456° N / -72.6766° W
33.1752° N / -75.8697° W
39.1583° N / -72.8697° W

The proposed 2014 survey activities will generally occur within the outer portions of the Study Area. The proposed 2015 survey will in-fill more of the Study Area. The track lines proposed for both years occur primarily within International Waters (approximately 80% in 2014 and 90% in 2015, **Figure 2**). Water depths range between approximately 1,450 meters and 5,400 meters; no survey lines will extend to water depths less than 1,000 m. The exact dates of the survey are dependent on logistics and weather conditions; however, the *R/V Langseth* is expected to depart Newark, New Jersey, on August 16, 2014, and transit to the survey area, returning to Norfolk, Virginia, on September 6, 2014. The seismic operations will take approximately 16 days to complete. Approximately one day transit will be required at the beginning and end of the program. The survey schedule is inclusive of weather and other contingency (e.g. equipment failure) time.

The proposed 2015 survey will be virtually identical to the program planned for 2014. Geographic area, duration, and trackline coverage are similar. Exact dates for the survey in 2015 are uncertain, but are scheduled to occur within the April to August time frame.

III. SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

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

Thirty-eight marine mammal species could occur within the Study Area. To avoid redundancy and consolidate species-specific information, required information regarding species and numbers of species as is required under Section III, is included below in Section IV

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

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

Sections III and IV are integrated here to minimize repetition.

Forty-five species of marine mammals, including 30 odontocetes, 7 mysticetes, 7 pinnipeds, and 1 sirenian are known to occur in western North Atlantic Ocean (Waring et al. 2013; Read et al. 2009). Of those 45 species of marine mammals, 34 cetaceans and 4 pinnipeds could be found within the Study Area during the summer months (see **Table 2**). Six of the cetaceans are listed as ***Endangered*** under the Endangered Species Act (ESA) (sei, blue, fin, North Atlantic right, humpback, and sperm whales). Fourteen of the 34 cetacean species, although present in the wider western North Atlantic Ocean, are considered rare in the survey area; however, due to the chance that an individual could be found within the Study Area during the proposed survey, they are discussed in this document. The four pinniped species (harbor seal, harp seal, gray seal, and hooded seal) also are considered rare within the Study Area. All pinnipeds known to occur within the North Atlantic Ocean are considered coastal species and any sightings would be considered extralimital; however, due to the limited chance that they could occur within the Study Area during the summer months, similar to the rare cetacean species, they are discussed in this document.

General information on the taxonomy, ecology, distribution, seasonality and movements, and acoustic capabilities of mysticetes, odontocetes, and pinnipeds are provided in Sections 3.6.1, 3.7.1, and 3.8.1 respectively, of the PEIS. The general distribution of mysticetes, odontocetes, and pinnipeds in the North Atlantic is discussed in Sections 3.6.3.4, 3.7.3.4, and 3.8.3.4, respectively, of the PEIS. In addition, Section 3.1 of the *Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas Final Programmatic Environmental Impact Statement* (Bureau of Ocean Energy Management 2012) reviews similar information for all marine mammals that may occur within the Study Area.

The rest of this section deals specifically with their distribution within the Study Area and near the proposed 2014 survey area. Various surveys have been conducted throughout the western North Atlantic, including within sections of the Study Area. The main source of information used here is the Ocean Biogeographic Information System (OBIS) database hosted by Rutgers and Duke Universities (Read et al. 2009). This database includes survey data collected during the

Cetaceans and Turtle Assessment Program (CeTAP) conducted between 1978 and 1982 and consisted of both aerial and vessel-based surveys between Cape Hatteras, North Carolina, and the Gulf of Maine. The database also includes survey data collected during the NOAA Northeast Fisheries Science Center (NEFSC) and the NOAA Southeast Fisheries Science Center (SEFSC) stock assessment surveys conducted in 2004 (which surveys between Nova Scotia, Canada, and Florida).

Table 2 The Habitat, Range, Seasonality, Regional Abundance, and Conservation Status of Marine Mammals that Could Occur In or Near the Study Area

Species	Occurrence Near Study Area	Habitat	Range along U.S. East Coast	Seasonality	Regional/SAR abundance estimates[1]	Population Status[1]	ESA[2]	MMPA
ORDER CETACEA								
***Suborder Mysticeti* (Baleen Whales)**								
Fin Whale *(Balaenoptera physalus)*	Regular	Coastal, banks	Canada to North Carolina	Year round	26,500[3] / 3,522	Unable to determine	EN	Depleted
Humpback Whale *(Megaptera novaeangliae)*	Regular	Coastal, banks	Canada to Caribbean	High-latitude summer feeding; low-latitude winter breeding/calving in coastal waters; some remain in high latitudes year round.	11,600[4] / 823[5]	Increasing	EN	Depleted
Minke Whale *(Balaenoptera acutorostrata)*	Regular	Coastal, banks, shelf	Arctic to Caribbean	Spring and Summer – widespread and common occurrence throughout range. Most abundant in New England waters at this time. Fall and Winter – lesser occurrence to largely absent from New England Waters Winter - potential distribution in the Caribbean and south and east of Bermuda	138,000[6] / 20,741	Unable to determine	NL	--
North Atlantic Right Whale (*Eubalaena glacialis)*	Regular	Coastal and shelf waters	Canada to Florida	Spring and Summer – Canada and New England Fall and Winter – migrating along U.S. east cast states and in Southeastern U.S. waters	455 / 455[7]	Increasing	EN	Depleted
Blue Whale (*Balaenoptera musculus*)	Rare	Coastal, shelf, and pelagic	Arctic to Florida	Year round	855[8] / 440[7]	Unable to determine[6]	EN	Depleted
Bryde's Whale (*Balaenoptera edeni*)	Rare	Coastal, offshore	N/A	Unknown	N/A	N/A	NL	--

Table 2 The Habitat, Range, Seasonality, Regional Abundance, and Conservation Status of Marine Mammals that Could Occur In or Near the Study Area

Species	Occurrence Near Study Area	Habitat	Range along U.S. East Coast	Seasonality	Regional/SAR abundance estimates[1]	Population Status[1]	ESA[2]	MMPA
Sei Whale *(Balaenoptera borealis)*	Rare	Mostly pelagic, some offshore	Canada to Massachusetts	Year round	10,300[9] / 357[10]	Unable to determine	EN	Depleted
Suborder Odontoceti (Toothed Whales, Dolphins, and Porpoises)								
Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)	Regular	Shelf and slope	Central West Greenland to North Carolina	January – May in Georges Bank to Jeffrey's Ledge June – September primarily in Bay of Fundy to George's Bank October - December in Gulf of Maine to George's Bank Year round from Massachusetts to North Carolina	10s–100s of 1000s[11] / 48,819[7]	Unable to determine	NL	--
Atlantic Spotted Dolphin *(Stenella frontalis)*	Regular	Shelf, offshore	Massachusetts to Caribbean	Year round	N/A / 44,715	Unable to determine	NL	--
Bottlenose Dolphin (*Tursiops truncatus*)	Regular	Coastal, shelf, pelagic	Canada to Florida	Year round	N/A / 77,532[12]	Unable to determine	NL	--
Long-Finned Pilot Whale *(Globicephala melas)*	Regular	Mostly pelagic	Canada to North Carolina	Year round	780,000[13] / 26,535	Unable to determine	NL	--
Short-Finned Pilot Whale *Globicephala macrorhynchus)*	Regular	Mostly pelagic, high relief	North Carolina to Florida	Year round	780,000[13] / 21,515	Unable to determine	NL	--
Pantropical Spotted Dolphin (*Stenella attenuata*)	Regular	Coastal, shelf and slope	Massachusetts to Florida	Year round	N/A / 3,333	Unable to determine	NL	--
Risso's Dolphin *(Grampus griseus)*	Regular	Shelf, slope, seamounts	Canada to Florida	Spring, summer and Fall in George's Bank to North Carolina Winter in the mid-Atlantic Bight out to oceanic waters	N/A / 18,250	Unable to determine	NL	--

Table 2 The Habitat, Range, Seasonality, Regional Abundance, and Conservation Status of Marine Mammals that Could Occur In or Near the Study Area

Species	Occurrence Near Study Area	Habitat	Range along U.S. East Coast	Seasonality	Regional/SAR abundance estimates[1]	Population Status[1]	ESA[2]	MMPA
Shorted-beaked Common Dolphin *(Delphinus delphis)*	Regular	Shelf, pelagic, high relief	Canada to Georgia	Mid-January – May in George's Bank to North Carolina Mid-summer and Autumn in George's Bank and Scotian shelf	N/A / 173,486	Unable to determine	NL	--
Striped Dolphin *(Stenella coeruleoalba)*	Regular	Offshore convergence zones and upwellings	Canada to Caribbean	Year round	N/A / 54,807	Unable to determine	NL	--
Sperm Whale *(Physeter macrocephalus)*	Regular	Pelagic, slope, canyons	Canada to Caribbean	Winter – concentrated east and northeast of North Carolina Spring – widespread in central portion of the mid-Atlantic Bight and southern George's Bank Summer – widespread in central portion of the mid-Atlantic Bight and east and north of George's Bank Fall – south of New England and throughout the mid-Atlantic Bight	13,190[14] / 2,288	Unable to determine	EN	Depleted
Killer whale *(Orcinus orca)*	Rare	Coastal, pelagic	Arctic to Caribbean	Unknown	N/A / N/A	Unable to determine	NL	--
Clymene Dolphin *(Stenella clymene)*	Rare	Coastal, shelf and slope	North Carolina to Florida	Unknown	N/A / N/A	Unable to determine	NL	--
Spinner Dolphin (*Stenella longirostris*)	Rare	Mainly nearshore	Maine to Caribbean	Year round	N/A / N/A	Unable to determine	NL	--
Rough-Toothed Dolphin *(Steno bredanensis)*	Rare	Mostly pelagic	Virginia to Florida	Unknown	N/A / 271	Unable to determine	NL	--
Fraser's Dolphin *(Lagenodelphis hosei)*	Rare	Shelf and slope	North Carolina to Florida	Unknown	N/A / N/A	Unable to determine	NL	--

Table 2 The Habitat, Range, Seasonality, Regional Abundance, and Conservation Status of Marine Mammals that Could Occur In or Near the Study Area

Species	Occurrence Near Study Area	Habitat	Range along U.S. East Coast	Seasonality	Regional/SAR abundance estimates[1]	Population Status[1]	ESA[2]	MMPA
Harbor Porpoise *(Phocoena phocoena)*	Rare	Shelf, coastal, pelagic	Canada to North Carolina	October – December and April – June in Maine through New Jersey January – March in Canada to North Carolina July – September in northern Gulf of Maine and Southern Bay of Fundy	~500,000[15] / 79,833[9]	Unable to determine	NL	--
False Killer Whale *(Pseudorca crassidens)*	Rare	Pelagic	N/A	Unknown	N/A / N/A	N/A	NL	--
Pygmy Killer Whale *(Feresa attenuata)*	Rare	Pelagic	N/A	Unknown	N/A / N/A	Unable to determine	NL	--
Dwarf Sperm Whale *(Kogia sima)*	Rare	Deep waters off shelf	Massachusetts to Florida	Unknown	N/A / 3,785[16]	Unable to determine	NL	--
Pygmy Sperm Whale *(Kogia breviceps)*	Rare	Deep waters off shelf	Massachusetts to Florida	Unknown	N/A / 3,785[16]	Unable to determine	NL	--
Melon-Headed Whale *(Peponocephala electra)*	Rare	Deep waters off shelf	North Carolina to Florida	Year round	N/A / N/A	Unable to determine	NL	--
Sowerby's Beaked Whale *Mesoplodon bidens)*	Rare	Pelagic, deep slope, canyons	Canada to Florida	Year round	N/A / 7,092[17]	Unable to determine	NL	--
Blainville's Beaked Whale *(Mesoplodon densirostris)*			Canada to Florida	Year round	N/A / 7,092[17]			--
Gervais' Beaked Whale *(Mesoplodon europaeus)*			Canada to Florida	Year round	N/A / 7,092[17]			--
True's Beaked Whale *(Mesoplodon mirus)*			Canada to Bahamas	Year round	N/A / 7,092[17]			--
Cuvier's Beaked Whale *(Ziphius cavirostris)*			Canada to Florida	Year round	N/A / 6,532			--

Table 2 The Habitat, Range, Seasonality, Regional Abundance, and Conservation Status of Marine Mammals that Could Occur In or Near the Study Area

Species	Occurrence Near Study Area	Habitat	Range along U.S. East Coast	Seasonality	Regional/SAR abundance estimates[1]	Population Status[1]	ESA[2]	MMPA
Northern Bottlenose Whale *(Hyperoodon ampullatus)*	Rare	Pelagic	Arctic to New Jersey	Unknown	N/A / N/A	Unable to determine	NL	--
ORDER CARNIVORA								
Clade Pinnipedia								
Harbor seal (Phoca vitulina)	Rare	Coastal	Canada to North Carolina	Year round in Canada to Massachusetts September – May in Rhode Island to New Jersey (possibly south to North Carolina)	N/A / 70,142	Unable to determine	NL	--
Gray seal *(Halichoerus grypus)*	Rare	Coastal, pelagic	Canada to North Carolina	Year round in Canada to Massachusetts September – May in Rhode Island to New Jersey (possibly south to North Carolina)	N/A / 348,900	Increasing	NL	--
Harp seal *(Phoca groenlandica)*	Rare	Ice whelpers, pelagic	Canada to New Jersey	Winter – Summer in Arctic Fall as far south as New Jersey	8.6–9.6 million[18] / N/A	Unknown	NL	--
Hooded Seal *(Cystophora cristata)*	Rare	Ice whelpers, pelagic	Canada to Caribbean	January – May in New England Summer and Autumn in Caribbean	600,000[19] / N/A	Unable to determine	NL	--

Table 2 The Habitat, Range, Seasonality, Regional Abundance, and Conservation Status of Marine Mammals that Could Occur In or Near the Study Area

Species	Occurrence Near Study Area	Habitat	Range along U.S. East Coast	Seasonality	Regional/SAR abundance estimates[1]	Population Status[1]	ESA[2]	MMPA

Key:
N/A = Not available or not assessed
Sources:
[1] SAR (stock assessment report) abundance estimates are from the Draft Marine Mammal Stock Assessment Reports 2013 for the Western North Atlantic Stock unless otherwise noted.
[2] U.S. Endangered Species Act: EN = Endangered; NL = Not listed (ECOS 2013)
[3] Best estimate for the North Atlantic in 2007 (International Whaling Commission [IWC] 2014)
[4] Best estimate for the western North Atlantic in 1992–1993 (IWC 2014)
[5] Minimum estimate for Gulf of Maine Stock (Waring et al. 2013)
[6] Best estimate for the North Atlantic in 2002–2007 (IWC 2014)
[7] Estimate for the Western North Atlantic Stock (Waring et al. 2013)
[8] Estimate for the central and northeast Atlantic in 2001 (Pike et al. 2009)
[9] Estimate for the Northeast Atlantic in 1989 (Cattanach et al. 1993)
[10] Nova Scotia Stock (Waring et al. 2013)
[11] Tens to low hundreds of thousands in the North Atlantic (Reeves et al. 1999)
[12] Western North Atlantic Offshore Stock (Waring et al. 2013)
[13] Estimate for both long- and short-finned pilot whales in the central and eastern North Atlantic in 1989 (IWC 2014)
[14] Estimate for the North Atlantic (Whitehead 2002)
[15] Estimate for the North Atlantic (Jefferson et al. 2008)
[16] This estimate includes both the dwarf and pygmy sperm whales
[17] Estimate includes all *Mesoplodon* in the Atlantic
[18] Northwest Atlantic (Department of Fisheries and Oceans 2012)
[19] Northwest Atlantic (Andersen et al. 2009)

1.7 Mysticetes

1.7.1 Fin whale (*Balaenoptera physalus*)

Fin whales are one of the more common mysticete species found within the Study Area and in the waters surrounding it. According to Palka (2006), they are the most commonly sighted ESA-listed large whale in the western North Atlantic. Hundreds of OBIS sightings of this species near the Study Area boundaries are recorded and 14 sightings within it are recorded. The three most recent sightings were recorded in 2003 and 2004 and were observed during the NEFSC Right Whale Survey. All other sightings are from the 1970s and 1980s.

The NMFS (2010) reports summer feeding grounds mostly between 41°20’ and 51°00’N latitude (shore to 1,829 meters). The Study Area and proposed project survey dates coincide with this cycle of the fin whale. Fin whale mating and births occur in the winter (November to March), with reproductive activity peaking in December and January. Hain et al. (1992) suggested that calving takes place during October to January in latitudes of the U.S. Mid-Atlantic region. The proposed 2014 survey period of August–September will not interfere with the reproduction cycle.

1.7.2 Humpback whale (*Megaptera novaeangliae*)

Sightings data show that humpback whales traverse coastal waters from the northeastern to the southeastern U.S. They can also be found farther offshore, including the Study Area (Waring et al. 2011). Reports of humpback whale sightings off Delaware Bay and Chesapeake Bay during the winter suggest that the Mid-Atlantic region, including the western portion of the Study Area, may serve as wintering grounds for this species (Swingle et al. 1993; Barco et al. 2002). OBIS logged four sightings of humpback whales within the Study Area. The most recent sighting is from 2006 and was recorded by the NEFSC Right Whale Survey.

1.7.3 Minke whale (*Balaenoptera acutorostrata*)

The minke whale is among the most widely distributed and most abundant of the baleen whales (Carwardine 1998). The OBIS database reports several sightings of the minke whale along the western edge of the Study Area. The sightings increase toward the northwest, in an area identified as the year-round feeding and mating grounds for the North Atlantic right whale located in the waters off New England. In 1980, OBIS reported three sightings of the minke whale within the Study Area.

1.7.4 North Atlantic right whale (*Eubalaena glacialis*)

Research results suggest the existence of six major congregation areas for the North Atlantic right whale: the coastal waters of the southeastern U.S., the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf (Waring et al. 2011). Movements of individuals within and between these congregation areas are extensive, and data show distant excursions, including into deep water off the continental shelf (Mate, Nieukirk, and Kraus 1997; Baumgartner and Mate 2005). Congregations in U.S. eastern seaboard waters are recorded west of the Study Area; however, movements of the North Atlantic right whale could result in their presence within the Study Area. In addition, year-round feeding and mating grounds exist for the North Atlantic right whale located in the waters off New England. The area overlaps the north section of the Study Area. While the OBIS database makes reference to hundreds of sightings in the vicinity of the Study Area, mainly along the continental shelf, along the western boundary edge of the Study Area, and in the year-round feeding and mating grounds, the OBIS database does not report any sightings within the borders of the Study Area. Overall, the range and seasonal distribution of North Atlantic right whales (particularly males) is not fully understood at this time.

1.7.5 Blue whale (*Balaenoptera musculus*)

Blue whales are only considered "occasional visitors" within U.S. EEZ waters (Waring et al. 2010). However, this species has been acoustically recorded in the deep offshore waters east of the U.S. EEZ (Clark 1995). The OBIS database reports only one blue whale observation within the Study Area boundary, which was recorded in 1969. Blue whales are considered rare within the Study Area due to the lack of observations within the area, their overall sparse existence within the region, and their preference for the colder waters of Canada (Waring et al. 2013).

1.7.6 Bryde's whale (*Balaenoptera edeni/brydei*)

There is no known U.S. management population of Bryde's whale in the U.S. western North Atlantic waters. The seasonal distribution of this whale is not well known (Reilly et al. 2008). The species generally prefers sub-tropical to tropical and warm temperate waters. The northern extent of its range is ~40°N (NOAA Fisheries Service, Office of Protected Resources [NOAA Fisheries OPR] 2012a). There are no OBIS sightings reported within the Study Area or its surrounding waters. Bryde's whales are considered rare within the waters of the Study Area.

1.7.7 Sei whale (*Balaenoptera borealis*)

Sei whales are typically associated with steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges where prey is concentrated (Kenney and Winn 1987; Schiling et al. 1992; Best and Lockyer 2002). The range of this highly migratory species includes the continental shelf waters of the northeastern U.S. and extends to south of Newfoundland (Jefferson et al. 2008). Sei whales are not common in U.S. Atlantic waters (NMFS 2012); however, OBIS reports six sightings of the sei whale within the Study Area. The most recent sightings occurred in June 2001 and October 2006, both of which were recorded during the NEFSC Right Whale Survey.

1.8 Odontocetes

1.8.1 Atlantic White-sided Dolphin (*Lagenorhynchus acutus)*

The Atlantic white-sided dolphin has thousands of recorded sightings in the OBIS database. The sightings occur in coastal, shelf and slope waters, with the majority occurring on the shelf north of the Study Area. Within the Study Area boundaries, ten sightings of this species are recorded in the OBIS database. Nine of those sightings were from the late 1970s and early 1980s, and one sighting was reported in 2002 during the NEFSC Right Whale Survey.

1.8.2 **Atlantic Spotted Dolphin (*Stenella frontalis*)**

Within the Study Area, OBIS records indicate that eight Atlantic spotted dolphins have been sighted. The sightings were divided between mid- and base-slope waters. Four were observed in 1998 during the NEFSC survey. The other four were observed in 2004 during the NEFSC Mid-Atlantic Marine Mammal Abundance Survey.

1.8.3 **Bottlenose Dolphin (*Tursiops truncatus*)**

Within the western North Atlantic stock of bottlenose dolphin, at least six genetically distinct stocks are distributed from southern Long Island, New York, to central Florida (NOAA Fisheries OPR 2013a). These are further divided into two morphotypes: coastal and offshore (Waring et al. 2006). Those bottlenose dolphins expected to occur within the Study Area would primarily be from the offshore morphotype. The offshore morphotype is primarily found along the outer continental shelf and continental slope in the western North Atlantic (Waring et al. 2006). OBIS sightings are in the thousands for the bottlenose dolphin in coastal and shelf, slope and abyssal waters. Approximately 100 sightings of this species (likely consisting of the offshore morphotype) in the Study Area have been recorded.

As a note, the bottlenose dolphin population most recently affected by the 2013 Unusual Mortality Event (UME) along the U.S. Mid-Atlantic states was likely primarily that of the coastal morphotype. Due to the preference of the offshore morphotype for deeper continental shelf and slope waters, it is not expected that this population was affected by the UME.

1.8.4 **Long-Finned Pilot Whale (*Globicephala melas*)**

The long-finned pilot whale is considered uncommon in the mid-Atlantic waters, including the Study Area. While the species prefers deep pelagic waters in temperate and sub-polar climates (NOAA Fisheries OPR 2012b), there are only five OBIS sightings of this species within the Study Area boundary. Three of those five sightings occurred in the 1980s. The OBIS database has hundreds of sightings of this species along the shelf and coastal waters of the U.S. and Canada.

1.8.5 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

Similar to the long-finned pilot whale, the short-finned pilot whale is considered uncommon in mid-Atlantic waters, including the Study Area. This species also prefers deeper waters; however, it differs from the long-finned pilot whale in that it prefers warmer temperate and tropical waters (NOAA Fisheries OPR 2012c). While no OBIS sightings of this species within the Study Area are recorded, OBIS has records of 18 sightings of this species, all of which occurred since 2004. The sightings primarily occurred along the continental shelf break.

1.8.6 Pantropical Spotted Dolphin (*Stenella attenuata*)

This species is known to occur over deeper waters (Waring et al. 2009). There are six OBIS sightings of the pantropical spotted dolphin within the Study Area. Three occurred in shelf and slope waters, one in slopes waters, one at the base of the slope, and one in abyssal depths of 5000 meters. The latter was observed in 2005 during the Sargasso 2005 cetacean sightings survey.

1.8.7 Risso's Dolphin (*Grampus griseus*)

The Risso's dolphin is considered common within the Study Area. The OBIS database has over 100 sightings of this species within the boundaries, and thousands along adjacent coastal, shelf and slope waters. Many of the sightings occur in the shelf and slope waters, nine sightings occurred in the deeper waters, in isobaths of 4,400 meters.

1.8.8 Shorted-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin is considered common within the Study Area and surrounding waters. Within the Study Area, the OBIS database reports 83 sightings. Four studies have reported sightings since the year 2000. The NEFSC Right Whale Survey recorded 14 sightings in 2001 and four sightings in 2002. Also in 2001, the Canada Maritime Regional Cetacean Sightings identified one short-beaked common dolphin. Lastly, in 2004 the NEFSC Mid-Atlantic Marine Mammal Abundance Survey reported observing eight of these species.

1.8.9 Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin prefers oceanic and deep warm temperate and tropical waters (NOAA Fisheries OPR 2012d). OBIS records indicate approximately 75 sightings of the striped dolphin within the Study Area, nearly all occurring along the shelf and slope waters in the north and west extent.

1.8.10 Sperm Whale (*Physeter macrocephalus*)

The sperm whale is the most commonly occurring odontocete species within the Study Area and in the adjacent waters. The sperm whale spends summer months in the Mid-Atlantic Bight off the Eastern U.S. coast from Virginia to Massachusetts (Reeves et al. 2002; Palka 2006). Hundreds of OBIS sightings of the sperm whale place them primarily in shelf and slope waters of the northeast U.S. and Nova Scotia. Sperm whales can be found in groups that consist of 20 to 40 animals, including adult females, their calves, and juveniles (Waring et al. 2006). The OBIS also recorded several sightings at abyssal depths of 5,000 meters. Within the Study Area, greater than 300 OBIS sightings of the sperm whale have been recorded, with the majority occurring in the slope waters in the northern and western extent. Sperm whales tend to be found in association with frontal systems, canyon, slope, and seamount features within the region. The survey plan minimizes encroachment of such areas.

1.8.11 Killer whale (*Orcinus orca*)

The killer whale is a very rare species within the western North Atlantic Ocean. There are four recorded sightings of this species within the Study Area. All four sightings occurred during the CeTAP survey. One sighting occurred in 1978, one in 1980, and the remaining two occurred in 1981. The species is considered rare within the Study Area.

1.8.12 Clymene Dolphin (*Stenella clymene*)

The Clymene dolphin is a rare species within the western North Atlantic Ocean. The species prefers deep, warm temperate, tropical and sub-tropical waters within the Atlantic Ocean (NOAA Fisheries OPR 2012e). There are only seven sightings in shelf and slope waters in southern

U.S. waters. There are no OBIS sightings for the Clymene dolphin within the Study Area. This species is considered rare within the Study Area.

1.8.13 Spinner Dolphin (*Stenella longirostris*)

The spinner dolphin is a rare species within the western North Atlantic Ocean. The species prefers deep ocean waters within the Atlantic Ocean (NOAA Fisheries OPR 2012f). The OBIS database only has one sighting record of the spinner dolphin within the Study Area. The sighting occurred in 1997, during a CeTAP vessel survey. Other sightings in adjacent waters occurred in the slopes west of the Study Area. The species is considered rare within the Study Area.

1.8.14 Rough-Toothed Dolphin (*Steno bredanensis*)

The rough-toothed dolphin prefers deep ocean warm temperate and tropical waters within the western North Atlantic Ocean. Observations of this species offshore the East Coast of the U.S. are rare (NOAA Fisheries OPR 2012g). Within the Study Area, there are two OBIS sightings of the rough-toothed dolphin. One observation occurred near the shelf edge in slope waters during the 1998 NEFSC Survey. The other observation occurred near the base of the slope in 1979 during the CeTAP vessel survey. The species is considered rare within the Study Area.

1.8.15 Fraser's Dolphin (*Lagenodelphis hosei*)

The Fraser's dolphin prefers deep ocean waters, primarily deeper than 1,000 meters (NOAA Fisheries OPR 2012h). The overall number of sightings of this species in the western North Atlantic Ocean is low. There are no OBIS sightings of the Fraser's dolphin within the Study Area and only one OBIS sighting in the waters adjacent to its boundaries. This dolphin species was observed near the western boundary of the Study Area and is considered rare within the Study Area.

1.8.16 Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise is primarily a coastal species, preferring waters less than 200 meters deep (NOAA Fisheries OPR 2013b). The OBIS database has records for thousands of sightings of the harbor porpoise in the coastal and shelf waters around the Gulf of Maine. Within the Study Area, only three sightings have been reported. Two observations occurred in the slope waters near the northern extent of the Study Area, and one at abyssal depth of 5,000 meters. The third observation was recorded in 1978 during the Programme Integre de recherches sur les oiseaux pelagiques Northwest Atlantic survey. The species is considered rare within the Study Area.

1.8.17 False Killer Whale (*Pseudorca crassidens*)

The false killer whale does not have a U.S.-managed population in the western North Atlantic Ocean, yet the species can be found sparingly offshore of the Mid-Atlantic states, primarily in waters deeper than 1,000 meters (NOAA Fisheries OPR 2013c). There are only 11 OBIS sightings of this species off the U.S. coast with two occurring within the Study Area; one was recorded in 1971, with the other two occurring in 1997. The false killer whale is considered rare within the Study Area and adjacent waters.

1.8.18 **Pygmy Killer Whale (*Feresa attenuata*)**

The pygmy killer whale is rare within the western North Atlantic Ocean. The species is found primarily in deeper tropical and sub-tropical waters (NOAA Fisheries OPR 2012i). There is only one OBIS sighting of the pygmy killer whale in the Study Area. It was observed in 1981 during the CeTAP aerial survey. Two other OBIS sightings were recorded along the shelf-waters, near the Study Area. The pygmy killer whale is considered rare with the Study Area.

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

Both the dwarf and pygmy sperm whale are most commonly found over the continental shelf edge and slope (NOAA Fisheries OPR 2012j, 2012k). Considered rare in the Mid-Atlantic region, the pygmy sperm whale has no OBIS-recorded sightings within the Study Area. However, three sightings have been recorded in the slope waters near the Study Area. One sighting was recorded in 2004 during the NEFSC Mid-Atlantic Marine Mammal Abundance Survey, and the two other sightings were recorded in 1998 during the NEFSC Survey. Similar to the pygmy sperm whale, the dwarf sperm whale is also considered rare in the Mid-Atlantic region, including in the Study Area. There are only two sightings recorded in the OBIS database. One sighting occurred in 2004 during the NEFSC Mid-Atlantic Marine Mammal Abundance Survey. The other sighting occurred in 1998 during the NEFSC Survey. Both species are considered rare within the Study Area.

1.8.20 Melon-Headed Whale (*Peponocephala electra*)

The melon-headed whale prefers warm, deeper, tropical waters (NOAA Fisheries OPR 2012l). The melon-headed whale is considered rare within the Study Area and in all adjacent waters. While no OBIS sightings within the Study Area have been recorded, one sighting was recorded near the southeastern extent of its boundary. This sighting occurred during the Sargasso 2005 cetacean sightings survey. This species is considered rare within the Study Area

1.8.21 Sowerby's Beaked Whale (*Mesoplodon bidens*)

The Sowerby's beaked whale prefers deep, cold temperate waters within the western North Atlantic (NOAA Fisheries OPR 2012m). During surveys (both aerial and vessel), the various *Mesoplodon* species are difficult to differentiate. OBIS reports eight sightings of the Sowerby's beaked whale within the Study Area. Six have occurred along the shelf with the other two being in the slope waters. The species is considered rare within the Study Area.

1.8.22 Blainville's Beaked Whale (*Mesoplodon densirostris*)

The Blainville's beaked whale is known to occur in deep, offshore waters spanning from tropical to temperate (NOAA Fisheries OPR 2012n). Similar to the Sowerby's beaked whale, the Blainville's beaked whale is difficult to discern from other *Mesoplodon* species during both aerial and vessel surveys. The OBIS data report only one sighting of the Blainville's beaked whale, recorded in 2004 during the NEFSC Mid-Atlantic Marine Mammal Abundance Survey. A second sighting near the northeast extent of the Study Area was logged in 1995 by the NEFSC. The species is considered rare within the Study Area.

1.8.23 Gervais' Beaked Whale (*Mesoplodon europaeus*)

The Gervais' beaked whale can primarily be found in deep warm temperate, tropical, and sub-tropical waters (NOAA Fisheries OPR 2012o). Similar to the Sowerby's beaked whale, the Gervais' beaked whale is difficult to discern from other *Mesoplodon* species during both aerial and vessel surveys. No OBIS sightings of the Gervais' beaked whale within the Study Area or in any adjacent waters have been recorded. This species is considered rare within the Study Area.

1.8.24 True's Beaked Whale (*Mesoplodon mirus*)

The True's beaked whale can primarily be found in deeper, warm temperate waters in the western North Atlantic Ocean (NOAA Fisheries OPR 2012p). Similar to the Sowerby's beaked whale, the True's beaked whale is difficult to discern from other *Mesoplodon* species during both aerial and vessel surveys. The OBIS database does not have any records for sightings of the True's beaked whale within the Study Area. However, of the 20 OBIS sightings for this species, two exist in the waters adjacent to the northwest boundary line of the Study Area. During the NEFSC 1995 survey, one True's beaked whale was spotted along the shelf edge. In 2003, during the Virginia Aquarium Marine Mammal Strandings 1998-2008, the second was reported stranded near approximately 76°N, 37°W. Survey details do not report on the type of stranding. This species is considered rare within the Study Area.

1.8.25 Cuvier's Beaked Whale (*Ziphius cavirostris*)

The Cuvier's beaked whale in can be found in temperate, tropical, and sub-tropical waters. Primarily, this species prefers deeper pelagic waters, being found in water depths greater than 1,000 meters (NOAA Fisheries OPR, 2012q). Of all the beaked whales, the Cuvier's was the most commonly recorded in the OBIS database. The recorded sightings occurred in the shelf and slope waters adjacent to and within the Study Area. The 15 sightings within the Study Area occurred mostly in the slope waters in the northwest portion. While more common than the other beaked whale species, the Cuvier's beaked whale is considered rare within the Study Area.

1.8.26 Northern Bottlenose Whale (*Hyperoodon ampullatus*)

The northern bottlenose whale is considered extremely uncommon/rare within U.S. western North Atlantic Ocean waters. This species prefers cold, deep waters (greater than 2,000 meters), primarily within the temperate to sub-arctic region (NOAA Fisheries OPR 2012r). Only one sighting of this species is in the OBIS database. The observation occurred in 2006 during the NEFSC Right Whale Survey. The northern bottlenose whale is considered rare within the Study Area and adjacent waters.

1.9 **Pinnipeds**

1.9.1 **Harbor seal (*Phoca vitulina*)**

The harbor seal is considered rare outside of their coastal habitat in the U.S. western North Atlantic Ocean waters. This species prefers temperate coastal habitats, using rock, reefs, beach, or drifting ice on which to haul out. During summer months, this species can primarily occur in the nearshore waters of the Gulf of Maine and into Canadian waters (Waring et al. 2013). Two aerial sightings of this species were recorded offshore Cape Cod, Massachusetts around the 100-meter isobath. No sightings of harbor seals within or adjacent to the Study Area are recorded in the OBIS database. The harbor seal is considered rare within the Study Area and adjacent waters.

1.9.2 Gray seal (*Halichoerus grypus*)

The gray seal is considered rare outside of their coastal habitat in the U.S. western North Atlantic Ocean waters. This species prefers cold water coastal habitats, using rocks, sandbars and icebergs to haul out on. During summer months, this species can primarily be found in the nearshore waters of the Gulf of Maine and into Canadian waters (Waring et al. 2013). No sightings of gray seals within or adjacent to the Study Area are recorded in the OBIS database. The gray seal is considered rare within the Study Area and adjacent waters.

1.9.3 Harp Seal (*Pagophilus groenlandicus*)

The harp seal is considered rare outside its cold water habitat in the North Atlantic, and can be found primarily in the pack ice in the North Atlantic Ocean. During summer months, the harp seal can be found at its Arctic summer feeding grounds. No sightings of harp seals within or adjacent to the Study Area are recorded in the OBIS database. The harp seal is considered rare within the Study Area and adjacent waters.

1.9.4 Hooded seal (*Cystophora cristata*)

The hooded seal is considered rare outside its cold weather habitat. While this species can be found in deep waters, they are primarily found among pack ice. The species has been observed as far south as the Florida and the Caribbean; however, this is unusual as the species survives best in cold water habitats (NOAA Fisheries OPR 2012s). No sightings of hooded seals within or adjacent to the Study Area are recorded in the OBIS database. The hooded seal is considered rare within the Study Area and adjacent waters.

V. TYPE OF AUTHORIZATION REQUESTED

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

The USGS requests an IHA pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) for incidental take by harassment during its planned seismic surveys in the western North Atlantic Ocean during late August and early September, 2014.

The operations outlined in Section I have the potential to take marine mammals by harassment. Sounds will be generated by the airguns used during the survey, by the echosounder and sub-bottom profiler, and by general vessel operations. “Takes” by harassment potentially could result when marine mammals near the activities are exposed to the pulsed sounds generated by the seismic sources. The effects will depend on the species of cetacean, the behavior of the animals at the time of reception of the stimulus, and received level of the sound (see Section VII). The proposed survey activities may result in disturbance reactions from any marine mammals within proximity to the source vessel. Based on the planned operations and mitigation measures (see Section XI), no serious injury to any marine mammals is expected, and no lethal takes are expected.

VI. NUMBERS OF MARINE MAMMALS THAT COULD BE TAKEN

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

The materials for Sections VI and Section VII are combined and presented in reverse order to minimize duplication among sections.

VII. POTENTIAL IMPACT ON SPECIES OR STOCKS

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

The materials for Section VI and Section VII are combined and presented in reverse order to minimize duplication between sections:

- A summary of potential impacts on marine mammals from airgun operations is presented first, as required for Section VII. A more comprehensive review of the relevant background information is included in the PEIS in Sections 3.6.4.3, 3.7.4.3, and 3.8.4.3, and in Appendix E.
- The estimated numbers of marine mammals that could be affected by the proposed survey in the U.S. ECS region off the Atlantic Seaboard during late August and early September, 2014are presented. This section includes a description of the rationale for the USGS's estimates of the potential numbers of harassment "takes" during the planned survey, as required in Section VI.

1.10 Summary of Potential Effects of Airgun Sounds

Airguns have the potential to affect marine mammals in a number of ways, including tolerance, masking (of natural sounds including inter- and intra-specific calls), behavioral disturbance, and physiological responses such as temporary or permanent hearing impairment or other non-auditory effects (Richardson et al.1995; Nowacek et al. 2007; Southall et al. 2007; Wright et al. 2007; Tyack 2009). Physiological impacts, such as permanent threshold shift (PTS) (which could be considered an injurious event) and temporary threshold shift (TTS) (which is not considered an injurious event) could occur as a result of airgun operations (Southall et al. 2007). However, neither physiological impact is expected to occur during the proposed survey due to use of mitigation measures (described below). While the potential for PTS and TTS cannot be entirely excluded, it is highly unlikely (as summarized in the PEIS in Sections 3.6.7, 3.7.7, and 3.8.7) that this auditory impairment would occur as a result of the proposed 2014 survey. It is also highly unlikely that other non-auditory physiological or physical effects would occur as a result of the proposed survey. It is more likely that, should a marine mammal come within proximity to the proposed survey while the seismic airguns are operating, some behavioral disturbance could occur. However, this disturbance is expected to be short-term and localized. Monitoring and mitigation protocols will reduce any potential impacts to marine mammals. As a result of these protocols, it is anticipated that no marine mammals will be exposed to survey sounds that could cause behavioral disturbance.

1.10.1 Tolerance

Tolerance occurs when animals, often within areas commonly exposed to human-generated noise, do not appear to display a response to these human-generated sounds (Richardson et al. 1995). The pulsed sounds from airguns are known to be detectable in the water up to thousands of kilometers away from the source (Nieukirk et al. 2004). Numerous studies have been conducted on the reaction of marine mammals to seismic airgun pulses. Responses vary as marine mammals have been found to both tolerate the noise and to avoid the noise, indicating that response to noise may be related to individual species. Some studies have reported that marine mammals located a few kilometers from the seismic source have shown no apparent reaction to the noise, while other studies report behavioral reactions such as avoidance in both baleen whales and toothed whales (specifically sperm whales) (Malme et al. 1985; Richardson, Würsig, and Greene 1986; Ljungblad et al. 1988; McCauley et al. 2000a). Although individual baleen and toothed whales, as well as (less frequently) pinnipeds, have shown to exhibit behavioral reactions to airgun pulses at certain times, at other times, all three types of marine mammals have exhibited no obvious response. The relative responses of individual baleen whales, toothed whales, and pinnipeds are expected to be quite variable and depend on factors such as species, age, and previous exposures of the animal to human-generated sound.

1.10.2 Masking

Masking occurs when human-generated sounds interfere or obscure the ability of a marine mammal to detect sound signals they would otherwise receive (Richardson et al. 1995). The number of studies specific to the masking effects of pulsed sounds on marine mammal calls is limited. It is expected that those marine mammal species that could potentially be affected by masking may still be able to receive and emit sounds during the relatively quiet periods between the airgun pulses (Simard 2005; Clark and Gagnon 2006). Some baleen whales have been reported to cease calling due to the presence of pulsed sounds; however, other studies have reported that some baleen have increased the consistency of calls to compensate for presence of pulsed sounds (Clark and Gagnon 2006; Di Iorio and Clark 2010). Other studies have reported that whales have continued calling in the presence of seismic activity (Nieukirk et al. 2004; Richardson et al. 1986; Madsen et al. 2002). Small odontocetes predominantly rely on sounds within the higher frequencies. These frequencies are much higher than the dominant frequencies produced by seismic airguns, thereby limiting the potential for masking related to these species. Due to the intermittent nature of seismic airgun pulses, the relatively short timeframe of the proposed 2014 survey, and the large area to be covered during the proposed 2014 survey (reducing repeated seismic pulses within a small area as is common of seismic surveys), it is expected that masking effect from the seismic pulses will be minor.

1.10.3 Disturbance Reactions

Disturbance effects can be expressed in a variety of ways including both obvious and more subtle reactions. These behavioral disturbance reactions can include (but are not limited to) flight response, changes in diving patters, foraging, and breathing, and avoidance or displacement (Tyack 2009; Nowacek et al. 2007). Temporary exposure and the potential brief reactions to that exposure are not expected to result in any significant disruption to behavioral patterns and will not result in harassment or "taking" (NMFS 2001; National Research Council 2005; Southall et al. 2007). The proposed 2014 survey is not expected to result in any permanent effects to any individuals or populations.

Reactions to sound, if any, depend on the 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). If a marine mammal reacts to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (Lusseau and Bejder 2007; Weilgart 2007). Currently, the majority of research and information regarding effects of seismic surveys is focused on individual animals and little information exists regarding effects at the population or community level.

Given the many uncertainties in predicting the quantity and types of impacts of sound on marine mammals, it is common practice to estimate how many mammals would be present within a particular distance of human activities and/or exposed to a particular level of anthropogenic sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically important manner. One of the reasons for this is that the selected distances/isopleths are based on limited studies indicating that some animals exhibited short-term reactions at that specific distance or sound level. The exposure calculations then assume that all animals exposed to this level would react in a biologically significant manner, similar to the few species that were observed exhibiting a reaction at that time.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically significant degree by seismic survey activities are primarily based on behavioral observations of a few species. Detailed studies have been done on humpback, gray, bowhead, and sperm whales, and on ringed seals. 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 often are 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. Overall, the largest avoidance radii recorded (20 to 30 kilometers) for a reaction to seismic airguns involved migrating bowhead whales (Miller et al. 1999; Richardson et al. 1995). 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, still 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 also has been discussion of effects on the Brazilian wintering grounds. During full-scale seismic surveys off Western Australia, avoidance reactions were reported to begin at 5 to 8 kilometers away from the full airgun array and 2 kilometers away from the single airgun. Traveling pods of humpback whales generally remained approximately 3 to 4 kilometers away from the active survey, and more sensitive resting pods of cow-calf pairs maintained an avoidance distance of 7 to 12 kilometers. However, some individual humpback whales, especially males, approached within distances of 100 to 400 meters (McCauley et al. 1998, 2000b).

On summer feeding grounds in southeast Alaska, humpback whales did not exhibit persistent avoidance when exposed to seismic pulses, although some humpback whales did exhibit a “startle” response (Malme et al. 1985). It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even may strand upon exposure to seismic surveys; however, these data were more circumstantial and subject to other explanations (International Association of Geophysical Contractors 2004). Data from subsequent years indicated that no observable direct correlation between strandings and seismic surveys existed.

Currently, there are no data on reactions of *right whales* to seismic surveys. However, results from studies conducted of the closely related *bowhead whale* indicate that responses of this whale can be variable, depending on their activity (migrating vs. feeding). While at summer feeding grounds, bowhead whales showed no reactions to seismic surveys being conducted between 6 and 99 kilometers away (Richardson et al. 1986). More recent studies also indicate that feeding bowhead whales are more tolerant of higher sound levels. Migrating bowhead whales, on the other hand, appear to be more sensitive and responsive to pulsed seismic sounds. Bowhead whale migrating in the Alaskan Beaufort Sea generally show substantial avoidance of seismic surveys (Miller et al. 1999; Richardson et al. 1995).

Reactions of feeding and migrating (not wintering) *gray whales* to seismic sounds also have been studied. In the Bering Sea (off St. Lawrence Island), 50 percent of feeding gray whales were reported to have stopped feeding at received sound pressure levels of 173 dB re 1 μPa on an (approximate) RMS basis, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa_{RMS} (Malme et al. 1986, 1988). These findings were generally consistent with the results of studies conducted on larger numbers of gray whales migrating off California and western Pacific gray whales feeding off Sakhalin, Russia.

Studies have not been conducted on other *Balaenoptera* species (i.e., blue, sei, fin, and minke whales); however, these species occasionally have been observed in ensonified areas during various seismic surveys. Observations made during seismic surveys off the United Kingdom between 1997 and 2000 indicate that mysticetes (mainly fin and sei whales) were sighted at a similar rate while large seismic arrays were operating and while they were silent (Stone 2003;

Stone and Tasker 2006). Localized avoidance also was observed during this time. Fin/sei whales also have been reported to spend less time submerged during periods when seismic arrays were firing compared to times when silent.

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. Whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years is unknown. 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. Bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably

Toothed whales. Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales (i.e., Gordon et al. 2006; Madsen et al. 2006). There is also an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (i.e., Stone 2003; Smultea et al. 2004; Stone and Tasker 2006). 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 (Richardson et al. 2009; Barkaszi, Epperson, and Bennett 2009). In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 kilometer or less, and some individuals show no apparent avoidance. Based on observations from active seismic surveys off the United Kingdom, small odontocetes exhibited greater avoidance to operating airguns than previously reported (Stone et al. 2003; Gordon et al. 2004; Stone and Tasker 2006). The observer data also indicated that small odontocetes were feeding less and were interacting with the vessel less during activity seismic surveys. 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 (Finneran et al. 2000, 2002, 2005). However, overall, the animals tolerated high, received levels of sound before exhibiting aversive behaviors. Porpoises, like delphinids, show variable reactions to seismic operations, and reactions apparently depend on species. Harbor porpoises have been reported to show stronger avoidance to seismic operations than Dall's porpoises (Stone 2003; MacLean and Koski 2005; Bain and Williams 2006).

Studies of all three species of sperm whale reported that they show avoidance reactions in general to vessels not operating seismic airguns (Richardson et al. 1995; Würsig et al. 1998; Baird 2005). In studies where sperm whales were exposed to seismic airguns, the species response indicates considerable tolerance to the airgun noise. The whales generally do not show strong avoidance, and they continue to call. Research does indicate; however, that diving and foraging behaviors can be altered upon exposure to airgun sound (Jochens et al. 2008; Miller et al. 2009; Tyack 2009). Specific data on the behavioral reactions of *beaked whales* to seismic surveys is almost non-existent; the majority of information regarding beaked whales is in connection with military sonar events. Most beaked whales are illusive and tend to avoid approaching vessels of other types (Würsig et al. 1998). The species may dive for an extended period when approached by a vessel. However, based on both visual and acoustic observations, 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. Most beaked whales would likely show strong avoidance of an approaching seismic vessel, as they would with any other vessel, although this has not been specifically documented.

Overall, 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. Based on available data, ≥170 dB re 1 μPa_{RMS} disturbance criterion (rather than ≥160 dB re 1 μPa_{RMS}) would be appropriate for delphinids. This is based on reaction distances for delphinids being more consistent with the 170 dB re 1 μPa_{RMS} radius, and delphinids being less responsive than other more responsive cetaceans.

Pinnipeds. Information on the reactions of pinniped species to pulsed seismic airgun sounds is limited. Based on early observations, pinnipeds appear to be quite tolerant of pulsed sounds. Other reports indicate that pinnipeds were tolerant of loud, pulsed sounds when they were strongly attracted to an area for feeding or reproductive purposes (Mate and Harvey 1987; Reeves et al. 1996). In more recent studies, avoidance of pinnipeds during seismic surveys has been reported as being relatively small, within 100 to a few hundred meters. Many seals remained within 100 to 200 meters of the survey track lines while an operating seismic survey passed (Moulton and Lawson 2002). Other observations made during seismic surveys in the Chuckchi and Beaufort Seas reported that pinnipeds were observed less when the seismic airguns were operating than when they were silent (Miller et al. 2005). Overall, behavioral reactions from pinnipeds to pulsed seismic sounds are variable. It is expected that localized avoidance of operating seismic airguns may occur; however, it cannot be guaranteed that these species would fully avoid an operating seismic vessel during active surveys.

1.10.4 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 (Southall et al. 2007). However, neither specific occurrences of TTS nor permanent hearing damage (i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions) have been documented. 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 (shutdown) zones planned for the proposed seismic survey. However, those criteria were established before any information about minimum received levels of sounds necessary to cause auditory impairment in marine mammals existed.

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 have not, as of late 2013, been formally adopted by the NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys. However, some aspects of the recommendations have been considered in certain EISs and small take authorizations under the MMPA. The NMFS has indicated that they may soon issue new noise exposure criteria for marine mammals that account for the now-available scientific data on TTS, the expected offset between the TTS and PTS thresholds, differences in the acoustic frequencies to which different marine mammal groups are sensitive, and other relevant factors.

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 have the potential, to cause hearing impairment (see Sections XI and XIII). Also, many cetaceans and (to a limited degree) pinnipeds show some avoidance of the area where received levels of airgun sounds 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. Appendix E of the PEIS provides a thorough review of the current knowledge available regarding TTS, PTS, and strandings and mortalities for marine mammals and seismic surveys.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater, pulsed sound. These non-auditory physiological effects or injuries could include stress, neurological effects, gas bubble formation in the blood or tissues, 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 pulsed sounds. This is likely due to the deep-diving behavior of these species, which could result in a situation similar to “the bends” in humans if the animals are disturbed at depth and rise too quickly to the surface. However, no specific evidence exists regarding the potential for non-auditory effects to occur as a result of seismic surveys. Any effects resulting from the proposed seismic survey are expected to be limited to behavioral avoidance of the seismic vessel, as this reaction appears the most common among most baleen whales, some toothed whales, and some pinnipeds. Therefore, those animals avoiding the seismic survey vessel would be even less likely to incur auditory or non-auditory physical effects. The planned monitoring and mitigation, along with the brief duration of exposure expected, and the deep water environment of the Study Area, would all further reduce the potential for marine mammals to be exposed to pulsed sounds strong enough to cause non-auditory physical effects.

1.10.5 Potential Effects of Multibeam Echosounder and Sub-bottom Profiler Signals

The PEIS included a comprehensive review of potential affects from both MBESs and SBPs (see Sections 3.6.4.3; 3.7.4.3; 3.8.4.3; and Appendix E). The PEIS concluded that the operation of MBESs and SBPs is unlikely to impact odontocetes, mysticetes, or pinnipeds because the intermittent and narrow, downward-directed nature of both acoustic sources would result in no more than one or two brief pinging exposures of any individual animal, due to the movement and speed of the survey vessel.

1.11 Number of Marine Mammals that could be Exposed to 160 dB re 1μPA$_{RMS}$

All anticipated takes would be “takes by harassment” of small numbers of marine mammals and are expected to involve only temporary changes in behavior. No injury is expected to result from the proposed 2014 survey due to the proposed mitigation measures discussed below in Section XI. The methods used to estimate the number of marine mammals that could be affected during the proposed survey are described below. In general, the estimates are based on the consideration of the number of marine mammals that could be disturbed by the sounds resulting from the 36-airgun array during the approximately 3,165 kilometers of proposed 2014 survey lines in the U.S. ECS region of the Atlantic seaboard. The sources of data used to determine the “take” estimates are described below.

It is assumed that the airgun array and other sound sources (i.e., MBESs and SBPs) will be operated simultaneously. Therefore, any marine mammal close enough to be affected by an MBES or an SBP would already be affected by the airguns. However, even if the airguns are not operating simultaneously with the other sound sources, as stated earlier, marine mammals are not expected to exhibit anything more than short-term and negligible responses to the MBES and the SBP given the characteristics of the sound (i.e., narrow-downward directed beam) and other considerations as described in Sections 3.6.4.3; 3.7.4.3, 3.8.4.3, and Appendix E of the PEIS. Such reactions, as those expected from an MBES and an SBP alone are not considered to constitute a “taking” (NMFS 2001). Therefore, the “take” estimates described below do not take into account any additional allowance to include any marine mammals that could be affected by sound sources other than airguns.

1.11.1 **Basis for Estimating Exposure**

Incidental takes were estimated for each species by estimating the likelihood of a marine mammal being present within the expected ensonified area during active 2-D seismic surveys. Expected marine mammal presence in the vicinity of the Study Area during the proposed summer 2014 survey are described in Section IV. Based on the location of the Study Area and the time of year of the proposed 2014 survey, up to 38 marine mammal species have the potential to occur somewhere within the Study Area. Potential exposure is estimated based on the estimated density (animals per unit area) of each species within the Study Area and the amount of area estimated to be within the 160 dB re 1μPa_{RMS} ensonified radius of the 36-airgun array (**Table 1**; **Figure 5**). The estimated 160 dB re 1μPa_{RMS} ensonified zone was determined as described in Section I.

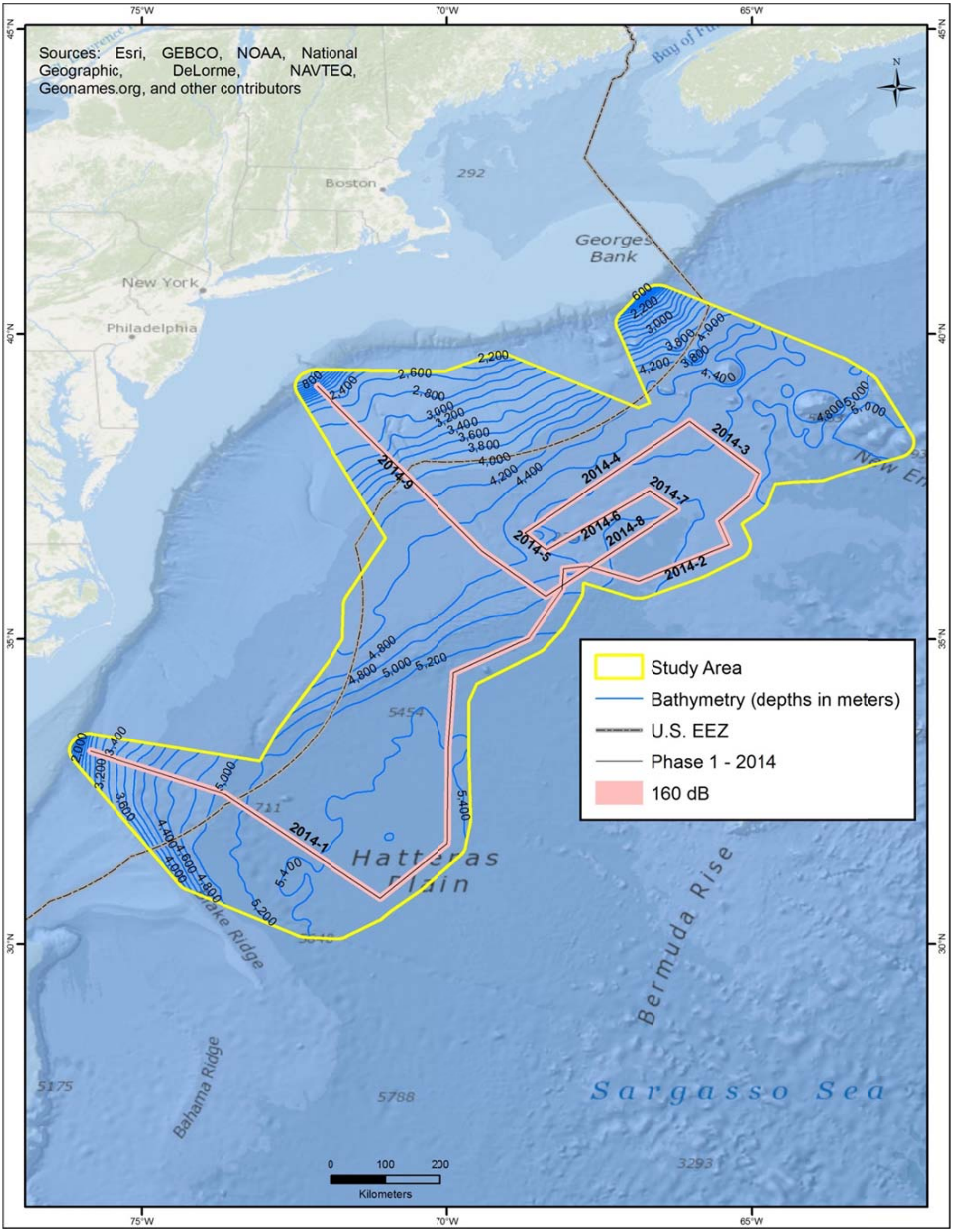


Figure 5 Proposed 2014 Survey – Ensonified Buffer

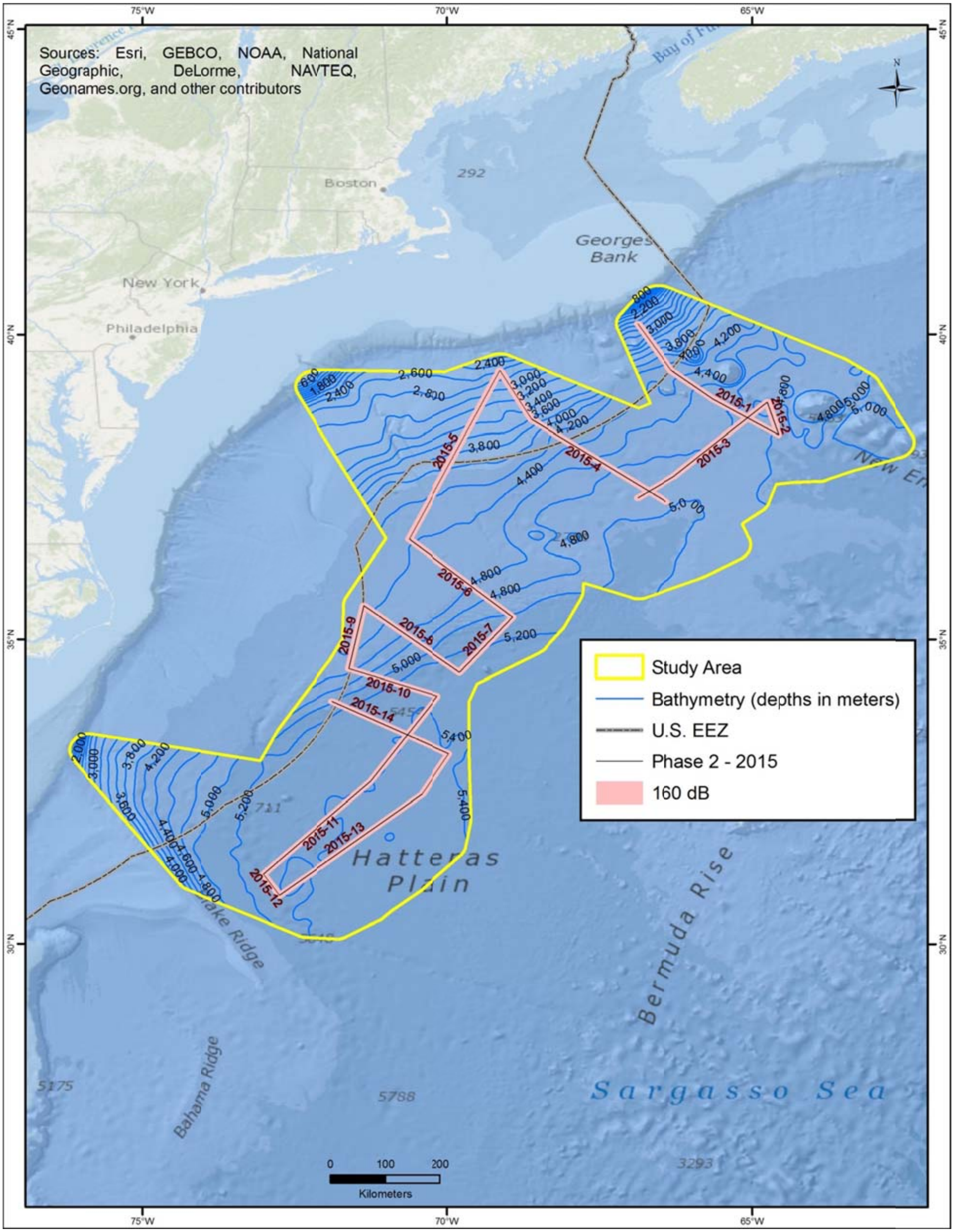


Figure 6 Proposed 2015 Survey – Ensonified Buffer

Density estimates for marine mammals within the vicinity of the Study Area are limited. Density data for species found along the East Coast of the U.S. generally extend slightly outside of the U.S. EEZ. The Study Area, however, extends well beyond the U.S. EEZ, and is well off the continental shelf break. The survey lines for the proposed 2014 survey are located in the far eastern portion of the Study Area, primarily within the area where little to no density data are currently available. It was determined that the best available information for density data (for those species where density data existed) of species located off the U.S. East Coast was housed at the Strategic Environmental and Development Program (SERDP) / National Aeronautics and Space Administration (NASA) / NOAA Marine Animal Model Mapper and OBIS-SEAMAP database. Within this database, the model outputs of all four seasons from the U.S. Department of the Navy Operating Area (OPAREA) Density Estimates (NODE) for the Northeast OPAREA and Southeast OPAREA (Department of the Navy 2007a, 2007b) were used to determine the mean density (animals per square kilometer) for 19 of the 38 marine mammals with the potential to occur within the Study Area. Those species include fin whale, minke whale, Atlantic spotted dolphin, bottlenose dolphin, long-finned and short-finned pilot whale, Pantropical spotted dolphin, Risso's dolphin, Short-beaked common dolphin, striped dolphin, sperm whale, rough-toothed dolphin, dwarf and pygmy sperm whale, and Sowerby's, Blainville's, Gervais', True's, and Cuvier's beaked whales. Model outputs for each season are available in the database. The data from the NODE summer density models, which include the months of June, July, and August, were used as the 2014 survey is proposed to take place between late August and early September. Of the seasonal NODE density models available, it is expected that the summer models are the most accurate and robust as the survey data used to create all of the models were obtained during summer months. The models for the winter, spring, and fall are derived from the data collected during the summer surveys, and therefore are expected to be less representative of actual species density during those seasons.

It should be noted that the mean density for those species was calculated based on the area within the Study Area where density data existed. The outer portion of the Study Area, where the majority of the proposed 2014 survey lines are located, was classified as "no data" in the database. Therefore, the density estimates that were used are based on species density for a portion of the Study Area. Due to the lack of more comprehensive and available data, the NODES data have been determined to be the best available data for that area. The density data likely do not extend out to the eastern portion of the Study Area as marine mammal surveys generally do not occur this far offshore. Therefore, there is a general lack of information in this region.

For those species that did not have density model outputs within the SERDP/NASA/NOAA and OBIS-SEAMAP database, or those species with density outputs that did not extend into the Study Area at all (i.e., all four pinniped species, or the sei whale), but for which OBIS sightings data within or adjacent to the Study Area exists, a *Requested Take Authorization* for the mean group size of the species is included. Mean group sizes were determined based on data reported from the CeTAP surveys (CeTAP 1982).

The estimated numbers of animals potentially exposed to sound during the proposed 2014 survey were determined using the 160 dB re 1µPa$_{RMS}$ threshold criterion for all cetaceans and pinnipeds. It is assumed that any marine mammals that are exposed to airgun sounds within this threshold could change their behavior sufficiently to be considered "taken by harassment." Table 3 shows the density estimates for each species as described above and the estimated numbers of individual marine mammals that could be exposed to ≥160 dB re 1μPa$_{RMS}$ during the active 2-D seismic survey. This estimate assumes that the individual animals do not move away from the seismic survey vessel, therefore, resulting in exposure. As stated earlier, for species for which densities were unavailable, but for which OBIS sightings within or adjacent to the Study Area exist, a *Requested Take Authorization* for the mean group size of the species is included.

It should be noted, that unlike previous USGS, NSF, and L-DEO seismic surveys aboard the *R/V Langseth*, the proposed survey will be conducted as essentially one continuous line. The survey will not be conducted in a pattern of parallel lines and will not include full turns of the vessel. Therefore, the ensonified area for the proposed survey does not include a contingency factor (typically 25%) in line-kilometers. The proposed survey also is not expected to shut down the airguns, only to power-down the airguns, should a marine mammal enter within the 160 dB re 1μPa$_{RMS}$ EZ. Given this, the ensonified area for the single mitigation gun would be much smaller than that of the full array (see Table 1). Therefore, the use of the full 160 dB re 1μPa$_{RMS}$ ensonified area for the entire 3,165 kilometers of survey lines is expected to overestimate of the actual ensonified area should the single mitigation airgun need to be used at any time. It is assumed that the estimates of the numbers of individual marine mammals that could be exposed to sounds at 160 dB re 1μPa$_{RMS}$ are overall precautionary due to the overestimated ensonified area and the estimation of species presence within the large Study Area, and are likely to overestimate the actual number of marine mammals that could be exposed. These estimates assume that there would be no weather, equipment, or mitigation delays, which is highly unlikely.

Note that although the survey track is continuous through the turns and no mitigation gun will be necessary. However, the mitigation airgun may be used in the event of minor, short duration equipment maintenance. Longer maintenance or repair periods (greater than two hours) of the seismic equipment would warrant complete shut-down of the seismic source, including the mitigation gun. The normal ramp-up procedures would be followed at the completion of these longer shut-down periods.

Table 3: Densities and Estimates of Possible Numbers of Individuals That Could be Exposed to 160 dB re 1 μPA_{RMS} During Each of Proposed Summer (June, July, August) 2014 and 2015 2-D Seismic Surveys

Species	Mean Density (#/km^2)[a]	Ensonified Area (km^2)	Calculated Take[b]	% of Regional Population[c]	Requested Level B Take Authorization
Mysticetes					
Fin Whale	0.0000610	36,600	3	0.0113	3
Humpback Whale	N/A	36,600	0	0.0259	3[d]
Minke Whale	0.0000360	36,600	2	0.0014	2
North Atlantic Right Whale	N/A	36,600	0	0.6593	3[d]
Blue Whale	N/A	36,600	0	0.2339	2[d]
Bryde's Whale	N/A	36,600	0	N/A	3[d]
Sei Whale	N/A	36,600	0	0.0291	3[d]
Odontocetes					
Atlantic White-sided Dolphin	N/A	36,600	0	0.1106	54[d]
Atlantic Spotted Dolphin	0.0288400	36,600	1056	2.3616	1056
Bottlenose Dolphin	0.0066470	36,600	244	0.3147	244
Long-Finned Pilot Whale	0.0190400	36,600	697	0.0894	697
Short-Finned Pilot Whale	0.0190400	36,600	697	0.0894	697
Pantropical Spotted Dolphin	0.0197600	36,600	724	21.7222	724
Risso's Dolphin	0.0093180	36,600	342	1.8740	342
Shorted-beaked Common Dolphin	0.0055320	36,600	203	0.1170	203
Striped Dolphin	0.1343000	36,600	4,916	8.9697	4,916
Sperm Whale	0.0022510	36,600	83	0.6293	83
Killer whale	N/A	36,600	0	N/A	7[d]
Clymene Dolphin	0.0093110	36,600	0	N/A	346
Spinner Dolphin	N/A	36,600	0	N/A	65[d]
Rough-Toothed Dolphin	0.0004260	36,600	16	5.5351	16
Fraser's Dolphin	N/A	36,600	0	N/A	100[d]
Harbor Porpoise	N/A	36,600	0	0.0010	5[d]
False Killer Whale	N/A	36,600	0	N/A	15[d]
Pygmy Killer Whale	N/A	36,600	0	N/A	25[d]
Dwarf Sperm Whale	0.0008970	36,600	33	0.8719	33
Pygmy Sperm Whale	0.0008970	36,600	33	0.8719	33
Melon-Headed Whale	N/A	36,600	0	N/A	100[d]
Sowerby's Beaked Whale	0.0022870	36,600			
Blainville's Beaked Whale	0.0022870	36,600		1.1844	
Gervais' Beaked Whale	0.0022870	36,600	84		84
True's Beaked Whale	0.0022870	36,600			
Cuvier's Beaked Whale	0.0022870	36,600		1.2860	
Northern Bottlenose Whale	N/A	36,600	0	N/A	2[d]
Pinnipeds					
Harbor seal	0	36,600	0	N/A	0
Gray seal	0	36,600	0	N/A	0
Harp seal	0	36,600	0	N/A	0
Hooded Seal	0	36,600	0	N/A	0

[a] Source: OBIS-SERDP-Navy NODE 2007a and 2007b (for those species where density data were available).
[b] Calculated take is estimated density multiplied by the 160-db ensonified area. These calculations do not include any contingency as the survey will be conducted as one continuous line.
[c] Requested takes expressed as percentages of the larger regional populations, where available; where not available (most odontocetes–see Table 2), Draft 2013 SAR population estimates were used; N/A means not available
[d] Requested take authorization was increased to average group size for species for which densities were not available but have been sighted near or have the potential to be observed within the Study Area. Average group size from CeTAP 1984.

Table 4: Densities and Estimates of Possible Numbers of Individuals That Could be Exposed to 160 dB re 1 μPA_{RMS} During Spring (March, April, May) 2015 2-D Seismic Surveys

Species	Mean Density $(\#/km^2)$[a]	Ensonified Area (km^2)	Calculated Take[b]	% of Regional Population[c]	Requested Level B Take Authorization
Mysticetes					
Fin Whale	0.0000600	36,600	3	0.113	3
Humpback Whale	0.0010170	36,600	38	0.3276	38
Minke Whale	0.0000350	36,600	2	0.0014	2
North Atlantic Right Whale	N/A	36,600	0	0.6593	3[d]
Blue Whale	N/A	36,600	0	0.2339	2[d]
Bryde's Whale	N/A	36,600	0	N/A	3[d]
Sei Whale	N/A	36,600	0	0.0291	3[d]
Odontocetes					
Atlantic White-sided Dolphin	N/A	36,600	0	0.1106	54[d]
Atlantic Spotted Dolphin	0.0285700	36,600	1046	2.3393	1046
Bottlenose Dolphin	0.0069560	36,600	255	0.3289	255
Long-Finned Pilot Whale	0.0108000	36,600	396	0.0408	396
Short-Finned Pilot Whale	0.0108000	36,600	396	0.0508	396
Pantropical Spotted Dolphin	0.0194900	36,600	714	21.422	714
Risso's Dolphin	0.0092150	36,600	338	1.8520	338
Shorted-beaked Common Dolphin	0.0053940	36,600	198	0.1141	198
Striped Dolphin	0.1330000	36,600	4,868	8.8817	4,868
Sperm Whale	0.0019050	36,600	70	0.5307	70
Killer whale	N/A	36,600	0	N/A	7[d]
Clymene Dolphin	0.0093110	36,600	341	N/A	341
Spinner Dolphin	N/A	36,600	0	N/A	65[d]
Rough-Toothed Dolphin	0.0004200	36,600	16	5.9041	16
Fraser's Dolphin	N/A	36,600	0	N/A	100[d]
Harbor Porpoise	N/A	36,600	0	0.00010	5[d]
False Killer Whale	N/A	36,600	0	N/A	15[d]
Pygmy Killer Whale	N/A	36,600	0	N/A	25[d]
Dwarf Sperm Whale	0.0008850	36,600	33	0.8719	33
Pygmy Sperm Whale	0.0008850	36,600	33	0.8719	33
Melon-Headed Whale	N/A	36,600	0	N/A	100[d]
Sowerby's Beaked Whale		36,600			
Blainville's Beaked Whale		36,600			
Gervais' Beaked Whale	0.0021370	36,600	79	1.1139	79
True's Beaked Whale		36,600			
Cuvier's Beaked Whale		36,600		1.2094	
Northern Bottlenose Whale	N/A	36,600	0	N/A	2[d]
Pinnipeds					
Harbor seal	0	36,600	0	N/A	0
Gray seal	0	36,600	0	N/A	0
Harp seal	0	36,600	0	N/A	0
Hooded Seal	0	36,600	0	N/A	0

[a] Source: OBIS-SERDP-Navy NODE 2007a and 2007b (for those species where density data were available).
[b] Calculated take is estimated density multiplied by the 160-db ensonified area. These calculations do not include any contingency as the survey will be conducted as one continuous line.
[c] Requested takes expressed as percentages of the larger regional populations, where available; where not available (most odontocetes–see Table 2), Draft 2013 SAR population estimates were used; N/A means not available
[d] Requested take authorization was increased to average group size for species for which densities were not available but have been sighted near or have the potential to be observed within the Study Area. Average group size from CeTAP 1984.

It also should be noted that as summarized from the PEIS in the above section, "Summary of Potential Airgun Effects," delphinids appear to be less responsive to airgun sounds than some mysticetes. The 160 dB re 1μPa$_{RMS}$ criterion that the NMFS currently uses to determine potential Level B harassment to all cetaceans was based on recorded reactions of gray and bowhead whales. For delphinids and pinnipeds, a 170 dB re 1μPa$_{RMS}$ disturbance criterion may be more appropriate. Based on this, the estimates of potential "takes by harassment" presented in Table 3 would, therefore, be considered precautionary. Note that the ensonified area (36,600 km^2) shown in Table 3 is calculated for the 2014 survey. The 2015 survey is expected to ensonify an almost identical area (to within 2 %); therefore takes requested are identical for each of the two years. However, the 2015 survey may be scheduled for an earlier time slot. Table 4 indicates the number of takes that would be expected were the survey to be scheduled in the spring rather than summer. The data suggest that spring takes would be higher for only two species: Humpback Whale and Bottlenose Dolphin. Spring takes would be fewer for nine species, and unchanged for the remaining species.

1.11.2 **Potential Number of Marine Mammals Exposed**

The potential number of different individual marine mammals that could be exposed to airguns at or exceeding 160 dB re 1μPa$_{RMS}$ can be determined using the total area that will be located within the 160-dB radius at any one point during the entire survey. In many seismic surveys, this total marine area includes overlap, as seismic surveys are often conducted in parallel survey lines where the ensonified areas of each survey line will overlap. The proposed 2014 survey lines, however, will not have overlap as the individual line segments of the complete 2014 proposed survey line do no run parallel to each other. The entire survey could be considered one continual survey line with slight turns (no more than 90 degrees) between each line segment (see **Figures 5** and **6**). During the proposed 2014 survey, the seismic vessel will continue on the extensive survey line path, not staying within a smaller defined area as most seismic surveys do. Therefore, due to the structure of the proposed 2014 survey, there is a potential for one marine mammal to be exposed to the airgun sounds more than once. It is expected however that, if an individual is exposed at least once at any one point during the survey, that animal is more likely to avoid the survey vessel should it encounter the survey vessel farther down the survey line, reducing the likelihood of a second exposure.

The number of potential individuals exposed to airgun sounds ≥160 dB re 1μPa$_{RMS}$ were determined by multiplying each expected species density (for those species that had density data) by the total ensonified area for the entire 3,165 kilometers of the survey line. The total area expected to be ensonified was determined by creating the 160-dB buffer around the entire survey line (see Table 1). This was done using ESRI ArcGIS. Using this approach, a total of 33,193 square kilometers will fall within the 160-dB isopleth throughout the course of the proposed 2014 survey. This approach does not allow for turnover in the marine mammal populations in the area, therefore, the actual number of marine mammals could be underestimated. However, it is expected that the line kilometers used to calculate the potential exposures and the fact that these calculations assume that no marine mammals would move away from the track line during active surveys before the received sound levels reach 160 dB re 1μPa$_{RMS}$ result in an overestimation of potential individual exposures.

The total number of individual animals that could be exposed to received levels of seismic sounds ≥160 dB re 1μPa_{RMS} during the entire proposed 2014 survey is 9,866 (Table 3). That total includes 97 cetaceans listed as ***Endangered*** under the ESA, including 3 fin whales (0.011 percent of the regional population), 3 humpback whales (0.026 percent of the regional population), 3 North Atlantic right whales (0.66 percent of the regional population), 2 blue whales (0.234 percent of the regional population), 3 sei whales (0.029 percent of the regional population), and 83 sperm whales (0.629 percent of the regional population).

Most of the cetaceans (89.2 percent) potentially exposed are delphinids. The most common species in the area are expected to be the striped dolphin (4,916 estimated individuals [8.97 percent of the regional population]), Atlantic spotted dolphin (1056 estimated individuals [2.36 percent of the regional population]), and Pantropical spotted dolphin (724 estimated individuals [21.72 percent of the regional population]). No “takes” of pinnipeds are expected due to a lack of species observations within the Study Area, the great distance offshore , and the extreme depth of the Study Area, as these species are primarily found in coastal waters. It should be noted that the regional populations for each species are the populations reported in the 2013 NMFS Stock Assessment Report (SAR) for species populations within U.S. waters. Therefore, population percentages may be underestimated for actual population sizes that would include waters outside the U.S. EEZ.

1.11.3 Conclusions

As stated earlier, the proposed 2014 survey will consist of operating a seismic airgun array that will introduce pulsed intermittent noise into the marine environment. During this time, both an MBES and an SBP will be operating simultaneously. During the survey, the R/V *Langseth* will be towing a full 36-airgun array with a total volume discharge of approximately 6,600 in^3. Regular vessel operations also are likely to produce sound within the marine environment; however, continuous noise sources such as this are not commonly known to affect marine mammals to the point of “taking.” In addition, no takes are expected to result from the operation of the echosounder operations given the discussion found in Sections 3.6.4.3, 3.7.4.3, 3.8.4.3, and Appendix E of the PEIS.

Cetaceans. Sections 3.6.7 and 3.7.7 of the PEIS concluded that with the implementation of the proposed monitoring and mitigation measures, unavoidable impacts to mysticetes and odontocetes (in the Northwest Atlantic Detailed Analysis Area and Mid-Atlantic Ridge Qualitative Analysis Area) are expected to be limited to short-term behavioral disturbance and short-term localized avoidance of the area where airguns are operating. These impacts will result in only a small number of Level B behavioral effects. Level A effects are highly unlikely, and seismic operations are unlikely to adversely affect any ESA-listed species.

Pinnipeds. Section 3.8.7 of the PEIS concluded that pinnipeds are absent or rare in most locations where seismic surveys occur. This is true for the proposed 2014 surveys. However, with the implementation of the proposed monitoring and mitigation measures, impacts to pinnipeds are expected to be limited to behavioral disturbance and, in some cases, localized avoidance of the area where airguns are operating. Level A effects are highly unlikely. Due to the lack of species presence data within the Study Area and the species’ preferences for more coastal waters, the proposed survey is not expected to encounter any pinniped species.

This IHA application presents the estimated potential number of marine mammals that could be exposed to pulsed seismic airgun sounds during the proposed 2014 survey. Based on this, “take authorizations” by Level B harassment also have been requested for each species. Overall, the requested take authorizations represent a small percentage of the overall U.S. regional population for each species (see Table 3). Exposure estimates for only one species, the pantropical spotted dolphin, represent greater than 20 percent of the regional population of any species with 656 requested takes. However, it is expected that these, as with the estimates for all of the potential species exposures, are overestimates for the reasons outlined previously. It should also be noted that any bottlenose dolphins potentially encountered during the proposed 2014 survey would primarily be from the offshore morphotype population. This morphotype is genetically distinct from the coastal morphotype populations, which are the populations primarily affected by the recent 2013 UME. Therefore, the potential for Level B harassment of 221 individuals of the offshore bottlenose dolphin morphotype, which represents 0.28 percent of the regional population, would not further affect the potentially vulnerable population of the coastal morphotype.

Overall, the relatively short-term exposures to any marine mammals are unlikely to result in any long-term negative consequences to either individual and animals or populations.

VIII. ANTICIPATED IMPACTS ON SUBSISTENCE USES

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

There is no legal subsistence hunting for marine mammals in the western North Atlantic, so the proposed activities will not have any impact on the availability of the species or stocks for subsistence users.

IX. ANTICIPATED IMPACTS ON HABITAT

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

The proposed seismic survey would not result in any permanent impact on habitats used by marine mammals or to their food sources. The main impact on marine mammals associated with the proposed 2014 survey activity will be temporarily elevated noise levels and the associated direct effects, as discussed in Section VII, above. Seismic airguns also have the potential to affect fish and invertebrates that serve as prey for marine mammal species. The effects of airguns on fish and invertebrates are reviewed in the PEIS in Sections 3.2.4.3 and 3.3.4.3, and in Appendix D. The PEIS concluded that seismic airguns could have both direct and indirect effects on fish and invertebrate species, including behavioral changes and other non-lethal, temporary impacts, and injury or mortal impacts on individual fish located within direct proximity to an active high-energy acoustic source. However, significant impacts from the proposed 2014 survey to fish or invertebrate populations are not anticipated.

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

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

The proposed 2014 survey is not expected to have any habitat-related effects with the potential to result in significant or long-term impacts on either individual marine mammals or their populations. This is a result of the limited duration of the proposed 2014 survey (approximately 19 days) and the large area the survey will cover. There is a potential that the small number of marine mammals present within the vicinity of the survey vessel while the full airgun array is operating would be temporarily displaced as much as a few kilometers. However, as stated earlier, the proposed 2014 survey is not operating in a small, defined location. The proposed 3,165 kilometers of survey lines are not parallel and the seismic vessel will continuously move along that line. This reduces the potential to create a specific area offshore with repeated seismic activity that marine mammals may avoid.

XI. MITIGATION MEASURES

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

Marine mammals are known to occur within the Study Area. To minimize potential impacts that could occur to species and/or stocks, airgun operations will be conducted in accordance with the MMPA and the ESA. This will include obtaining permission for incidental harassment of incidental "takes" of marine mammals and other federally listed species. The proposed activities will take place both within the U.S. EEZ and in International Waters.

The following subsections outline the proposed mitigation measures that will be followed during the proposed 2014 survey. The procedures described here are based on protocols used during previous L-DEO seismic research cruises as approved by the NMFS.

1.12 Planning Phase

As discussed in the PEIS (Section 2.4.1.1), mitigation of potential impacts from the proposed survey begins during the planning phase. The USGS worked with L-DEO and NSF to identify potential time periods to carry out the survey, taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals). As most marine mammal species are expected to occur in the Study Area year-round, altering the timing of the proposed 2014 survey from summer months would result in no net benefits to these species. After consideration of what energy source level was necessary to achieve the research goals, USGS determined that the standard *R/V Langseth* 36-airgun array with a total volume of approximately 6,600 in^3 was appropriate.

1.13 Proposed Exclusion Zones

Based on L-DEO's model (Diebold et al. 2010 and Appendix H of the PEIS), received sound levels have been predicted for the proposed 2014 survey. The predicted received sound levels are a function of distance from the airguns for both the full 36-airgun array and the single 1900LL 40-in^3 airgun (mitigation gun), which would be used during power-downs (see **Figures 3** and **4**). 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 meters have been reported in approximately 1,600 meters water depth (deep water), 50 meters depth (shallow water) and a slope site (intermediate water depth) in the Gulf of Mexico in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

For deep water and intermediate water depth cases, these field measurements cannot be used readily to derive mitigation radii. At these sites, the calibration hydrophone was located at a roughly constant depth of 350 to 500 meters, which may not intersect all the SPL isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of approximately 2,000 meters. 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 suited 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.

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 consistent (Figures 12 and 14 in Appendix H of the PEIS). Consequently, isopleths falling within this domain can be reliably predicted by the L-DEO model, while 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, while the direct arrivals become weak and/or incoherent (Figures 11, 12 and 16 in Appendix H of the PEIS). Aside from local topography effects, the region around the critical distance (approximately 5 kilometers on Figures 11 and 12, and approximately 4 kilometers in Figure 16 in Appendix H of the PEIS) is where the observed levels rise close to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Figures 11, 12, and 16 in Appendix H of the PEIS). Thus, analysis of the Gulf of Mexico calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for estimating mitigation radii.

During the proposed 2014 survey, the proposed seismic operations will occur entirely in deep water (i.e., greater than 1,000 meters). Therefore, for the purposes of the proposed 2014 survey, only deep-water radii were predicted. For the full 36-airgun array, the deep-water radii were obtained from 9-meter tow depth L-DEO model results to a maximum water depth of 2,000 meters.

Measurements have not been reported for the single 40-in^3 airgun. The 40-in^3 airgun fits under the PEIS low-energy sources (i.e., any towed acoustic source whose receive level is ≤180 dB re 1 μPa_{RMS} at 100 meters from the source, including any single airgun with a volume ≤ 425 in^3). In the PEIS (Section 2.4.2), Alternative B (the Preferred Alternative) conservatively applies a 100-meter EZ for all low-energy acoustic sources in water depths greater than 100 meters. This approach is adopted here for the single Bolt 1900LL 40-in^3 airgun that would be used during power-downs. In addition, L-DEO model results are used to determine the 160- and 190- dB radii for the 40-in^3 airgun in deep water.

Table 1 shows the modeled distances for both the 36-airgun array and the single mitigation gun at which the 160, 160, and 190 dB re 1 μPa_{RMS} received levels are expected to be reached. The 180-dB re 1 μPa_{RMS} distance is the safety criterion as specified by NMFS (2000) for cetaceans. If marine mammals or sea turtles are detected within, or about to enter, the appropriate exclusion zone, the airguns would be immediately powered down (or shut down if necessary).

New, detailed recommendations for science-based noise exposure criteria have been presented by Southall et al. (2007). The USGS is aware that NOAA is in the process of revising the current guidance for marine mammals regarding acoustic exposure. However, at the time of this IHA application, that guidance has not been finalized. The USGS is prepared to revise its procedures for estimating the number of marine mammals “taken,” EZ’s, etc., as may be required by any new guidelines that may result.

1.14 Mitigation during Operations

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

1.14.1 Power-down Procedures

A power-down involves reducing the number of airguns operating such that the radius of the 180-dB (or 190-dB) zone is decreased to the extent that an observed marine mammal(s) is (are) no longer observed within the EZ. As the proposed survey does not include any full turns (only 90-degree turns maximum), the seismic airgun array will continue to operate at full power between line segments. The survey will be conducted as the segments are one continuous line. During a power-down, only one airgun will be operating. The continued operation of one-airgun is intended to alert any marine mammals of the presence of the seismic vessel.

If a marine mammal is detected within, or is likely to enter the EZ, the airgun array would be powered down immediately. During a power-down situation of the full air-gun array, only a 40-in^3 airgun will be operated. Following a power-down situation, airgun activity will not resume until the marine mammal has cleared the EZ. The animal will be considered clear of the EZ if it:

- is visually observed to have left the EZ; or

- has not been seen within the EZ for 15 minutes in the case of small odontocetes and pinnipeds; or
- has not been seen within the EZ for 30 minutes in the case of mysticetes and large odontocetes including sperm, pygmy sperm, dwarf sperm, and beaked whales; or
- the vessel has moved outside the applicable EZ in which the animal in question was last seen.

Following a power-down and subsequent animal departure from the EZ as described above, the airgun array would resume full operations. Based on previous *R/V Langseth* marine seismic surveys, it has been determined that following a power-down, ramp-up from the single mitigation gun is not necessary as the single mitigation gun serves to warn any marine mammals within the vicinity of the survey of the seismic activities underway. It has also been determined that the ramp-up procedures may unnecessarily extend the length of the survey time needed to collect the seismic data. Previous surveys conducted by L-DEO and NSF in consultation with the NMFS have concluded that undergoing ramp-up procedures following an extended power-down is not necessary. Therefore, this IHA application does not include this practice as part of the monitoring and mitigation plan.

If an animal is observed within the smaller designated EZ for the single airgun (see Table 1), the airguns will be completely shut down. Airgun operation will not be resumed until the above conditions are met, as applicable.

1.14.2 Shutdown Procedures

Operating airgun(s) will be shut down if a marine mammal is observed within or approaching the EZ for the single airgun. During a shutdown, all operating airguns will be turned off immediately. Airgun activity will not resume until the marine mammal(s) has cleared the EZ for the full array, as described above under "Power-down Procedures."

1.14.3 Ramp-up Procedures

A ramp-up procedure will be followed when starting the airguns at the beginning of seismic operations or anytime the entire array has been shut down for a specified period of time. Based on other surveys conducted by L-DEO using the *R/V Langseth* and using an airgun array of similar size as the proposed 2014 survey, a period of approximately 10 minutes is proposed for the 2014 survey. Ramp-up will not occur if an observed marine mammal has not cleared the EZ as described above.

Ramp-up will consist of beginning with the smallest airgun in the array (40 in^3). Airguns will then be added in a sequence such that the source level of the array will increase in steps not exceeding 6 dB per 5-minute period. A 36-airgun array is expected to take approximately 30 minutes to achieve full operations. During the ramp-up, NMFS-approved Protected Species Visual Observers (PSVOs) will monitor the EZ, and if a marine mammal is sighted, a power-down or shutdown will be implemented, as applicable, as though the full array were operating.

Ramp-up may not be initiated unless the full EZ is visible to the PSVOs for no less than 30 minutes, whether conducted in daytime or nighttime. Ramp-up may commence even if the entire EZ is not visible for 30 minutes if at least one airgun (40 in^3 or smaller) has been operating during the interruption of seismic survey operations. Therefore, it is not expected that the full airgun array will be ramped-up from a completion shutdown at night or during poor visibility conditions (i.e., thick fog). However, if one airgun has continued during a power-down period, ramp up to full power will be permissible at night or in poor visibility conditions. This is based on the assumption that marine mammals would be alerted to the presence of the seismic vessel by the continually operating mitigation airgun. Ramp-up of the airguns will not be initiated if a marine mammal is present within the EZ of the airgun array to be operated.

As stated above under “Power-down Procedures,” based on previous *R/V Langseth* marine seismic surveys, it has been determined that following a power-down, ramp-up from the single mitigation gun is not necessary as the single mitigation gun serves to warn any marine mammals within the vicinity of the survey of the seismic activities underway. Therefore, this IHA application does not include this practice as part of the monitoring and mitigation plan.

1.14.4 Special Procedures for Situations or Species of Concern

It is unlikely that a North Atlantic right whale (NARW) will be encountered during the proposed survey. However, if a NARW is visually identified at any distance from the vessel during seismic operations, the airguns will be shut down immediately and remain off for a minimum of 30 minutes after the animal is beyond visual range before resuming with ramp-up. This is due to the species rarity and conservation status. In addition, it is unlikely that concentrations (groups of 6 or more individuals) of humpback, fin, sperm, blue, or sei whales will be encountered, but if so, they will be avoided.

XII. PLAN OF COOPERATION

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

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

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

XIII. MONITORING AND REPORTING PLAN

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

The USGS proposes to sponsor marine mammal monitoring during the proposed 2014 survey in order to implement the proposed mitigation measures that require real-time monitoring and to satisfy the anticipated monitoring requirements of the IHA.

The proposed Monitoring and Reporting Plan for the USGS is described below. The USGS understands that this Monitoring and Reporting Plan will be subject to review by the NMFS and that refinements may be required.

The monitoring work described in association with the proposed 2014 survey has been planned as a self-contained project, independent of any other related monitoring projects that may be occurring simultaneously in the same regions. The USGS is prepared to discuss coordination of its monitoring program with any related work that subsequently might be conducted by other groups insofar as it is practicable and desirable.

1.15 Vessel-based Visual Monitoring

Vessel-based PSVO observations will take place during daytime airgun operations and before and during start-ups of airguns during daytime or nighttime. Airgun operations will be suspended when marine mammals are observed within, or about to enter, the designated EZ where there is concern about potential effects on hearing or other physical effects (see Section XI). PSVOs also will be on watch for marine mammals within the EZ for at least 30 minutes prior to the start of seismic operations following an extended shutdown. PSVOs will remain on watch during daytime periods when the seismic airguns are not operating in order to compare animal abundance and behaviors during times of operation and no operation.

In total, five PSVOs will be deployed aboard the *R/V Langset*. Two PSVOs will remain on watch during daytime seismic operations, with at least one PSVO remaining on watch during meal times and restroom breaks. PSVO shifts will last no longer than four hours at a time. The *R/V Langseth* crew will be instructed to assist in observing any marine mammals while they are on watch.

The *R/V* Langseth will serve as the observation platform for marine mammals during the proposed 2014 survey. When the PSVO is stationed on the observation platform, the PSVO eye level will be approximately 21.5 meters above sea level, and each observer will have a good view around the entire vessel. PSVOs will use reticle binoculars (7x50 Fujinon), big-eye binoculars (25x150), and the naked eye during observations. Laser range-finding binoculars (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. Those are useful in training PSVOs to estimate distances visually, but are generally not useful in measuring distances to animals directly; that is done primarily with the reticles in the binoculars. In addition, both forward-looking infrared camera and night vision monoculars will be available for use in low-light conditions.

1.16 Passive Acoustic Monitoring

Passive acoustic monitoring (PAM) will be conducted to complement the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustical monitoring can be used in addition to visual monitoring to improve species detection, identification, and localization of cetaceans. However, it should be noted that PAM only works when a marine mammal is actually vocalizing. During the proposed 2014 survey, PAM will be monitored in real-time so that visual observers can be advised when cetaceans are acoustically detected.

The PAM system available on-board the *R/V Langseth* consists of both hardware and software. The deployed part of the system includes a towed hydrophone array stretching approximately 250 meters behind the vessel. The hydrophones are located on the last 10 meters of the towed cable. The cable will typically be towed at 20 meters depth or less. The Pamguard software is used to amplify, digitize, and processed the acoustic signals received by the hydrophones. This particular system can detect marine mammal vocalizations at frequencies up to 250 kHz. The PAM hydrophones respond in the 10 Hz to 200 kHz bandwidth.

One Protected Species Acoustic Observer (PSAO) or one PSVO will monitor the PAM system at all times in shifts no greater than six hours. A PSAO will design and set up the PAM system and be present to operate, oversee, and troubleshoot any technical problems with the PAM system during the proposed survey. When the PAM system detects a vocalization, the PAM operator will alert the PSVOs to the presence of a marine mammal, and a power-down or shutdown can be initiated, if required. The PSAO will enter the vocalization data into a database. The data to be entered includes an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and when 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 the sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

1.17 PSVO Data and Documentation

PSVOs will record data to estimate the numbers of marine mammals exposed to various received sound levels and to document the behavior of the animal upon sighting. These data will be included in the report submitted to the NMFS and will be used to estimate numbers of marine mammals potentially "taken" by harassment. PSVOs will also provide information needed to order a power-down or a shutdown of airguns when marine mammals are within or near the appropriate EZ.

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

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

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

All observations and power-downs or shutdowns will be recorded in a standardized format. Data will be entered into an electronic database. The accuracy of the data entry will be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of data to be prepared during and shortly after the field program and will facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations will provide:

1. The basis for real-time mitigation (airgun power-down or shutdown).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to the NMFS.

3. Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted.
4. Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals and turtles seen at times with and without seismic activity.

A report will be submitted to the NMFS and the USGS within 90 days of the completion of the proposed 2014 survey cruise. A second report will similarly be filed upon completion of the 2015 survey. The report will describe the seismic operations conducted and sightings of marine mammals within the vicinity of the operations. The report will include full documentation of methods, results, and interpretation pertaining to all monitoring. The report will summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). Finally, the report will include estimates of the number and nature of exposures that could result in "takes" of marine mammals by Level B harassment or in other ways.

XIV. COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL TAKE

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

The USGS will coordinate the planned marine mammal monitoring program associated with the seismic survey (as summarized in Sections XI and XIII) with any parties who express interest in this survey activity. The USGS will coordinate with applicable U.S. agencies (i.e., NMFS) and will comply with their requirements.

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11 APPENDIX C: DESCRIPTION OF NSF NEW JERSEY AND GEOPRISMS/ENAM SURVEYS

APPENDIX C:
DESCRIPTION OF NSF 2014 SEISMIC SURVEYS UTILIZING
R/V *MARCUS G. LANGSETH*

Two NSF *Langseth* seismic surveys using high-energy sources are planned during 2014, in addition to the proposed USGS survey: (1) NJ Shelf project and (2) the Eastern North American (ENAM) survey. The locations of these surveys are shown in Figure C-1. Table C-1 gives a comparison of the planned survey tracks and source size. This appendix summarizes these surveys.

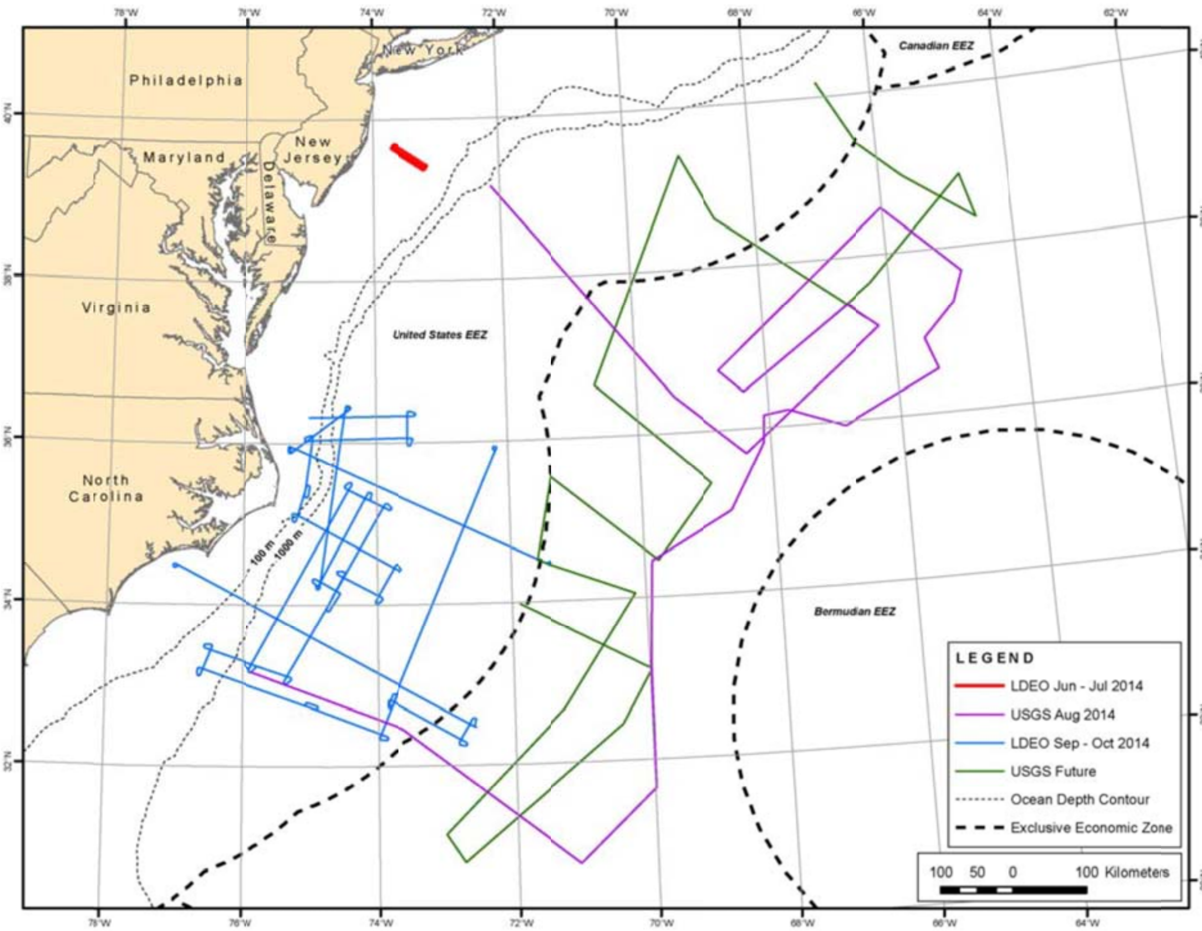

Figure C-1: Map showing the locations of the NJ Shelf (red), USGS (green and purple) and ENAM (blue) tracks. The tracks have been designed to avoid overlap and to complement their respective scientific objectives.

Table C-1: Summary of Survey Information for the NJ Shelf, USGS, and ENAM surveys.

Survey	Time of Year (2014)	Survey Days	Planned Track Length (km)	Planned Source Size (in^3)	Water Depths (m)
NJ Shelf	July	~30	4900	700/1400	30-75
USGS[1]	Aug. – Sep.	21	3150	6600	1450-5400
ENAM	Sep. – Oct.	38	5000	3300/6600	30-4300

[1]The proposed components of the 2015 survey are identical.

(1) NJ Shelf Survey

The NJ Shelf survey occurred in July, 2014, and collected 3-dimensional seismic reflection data between 25 and 75 km offshore from New Jersey (red box in Figure C-1) to study how sea-level rise affected the New Jersey shelf for the past 60 million years. The survey was proposed under a competitive research proposal that underwent merit-review at NSF. The topic of sea-level rise is an NSF program priority to meet NSF's critical need to foster a better understanding of Earth processes. The survey utilized a smaller airgun array than that proposed for the USGS survey (~700 in^3 or 1400 in^3 total volume airgun array).

Finding of No Significant Impact
After receiving all necessary authorizations, including an Incidental Harassment Authorization (MMPA) and Biological Opinion (ESA) allowing for the taking of a small number of marine mammals and endangered species by incidental harassment, NSF issued a FONSI and completed the environmental compliance process for this survey on July 1, 2014 (https://www.nsf.gov/geo/oce/envcomp/index.jsp). This survey was not completed as planned because of mechanical problems with the vessel, but did acquire a subset of multichannel data using specified mitigation and monitoring. The survey may be rescheduled next year at approximately the same time.

The conclusions of the FONSI were consistent with the earlier findings in the NSF/USGS PEIS.

(2) ENAM Survey

The ENAM survey is planned for September – October, 2014 utilizing R/V *Marcus G. Langseth* The proposed research covers a portion of the rifted margin of the eastern U.S., from un-extended 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 ENAM survey would be coordinated with complementary on-land studies involving the Earth Scope seismometer array along the East Coast. Additional arrays of Ocean Bottom Seismometers would be deployed offshore, and small, passive seismometers are 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 would be to study features representing the post-rift modification of the margin by slope instability and fluid flow.

The Draft EA for this site specific survey is consistent with the findings of the PEIS. The Draft EA for the ENAM survey provides a summary of relevant bioacoustic studies on marine mammals, sea turtles, fisheries, and habitats since publication of the NSF/USGS PEIS. The information from this more recent literature complements, and does not change the outcome of the effects assessment as presented in the PEIS.

12 APPENDIX D: NMFS CONSULTATION (ESSENTIAL FISH HABITAT)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

JUN 20 2014

Deborah R. Hutchinson, Ph.D.
U.S. Geological Survey
Woods Hole Science Center
384 Woods Hole Rd.
Woods Hole, MA 02543

Dear. Dr. Hutchinson:

This responds to your June 3, 2014, electronic mail inquiry regarding essential fish habitat (EFH) consultation requirements for a proposed regional marine two-dimensional seismic reflection scientific research survey in the Atlantic Ocean over the next two years. The U.S. Geological Survey (USGS), in cooperation with the National Science Foundation (NSF), prepared an environmental assessment (EA) dated May 2014 tiered off a 2011 Final Programmatic Environmental Impact Statement (FPEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the NSF. The study area is in the northwest Atlantic Ocean U.S. exclusive economic zone (EEZ) off Delaware and North Carolina and extends into international waters as far as 350 nautical miles from the coast.

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 New England, 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 USGS and NSF have determined the proposed survey activities may result in minor adverse impacts to water column habitats identified and described as EFH. The Habitat Conservation Divisions (HCDs) in the Southeast Regional and Greater Atlantic Regional Fisheries Offices have 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 survey we have no EFH conservation recommendations to provide pursuant to Section 305(b)(2) of the Magnuson-Stevens Act at this time.

However, much of the research available to date on the adverse effects of seismic survey activities on aquatic resources has been focused on marine mammals. Little information is available on the effects of these activities on fish and benthic organisms. Additional research and monitoring is needed to gain a better understanding of the potential effects these activities may have on EFH, federally managed species, their prey and other NOAA trust resources. This type of research should be a component of future NSF funded seismic survey activities. This will aid in the development of site and project specific EFH conservation recommendations for future projects as appropriate.

Be advised that by separate correspondence the HCDs have provided similar determinations to the NMFS Office of Protected Resources for their evaluation of an Incidental Harassment Authorization request for this action. Further EFH consultation on this matter by the USGS and NSF is not necessary unless future modifications to the survey are proposed and such actions may result in adverse impacts to EFH.

NMFS comments originate from two regions. The contacts for these offices are:

Mr. David Dale
NMFS Southeast Region
Habitat Conservation Division
263 13th Avenue South
St. Petersburg, Florida 33701-5505

David.Dale@noaa.gov
727-824-5317

Ms. Karen Greene
NMFS Greater Atlantic Region
Habitat Conservation Division
74 Magruder Road
Highlands, New Jersey 07732

Karen.Greene@noaa.gov
727-872-3023

If we can be of further assistance, please advise.

Sincerely,

Louis A. Chiarella
Assistant Regional Administrator
For Habitat Conservation

cc:
F/SER, David.Dale@noaa.gov
F/GAR, Karen.Greene@noaa.gov
F/HC, Terra.Lederhouse@noaa.gov
F/PR, Howard.Goldstein@noaa.gov

13 APPENDIX E: USFWS CONSULTATION (ENDANGERED SPECIES ACT)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

AUG 11 2014

In Reply Refer To:
FWS/AES/DER/BCH/058048
FWS 2014-I-0006

Mr. David Applegate
Pacific Coastal and Marine Geology Science Center
U.S. Geological Survey
Mail Stop 999
345 Middlefield Road
Menlo Park, California 94025

Subject: Informal Consultation on the 2-D Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards

Dear Mr. Applegate:

This letter is in response to your April 4, 2014 email, requesting the U.S. Fish and Wildlife Service's (Service) concurrence that the proposed 2-D seismic reflection scientific research surveys during 2014 and 2015 is not likely to adversely affect the endangered roseate tern (*Sterna dougallii*) and Bermuda petrel (*Pterodroma cahow*), 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 submitted document entitled a "Draft Environmental Assessment for Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards."

The proposed action is to conduct a seismic survey program that involves using a 36-airgun array with a total discharge volume of 6,600 cubic inches. The survey program is planned to occur over two years, for three weeks or fewer between August and September, 2014, and for a similar amount of time as yet unscheduled between April and August, 2015. The 2014 and 2015 surveys are planned with track lengths of 3,165 and 3,105 kilometers, respectively, and because they are within 1.5 % of each other in length, are considered to have identical impacts on the environment. The proposed action is in water depths greater than 1,000 meters, mostly in international waters outside the U.S. Atlantic continental margin, but partly within the deep-water portions of the U.S. exclusive economic zone. The proposed survey area would be bounded by the following geographic coordinates:

40.5694° N and -66.5324° W
38.5808° N and -61.7105° W

29.2456° N and -72.6766° W
33.1752° N and -75.8697° W
39.1583° N and -72.8697° W

The goal of the proposed research is to: 1) establish the outer limits of the U.S. continental shelf, also referred to as the Extended Continental Shelf, and; 2) study the sudden mass transport of sediments down the continental shelf as submarine landslides that may pose tsunamigenic hazards to the Atlantic and Caribbean coastal areas.

The surveys would involve one source vessel, the R/V *Langseth*. The proposed survey design consists of approximately nine sub-parallel, northwest to southeast lines (perpendicular to the margin) across the study area, with end-line transits and several northeast to southwest tie or strike lines. The airgun array would operate continuously during the survey, except for power/shut downs, equipment repair or weather issues. Data would continue to be acquired between line changes. Seismic airgun sources send sound waves through the water, and formations beneath the seafloor reflect the sound waves back to hydrophone streamers trailing behind the vessel. The components of the 2-D survey would include a seismic vessel, the source towed array (consisting of 36 airguns) and the receiver (hydrophone streamer). The vessel would be at sea during the entire survey operations. There would no crew changes planned and no additional support vessel or helicopter service anticipated.

Although unlikely to be encountered, the listed roseate tern or Bermuda petrel 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 approximately 100 nesting pairs. Currently, all known breeding pairs breed on islets in Castle Harbour, Bermuda. In the non-breeding season (mid-June – 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.

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 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 measure of shutting down the airguns if a roseate tern or Bermuda petrel are observed diving, we concur with your determination that this action will not adversely affect these two avian species.

We are pleased that USGS 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 Bright

Larry Bright
Acting Chief, Division of Environmental Review,
Ecological Services

14 APPENDIX F: FEDERAL REGISTER NOTICE (NMFS, IHA APPLICATION)

FEDERAL REGISTER

Vol. 79 Monday,
No. 120 June 23, 2014

Part II

Department of Commerce

National Oceanic and Atmospheric Administration

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey in the Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015; Notice

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XD214

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey in the Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015

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

ACTION: Notice; proposed Incidental Harassment Authorization; request for comments.

SUMMARY: NMFS has received an application from the United States (U.S.) Geological Survey (USGS), Lamont-Doherty Earth Observatory of Columbia University (L–DEO), and National Science Foundation (NSF) for an Incidental Harassment Authorization (IHA) to take marine mammals, by 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. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to USGS to incidentally harass, by Level B harassment only, 34 species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than July 23, 2014.

ADDRESSES: Comments on the application should be addressed to Jolie Harrison, Supervisor, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is *ITP.Goldstein@noaa.gov*. Please include 0648–XD214 in the subject line. Comments sent via email, including all attachments, must not exceed a 25-megabyte file size. NMFS is not responsible for email comments sent to addresses other than the one provided here.

Instructions: All comments received are a part of the public record and will generally be posted to *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications* without change. All Personal Identifying Information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit Confidential Business Information or otherwise sensitive or protected information.

An electronic copy of the application may be obtained by writing to the address specified above, telephoning the contact listed below (see **FOR FURTHER INFORMATION CONTACT**) or visiting the Internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications*. The following associated documents are also available at the same internet address: ''Draft Environmental Assessment for Seismic Reflection Scientific Research Surveys during 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards.'' Documents cited in this notice may also be viewed, by appointment, during regular business hours, at the aforementioned address.

The USGS, which is funding the proposed seismic survey, included with its application a ''Draft Environmental Assessment for Seismic Reflection Scientific Research Surveys during 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards,'' prepared by RPS Evan-Hamilton, Inc. in association with YOLO Environmental, Inc., GeoSpatial Strategy Group, and Ecology and Environment, Inc., on behalf of USGS, which is also available at the same internet address. Documents cited in this notice may be viewed, by appointment, during regular business hours, at the aforementioned address.

FOR FURTHER INFORMATION CONTACT: Howard Goldstein or Jolie Harrison, Office of Protected Resources, NMFS, 301–427–8401.

SUPPLEMENTARY INFORMATION:

Background

Section 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*), directs the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals, by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

An authorization for the incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined ''negligible impact'' in 50 CFR 216.103 as ''. . . an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.''

Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as: Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Summary of Request

On March 27, 2014, NMFS received an application from the USGS, L–DEO, and NSF (hereafter referred to as USGS) requesting that NMFS issue an IHA for the take, by Level B harassment only, of small numbers of marine mammals incidental to conducting a marine seismic survey within the Exclusive Economic Zone (EEZ) and on the high seas (i.e., International Waters) to map the U.S. Atlantic Eastern Seaboard Extended Continental Shelf (ECS) region and investigate tsunami hazards during August to September 2014 and April to August 2015. USGS plan to use one source vessel, the R/V *Marcus G. Langseth* (*Langseth*) and a seismic airgun array and a hydrophone streamer to collect seismic data as part of the proposed seismic survey in the Atlantic Ocean off the Eastern Seaboard. In addition to the proposed operation of the seismic airgun array and hydrophone streamer, USGS intends to operate a multi-beam echosounder and a sub-bottom profiler continuously during the seismic operations in order to map the ocean floor. The multi-beam echosounder and sub-bottom profiler would not be operated during transits at the beginning and end of the seismic survey. NMFS determined that the IHA application was adequate and complete on May 14, 2014.

Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the seismic airgun array are likely to result in the take of marine mammals. Take, by Level B harassment only, of individuals of 34 species of marine mammals is anticipated to result from the proposed specified activity. Take is not expected to result from the use of the multi-beam echosounder or sub-bottom profiler, for reasons discussed in this notice; nor is take expected to result from collision with the source vessel because it is a single vessel moving at a relatively slow speed (4.5 knots [kts]; 8.5 kilometers per hour [km/hr]; 5.3 miles per hour [mph]) during seismic acquisition within the survey, for a relatively short period of time (approximately two 17 to 18 day legs), and it is likely that any marine mammal would be able to avoid the vessel.

Description of the Proposed Specified Activity

Overview

USGS plans to conduct a marine seismic survey within the EEZ and on the high seas to map the U.S. Atlantic Eastern Seaboard ECS region and investigate tsunami hazards during August to September 2014 and April to August 2015. USGS proposes to use one source vessel, the *Langseth,* and a 36-airgun array and one 8 kilometer (km) (4.3 nautical mile [nmi]) hydrophone streamer to conduct the conventional seismic survey. In addition to the operations of airguns, the USGS intends to operate a multi-beam echosounder and a sub-bottom profiler on the *Langseth* during the proposed seismic survey to map the ocean floor.

Dates and Duration

The *Langseth* would depart from Newark, New Jersey on August 15, 2014. The seismic survey is expected to take approximately 16 days to complete. Approximately one day transit would be required at the beginning and end of the program. When the 2014 survey is completed, the *Langseth* would then transit to Norfolk, Virginia. The survey schedule is inclusive of weather and other contingency (e.g., equipment failure) time. The proposed activities for 2015 would be virtually identical to the proposed activities for 2014 as geographic area, duration, and trackline coverage are similar. The exact dates for the proposed activities in 2015 are uncertain, but are scheduled to occur within the April to August timeframe. The exact dates of the proposed activities depend on logistics and weather conditions.

Specified Geographic Region

The proposed survey would be bounded by the following geographic coordinates:

40.5694° North, –66.5324° West;
38.5808° North, –61.7105° West;
29.2456° North, –72.6766° West;
33.1752° North, –75.8697° West;
39.1583° North, –72.8697° West;

The proposed activities for 2014 would generally occur towards the periphery of the proposed study area (see Figures 1 and 2 of the IHA application). The proposed activities for 2015 would survey more of the central portions of the study area. The tracklines proposed for both 2014 and 2015 would be in International Waters (approximately 80% in 2014 and 90% in 2015) and in the U.S. EEZ. Water depths range from approximately 1,450 to 5,400 meters (m) (4,593.2 to 17,716.5 feet [ft]) (see Figure 1 and 2 of the IHA application); no survey lines would extend to water depths less than 1,000 m.

Detailed Description of the Proposed Specified Activity

USGS, Coastal and Marine Geology Program, (Primary Investigator [PI], Dr. Deborah Hutchinson) proposes to conduct a regional high-energy, two-dimensional (2D) seismic survey in the northwest Atlantic Ocean within the U.S. EEZ and extending into International Waters as far as 648.2 km (350 nmi) from the U.S. coast (see Figure 1 of the IHA application). Water depths in the survey area range from approximately 1,400 to greater than 5,400 meters (m) (4,593.2 to 17,716.5 feet [ft]). The proposed seismic survey would be scheduled to occur in two phases; the first phase during August to September 2014 (for approximately 17 to 18 days), and the second phase between April and August 2015 (for approximately 17 to 18 days, specific dates to be determined). The proposed activities for both Phase 1 and Phase 2 are included in this IHA application (see Figure 2 of the IHA application). Some minor deviation from these dates is possible, depending on logistics and weather.

USGS proposes to use conventional seismic methodology to: (1) Identify the outer limits of the U.S. continental shelf, also referred to as the ECS as defined by Article 76 of the Convention of the Law of the Sea; and (2) study the sudden mass transport of sediments down the continental shelf as submarine landslides that may pose significant tsunamigenic (i.e., tsunami-related) hazards to the Atlantic and Caribbean coastal communities.

The proposed survey would involve one source vessel, the *Langseth*. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of approximately 6,600 in^3. The receiving system would consist of one 8,000 m (26,246.7 ft) hydrophone streamer. As the airgun array is towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals from the towed airgun array and transfer the data to the on-board processing system. The data would be processed on-board the *Langseth* as the survey occurs.

Each proposed leg of the survey (2014 and 2015) would be 17 to 18 days in duration (exclusive of transit and equipment deployment and recovery) and would comprise of approximately 3,165 km (1,709 nmi) of tracklines of 2D seismic reflection coverage. The airgun array would operate continuously during the proposed survey (except for equipment testing, repairs, implemented mitigation measures, etc.). Data would continue to be acquired between line changes, as the successive track segments can be surveyed as almost one continuous line. Line turns of 90 and no greater than 120 degrees would be required to move from one line segment to the next. The 2014 proposed survey design consists primarily of the tracklines that run along the periphery of the overall study area, including several internal tracklines (see Figure 2 of the IHA application). The 2015 proposed survey design consists of additional dip and tie lines (i.e., dip lines are lines that are perpendicular to the north-south trend of the continental margin; strike lines are parallel to the margin; and tie lines are any line that connects other lines). The 2015 proposed survey design may be modified based on the 2014 results.

In addition to the operations of the airgun array, a Kongsberg EM 122 multi-beam echosounder and a Knudsen Model 3260 Chirp sub-bottom profiler would also be operated from the *Langseth* continuously during airgun operations throughout the survey to map the ocean floor. The multi-beam and sub-bottom profiler would not operate during transits at the beginning and end of the survey. All planned geophysical data acquisition activities would be conducted by USGS 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 for the entire cruise.

Vessel Specifications

The *Langseth,* a seismic research vessel owned by the National Science Foundation (NSF) and operated by the Lamont-Doherty Earth Observatory of Columbia University (L–DEO), would tow the 36 airgun array, as well as the hydrophone streamer(s), along predetermined lines (see Figure 2 of the IHA application). When the *Langseth* is towing the airgun array and the hydrophone streamer(s), the turning rate of the vessel is limited to three degrees per minute (2.5 km [1.5 mi]). Thus, the maneuverability of the vessel is limited during operations with the streamer. The vessel would ''fly'' the appropriate U.S. Coast Guard-approved day shapes (mast head signals used to communicate with other vessels) and display the appropriate lighting to designate the vessel has limited maneuverability.

The vessel has a length of 71.5 m (235 ft); a beam of 17.0 m (56 ft); a maximum draft of 5.9 m (19 ft); and a gross tonnage of 3,834. The *Langseth* was designed as a seismic research vessel with a propulsion system designed to be as quiet as possible to avoid interference with the seismic signals emanating from the airgun array. The ship is powered by two 3,550 horsepower (hp) Bergen BRG–6 diesel engines which drive two propellers directly. Each propeller has four blades and the shaft typically rotates at 750 revolutions per minute. The vessel also has an 800 hp bowthruster, which is not used during seismic acquisition. The *Langseth's* operation speed during seismic data acquisition is typically 7.4 to 9.3 km per hour (hr) (km/hr) (4 to 5 knots [kts]). When not towing seismic survey gear, the *Langseth* typically cruises at 18.5 to 24 km/hr (10 to 12 kts). The *Langseth* has a range of 25,000 km (13,499 nmi) (the distance the vessel can travel without refueling).

The vessel also has an observation tower from which Protected Species Visual Observers (PSVO) would watch for marine mammals before and during the proposed airgun operations. When stationed on the observation platform, the PSVO's eye level would be approximately 21.5 m (71 ft) above sea level providing the PSVO an unobstructed view around the entire vessel. More details of the *Langseth* can be found in the IHA application and the ''Final 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'' (2011) and the Record of Decision (2012) (NSF/USGS PEIS).

Acoustic Source Specifications

Seismic Airguns

The *Langseth* would deploy a 36-airgun array, consisting of two 18 airgun (plus 2 spares) sub-arrays. Each sub-array would have a volume of approximately 3,300 cubic inches (in^3) for a total volume of 6,600 in^3 for the 36-airgun array. The airgun array would consist of a mixture of Bolt 1500LL and Bolt 1900LLX airguns ranging in size from 40 to 360 in^3, with a firing pressure of 1,900 pounds per square inch (psi). The 18 airgun sub-arrays would be configured as two identical linear arrays or ''strings'' (see Figure 2.11 of the NSF/USGS PEIS). Each string would have 10 airguns, with the first and last airguns in the strings spaced 16 m (52.5 ft) apart. Of the 10 airguns, nine airguns in each string would be fired simultaneously (1,650 in^3), whereas the tenth would be kept in reserve as a spare, to be turned on in case of failure of another airgun. The sub-arrays would be fired simultaneously during the survey. The two airgun sub-arrays would be distributed across an area of approximately 12 x 16 m (40 x 52.5 ft) behind the *Langseth* and would be towed approximately 140 m (459.3 ft) behind the vessel. Discharge intervals depend on both the ship's speed. The shot interval would be 50 m (164 ft) during the study. The shot interval would be approximately 20 to 24 seconds (s) based on an assumed boat speed of 4.5 knots. During firing, a brief (approximately 0.1 s) pulse sound is emitted; the airguns would be silent during the intervening periods. The dominant frequency components range from 2 to 188 Hertz (Hz). The firing pressure of the airgun array is 2,000 pounds per square inch (psi).

The tow depth of the airgun array would be 9 m (29.5 ft) during the surveys. Because the actual source is a distributed sound source (36 airguns) rather than a single point source, the highest sound measurable at any location in the water would be less than the nominal source level. In addition, the effective source level for sound propagating in near-horizontal directions would be substantially lower than the nominal omni-directional source level applicable to downward propagation because of the directional nature of the sound from the airgun array (i.e., sound is directed downward).

Hydrophone Streamer

Acoustic signals would be recorded using a system array of one hydrophone streamer, which would be towed behind the *Langseth*. The streamer is Thompson-Marconi SENTRY solid cable construction and is approximately 8 km long. Cable-leveling birds would be used to keep the streamer cable and hydrophone at a constant depth. Cable-leveling birds would be spaced every 300 m (984.3 ft) with extra redundancy at the head and tail sections.

Metrics Used in This Document

This section includes a brief explanation of the sound measurements frequently used in the discussions of acoustic effects in this document. Sound pressure is the sound force per unit area, and is usually measured in micropascals (μPa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. Sound pressure level (SPL) is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in underwater acoustics is 1 μPa, and the units for SPLs are dB re 1 μPa. SPL (in decibels [dB]) = 20 log (pressure/reference pressure).

SPL is an instantaneous measurement and can be expressed as the peak, the peak-to-peak (p-p), or the root mean square (rms). Root mean square (rms), which is the square root of the arithmetic average of the squared instantaneous pressure values, is typically used in discussions of the effects of sounds on vertebrates and all references to SPL in this document refer to the root mean square unless otherwise noted.

Characteristics of the Airgun Pulses

Airguns function by venting high-pressure air into the water, which creates an air bubble. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by the oscillation of the resulting air bubble. The oscillation of the air bubble transmits sounds downward through the seafloor and the amount of sound transmitted in the near horizontal directions is reduced. However, the airgun array also emits sounds that travel horizontally toward non-target areas.

The nominal source levels of the airgun arrays used by L–DEO on the *Langseth* are 236 to 265 dB re 1 μPa (p-p) and the rms value for a given airgun pulse is typically 16 dB re 1 μPa lower than the peak-to-peak value (Greene, 1997; McCauley *et al.,* 1998, 2000a). However, the difference between rms and peak or peak-to-peak values for a given pulse depends on the frequency content and duration of the pulse, among other factors.

Accordingly, L–DEO has predicted the received sound levels in relation to distance and direction from the 36 airgun array and the single Bolt 1900LL 40 in^3 airgun, which would be used during power-downs. A detailed description of L–DEO modeling for this survey's marine seismic source arrays for protected species mitigation is provided in the NSF/USGS PEIS (see Appendix H). NMFS refers the reviewers to the IHA application and NSF/USGS PEIS documents for additional information.

Predicted Sound Levels for the Airguns

Tolstoy *et al.* (2009) and Diebold *et al.* (2010) reported results for propagation measurements of pulses from the *Langseth'*s 36 airgun, 6,600 in^3 array in shallow water (approximately 50 m [164 ft]), intermediate water (a slope site), and deep water depths (approximately 1,600 m [5,249 ft]) in the Gulf of Mexico in 2007 and 2008. Results of the Gulf of Mexico calibration study (Tolstoy *et al.,* 2009; Diebold *et al.,* 2010) showed that radii around the airguns for various received levels varied with water depth and that sound propagation varied with array tow depth.

The L–DEO used the results from the Gulf of Mexico study to determine the algorithm for its model that calculates the mitigation exclusion zones for the 36-airgun array and the single airgun. L–DEO has used these calculated values to determine buffer (i.e., 160 dB) and exclusion zones for the 36 airgun array and previously modeled measurements by L–DEO for the single airgun, to designate exclusion zones for purposes of mitigation, and to estimate take for marine mammals in the northwest Atlantic Ocean. A detailed description of the modeling effort is provided in the NSF/USGS PEIS.

Comparison of the Tolstoy *et al.* (2009) calibration study with the L–DEO's model for the *Langseth'*s 36-airgun array indicates that the model represents the actual received levels, within the first few kilometers and the locations of the predicted exclusion zones. However, the model for deep water (greater than 1,000 m; 3,280 ft) overestimated the received sound levels at a given distance but is still valid for defining exclusion zones at various tow depths. Because the tow depth of the array in the calibration study is less shallow (6 m [19.7 ft]) than the tow depths in the proposed survey (9 m [29.5 ft]), L–DEO used the following correction factors for estimating the received levels during the proposed surveys (see Table 1). The correction factors are the ratios of the 160, 180, and 190 dB distances from the modeled results for the 6,600 in^3 airgun arrays towed at 6 m (19.7 ft) versus 9, 12, or 15 m (29.5, 39.4, or 49.2 ft) (LGL, 2008). For a single airgun, the tow depth has minimal effect on the maximum near-field output and the shape of the frequency spectrum for the single airgun; thus, the predicted exclusion zones are essentially the same at different tow depths. The L–DEO's model does not allow for bottom interactions, and thus is most directly applicable to deep water.

Using the model (airgun array and single airgun), Table 1 (below) shows the distances at which three rms sound levels are expected to be received from the 36 airgun array and a single airgun. To avoid the potential for injury or permanent physiological damage (Level A harassment), NMFS's (1995, 2000) current practice is that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re 1 μPa and 190 dB re 1 μPa, respectively. L–DEO used these levels to establish the proposed exclusion zones. If marine mammals are detected within or about to enter the appropriate exclusion zone, the airguns would be powered-down (or shut-down, if necessary) immediately. NMFS also assumes that marine mammals exposed to levels exceeding 160 dB re 1 μPa may experience Level B harassment. Table 1 summarizes the predicted distances at which sound levels (160, 180, and 190 dB [rms]) are expected to be received from the 36 airgun array and a single airgun operating in deep water depths.

TABLE 1—MEASURED (ARRAY) OR PREDICTED (SINGLE AIRGUN) DISTANCES TO WHICH SOUND LEVELS ≥190, 180, AND 160 DB RE 1 μPA (RMS) COULD BE RECEIVED IN DEEP WATER DURING THE PROPOSED SEISMIC SURVEY IN THE NORTHWEST ATLANTIC OCEAN OFF THE EASTERN SEABOARD, AUGUST TO SEPTEMBER 2014 AND APRIL TO AUGUST 2015

Sound source and volume	Tow depth (m)	Water depth (m)	Predicted RMS radii distances (m)		
			190 dB	180 dB	160 dB
Single Bolt airgun (40 in^3)	9	>1,000	13 m (42.7 ft) *100 m would be used for pinnipeds as well as cetaceans.	100 m (328.1 ft)	388 m (1,273 ft).
36 airguns (6,600 in^3)	9	>1,000	286 m (938.3 ft)	927 m (3,041.3 ft)	5,780 m (18,963.3 ft).

Along with the airgun operations, two additional acoustical data acquisition systems would be operated from the *Langseth* continuously during seismic operations during the survey. The ocean floor would be mapped with the Kongsberg EM 122 multi-beam echosounder and a Knudsen 320B sub-bottom profiler. These sound sources would be operated continuously from the *Langseth* throughout the cruise, except for during transits at the beginning and end of the proposed survey.

Multi-Beam Echosounder

The *Langseth* would operate a Kongsberg EM 122 multi-beam echosounder concurrently during airgun operations to map characteristics of the ocean floor. The hull-mounted multi-beam echosounder emits brief pulses of sound (also called a ping) (10.5 to 13, usually 12 kHz) in a fan-shaped beam that extends downward and to the sides of the ship. The transmitting beamwidth is 1° or 2° fore-aft and 150° athwartship and the maximum source level is 242 dB re 1 μPa.

Each ping consists of eight (in water greater than 1,000 m) or four (less than 1,000 m) successive, fan-shaped transmissions, each ensonifying a sector that extends 1° fore-aft. Continuous-wave pulses increase from 2 to 15 milliseconds (ms) long in water depths up to 2,600 m (8,350.2 ft), and frequency modulated (FM) chirp pulses up to 100 ms long are used in water greater than 2,600 m. The successive transmissions span an overall cross-track angular extent of about 150°, with 2 ms gaps between the pulses for successive sectors (see Table 1 of the IHA application).

Sub-Bottom Profiler

The *Langseth* would also operate a Knudsen Chirp 3260 sub-bottom profiler continuously throughout the cruise simultaneously with the multi-beam echosounder to map and provide information about the sedimentary features and bottom topography. The beam is transmitted as a 27° cone, which is directed downward by a 3.5 kHz transducer in the hull of the *Langseth.* The nominal power output is 10 kilowatts (kW), but the actual maximum radiated power is 3 kW or 222 dB re 1 µPam. The ping duration is up to 64 milliseconds (ms). The ping interval is three to five seconds, depending on water depth. The sub-bottom profiler is capable of reaching water depths of 10,000 m (32,808.4 ft) and penetrating tens of meters into the sediments.

Both the multi-beam echosounder and sub-bottom profiler are operated continuously during survey operations. The multi-beam echosounder and sub-bottom profiler would not operate during transits at the beginning and end of the proposed seismic survey. Actual operating parameters would be established at the time of the survey.

NMFS expects that acoustic stimuli resulting from the proposed operation of the single airgun or the 36 airgun array has the potential to harass marine mammals. NMFS does not expect that the movement of the *Langseth,* during the conduct of the seismic survey, has the potential to harass marine mammals because of the relatively slow operation speed of the vessel (approximately 4.5 knots [kts]; 8.5 km/hr; 5.3 mph) during seismic acquisition.

Description of the Marine Mammals in the Area of the Proposed Specified Activity

Forty-five species of marine mammal (37 cetaceans [whales, dolphins, and porpoises] including 30 odontocetes and 7 mysticetes, 7 pinnipeds [seals and sea lions], and 1 sirenian [manatees]) are known to occur in the western North Atlantic Ocean study area (Read *et al.,* 2009; Waring *et al.,* 2013). Of those 45 species of marine mammals, 34 cetaceans and 4 pinnipeds could be found or are likely to occur in the proposed study area during the spring/summer/fall months. Several of these species are listed as endangered under the U.S. Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq.*), including the North Atlantic right (*Eubalaena glacialis*), humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and sperm (*Physeter macrocephalus*) whales. Fourteen cetacean species, although present in the wider western North Atlantic Ocean, are considered rare and likely would not be found near the proposed study area. The harbor porpoise (*Phocoena phocoena*) does not occur in deep offshore waters. The four pinniped species (harbor [*Phoca vitulina*], harp [*Phoca groenlandica*], gray [*Halichoerus grypus*], and hooded [*Cystophora cristata*] seals) are also considered coastal species (any sightings would be considered extralimital) and are not known to occur in the deep waters of the proposed survey area. No pinnipeds are expected to be present in the proposed study area. The West Indian manatee (*Trichechus manatus latirostris*) is listed as endangered under the ESA and is managed by the U.S. Fish and Wildlife Service and is not considered further in this proposed IHA notice.

General information on the taxonomy, ecology, distribution, seasonality and movements, and acoustic capabilities of marine mammals are given in sections 3.6.1, 3.7.1, and 3.8.1 of the NSF/USGS PEIS. The general distribution of mysticetes, odontocetes, and pinnipeds in the North Atlantic Ocean is discussed in sections 3.6.3.4, 3.7.3.4, and 3.8.3.4 of the NSF/USGS PEIS, respectively. In addition, Section 3.1 of the ''Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas Draft Programmatic Environmental Impact Statement'' (Bureau of Ocean Energy Management, 2012) reviews similar information for all marine mammals that may occur within the proposed study area.

Various systematic surveys have been conducted throughout the western North Atlantic Ocean, including within sections of the proposed study area. Records from the Ocean Biogeographic Information System (OBIS) database hosted by Rutgers University and Duke University (Read *et al.,* 2009) were used as the main source of information. The database includes survey data collected during the Cetaceans and Turtle Assessment Program (CeTAP) conducted between 1978 and 1982 that consists of both aerial and vessel-based surveys between Cape Hatteras, North Carolina, and the Gulf of Maine. The database also includes survey data collected during the NMFS Northeast Fisheries Science Center and Southeast Fisheries Science Center stock assessment surveys conducted in 2004 (surveys between Nova Scotia, Canada, and Florida).

No known current regional or stock abundance estimates are available in the proposed study area of the northwest Atlantic Ocean for the Bryde's whale (*Balaenoptera edeni*), Fraser's (*Lagenodelphis hosei*), spinner (*Stenella longirostris*), and Clymene dolphin (*Stenella clymene*), and melon-headed (*Peponocephala electra*), pygmy killer (*Feresa attenuata*), false killer (*Pseudorca crassidens*), and killer whales (*Orcinus orca*). Although NMFS does not have current regional population or stock abundance estimates for these species in the northwest Atlantic Ocean, abundance estimates from other areas such as the northern Gulf of Mexico stock, regional ocean basins (e.g., eastern tropical Pacific Ocean), or global summation are available. These abundance estimates are considered the best available information.

Bryde's whales are distributed worldwide in tropical and sub-tropical waters. In the western North Atlantic Ocean, Bryde's whales are reported from off the southeastern U.S. and the southern West Indies to Cabo Frio, Brazil (Leatherwood and Reeves, 1983). No stock of Bryde's whales has been identified in U.S. waters of the Atlantic coast. The northern Gulf of Mexico population is considered a separate stock and has a best abundance estimate of 33 animals. It has been postulated that the Bryde's whales found in the northern Gulf of Mexico may represent a resident stock (Schmidly, 1981; Leatherwood and Reeves, 1983).

Fraser's dolphins are distributed worldwide in tropical waters and are assumed to be part of the cetacean fauna of the tropical western North Atlantic (Perrin *et al.,* 1994). There are no abundance estimates for either the western North Atlantic or the northern Gulf of Mexico stocks. The western North Atlantic population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock. The numbers of Fraser's dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys. The population size for Fraser's dolphins is unknown; however, about 289,000 animals occur in the eastern tropical Pacific Ocean (Jefferson *et al.,* 2008).

Spinner dolphins are distributed in oceanic and coastal tropical waters (Leatherwood *et al.,* 1976). This is presumably an offshore, deep-water species, and its distribution in the Atlantic is poorly known (Schmidly, 1981; Perrin and Gilpatrick, 1994). The western North Atlantic population of spinner dolphins is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock. The numbers of spinner dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock since it was rarely seen in any of the surveys. The best abundance estimate available for the northern Gulf of Mexico spinner dolphins is 11,441 animals.

The Clymene dolphin is endemic to tropical and sub-tropical waters of the Atlantic (Jefferson and Curry, 2003). The western North Atlantic population of Clymene dolphins is provisionally considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock. The numbers of Clymene dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this species since it was rarely seen in any surveys. The best abundance estimate for the Clymene dolphin in the western North Atlantic was 6,086 in 2003 and represents the first and only estimate to date for this species in the U.S. Atlantic EEZ; however this estimate is older than eight years and is deemed unreliable (Wade and Angliss, 1997; Mullin and Fulling, 2003).

The melon-headed whale is distributed worldwide in tropical to sub-tropical waters (Jefferson *et al.,* 1994). The western North Atlantic population is provisionally being considered a separate stock from the northern Gulf of Mexico stock. The numbers of melon-headed whales off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys. The best abundance estimate available for northern Gulf of Mexico melon-headed whales is 2,235 animals.

The pygmy killer whale is distributed worldwide in tropical to sub-tropical waters and is assumed to be part of the cetacean fauna of the tropical western North Atlantic (Jefferson *et al.,* 1994). The western North Atlantic population of pygmy killer whales is provisionally being considered one stock for management purposes. The numbers of pygmy killer whales off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys. The best abundance estimate available for the northern Gulf of Mexico pygmy killer whale is 152 animals.

The false killer whale is distributed worldwide throughout warm temperate and tropical oceans (Leatherwood and Reeves, 1983). No stock has been identified for false killer whales in U.S. waters off the Atlantic coast. The Gulf of Mexico population is provisionally being considered one stock for management purposes, although there is currently no information to differentiate this stock from the Atlantic Ocean stock. The current population size for the false killer whale in the northern Gulf of Mexico is unknown because the survey data is more than 8 years old; however, the most recent abundance estimate pooled from 2003 to 2004 was 777 animals (Wade and Angliss, 1997; Mullin, 2007).

Killer whales are characterized as uncommon or rare in waters of the U.S. Atlantic EEZ (Katona *et al.,* 1988). Their distribution, however, extends from the Arctic ice-edge to the West Indies, often in offshore and mid-ocean areas. The size of the western North Atlantic stock population off the eastern U.S. coast is unknown. No information on stock differentiation for the Atlantic Ocean population exists, although an analysis of vocalizations of killer whales from Iceland and Norway indicated that whales from these areas may represent different stocks (Moore *et al.,* 1988). The northern Gulf of Mexico population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the Atlantic Ocean stock. The best abundance estimate available for northern Gulf of Mexico killer whales is 28 animals. There are estimated to be at least approximately 92,500 killer whales worldwide (i.e., 80,000 south of Antarctic Convergence, 445 in Norway, 8,500 in eastern tropical Pacific Ocean, 1,500 in North America coastal waters, and 2,000 in Japanese waters) (Jefferson *et al.,* 2008).Table 2 (below) presents information on the abundance, distribution, population status, and conservation status of the species of marine mammals that may occur in the proposed study area during August to September 2014 and April to August 2015.

TABLE 2—THE HABITAT, OCCURRENCE, RANGE, ABUNDANCE, AND CONSERVATION STATUS OF MARINE MAMMALS THAT MAY OCCUR IN OR NEAR THE PROPOSED SEISMIC SURVEY AREA IN THE NORTHWEST ATLANTIC OCEAN OFF THE EASTERN SEABOARD

[See text and Table 3 in USGS's IHA application for further details]

Species	Habitat	Occurrence	Range in Atlantic Ocean	Population estimate in the North Atlantic region/ stock/other [3]	ESA [1]	MMPA [2]
Mysticetes:						
North Atlantic right whale (*Eubalaena glacialis*).	Pelagic, shelf and coastal	Regular	Canada to Florida	455/455 (Western Atlantic stock).	EN	D
Humpback whale (*Megaptera novaeangliae*).	Mainly nearshore, banks	Regular	Canada to Caribbean	11,600 [4]/823 (Gulf of Maine stock).	EN	D
Minke whale (*Balaenoptera acutorostrata*).	Pelagic and coastal	Regular	Arctic to Caribbean	138,000 [5]/20,741 (Canadian East Coast stock).	NL	NC
Bryde's whale (*Balaenoptera edeni*).	Coastal, offshore	Rare	40° North to 40° South	NA/NA/33 (Northern Gulf of Mexico stock)/20,000 to 30,000 [16] (North Pacific Ocean).	NL	NC
Sei whale (*Balaenoptera borealis*).	Primarily offshore, pelagic	Rare	Canada to New Jersey	10,300 [6]/357 (Nova Scotia stock).	EN	D

TABLE 2—THE HABITAT, OCCURRENCE, RANGE, ABUNDANCE, AND CONSERVATION STATUS OF MARINE MAMMALS THAT MAY OCCUR IN OR NEAR THE PROPOSED SEISMIC SURVEY AREA IN THE NORTHWEST ATLANTIC OCEAN OFF THE EASTERN SEABOARD—Continued

[See text and Table 3 in USGS's IHA application for further details]

Species	Habitat	Occurrence	Range in Atlantic Ocean	Population estimate in the North Atlantic region/stock/other [3]	ESA [1]	MMPA [2]
Fin whale (*Balaenoptera physalus*).	Continental slope, pelagic	Regular	Canada to North Carolina	26,500 [7]/3,522 (Western North Atlantic stock).	EN	D
Blue whale (*Balaenoptera musculus*).	Pelagic, shelf, coastal	Rare	Arctic to Florida	855 [8]/440 (Western North Atlantic stock).	EN	D
Odontocetes:						
Sperm whale (*Physeter macrocephalus*).	Pelagic, slope, canyons, deep sea.	Regular	Canada to Caribbean	13,190 [9]/2,288 (North Atlantic stocks).	EN	D
Pygmy sperm whale (*Kogia breviceps*).	Deep waters off shelf	Rare	Massachusetts to Florida	NA/3,785 (Western North Atlantic stock).	NL	NC
Dwarf sperm whale (*Kogia sima*).	Deep waters off shelf	Rare	Massachusetts to Florida	....	NL	NC
Cuvier's beaked whale (*Ziphius cavirostris*).	Pelagic, slope, canyons	Rare	Canada to Caribbean	NA/6,532 (Western North Atlantic stock).	NL	NC
Northern bottlenose whale (*Hyperoodon ampullatus*).	Pelagic	Rare	Arctic to New Jersey	40,000 [10]/NA (Western North Atlantic stock).	NL	NC
True's beaked whale (*Mesoplodon mirus*).	Pelagic, slope, canyons	Rare	Canada to Bahamas	NA/7,092 (Western North Atlantic stock).	NL	NC
Gervais' beaked whale (*Mesoplodon europaeus*).	Pelagic, slope, canyons	Rare	Canada to Florida	....	NL	NC
Sowerby's beaked whale (*Mesoplodon bidens*).	Pelagic, slope, canyons	Rare	Canada to Florida	....	NL	NC
Blainville's beaked whale (*Mesoplodon densirostris*).	Pelagic, slope, canyons	Rare	Canada to Florida	....	NL	NC
Bottlenose dolphin (*Tursiops truncatus*).	Coastal, oceanic, shelf break.	Regular	Canada to Florida	NA/77,532 (Western North Atlantic Offshore stock).	NL	NC
Atlantic white-sided dolphin (*Lagenorhynchus acutus*).	Shelf and slope	Regular	Greenland to North Carolina.	10,000 to 100,000s [11]/48,819 (Western North Atlantic stock).	NL	NC
Fraser's dolphin (*Lagenodelphis hosei*).	Shelf and slope	Rare	North Carolina to Florida	NA/NA (Western North Atlantic stock)/289,000 [16] (eastern tropical Pacific Ocean).	NL	NC
Atlantic spotted dolphin (*Stenella frontalis*).	Shelf, offshore	Regular	Massachusetts to Caribbean.	NA/44,715 (Western North Atlantic stock).	NL	NC
Pantropical spotted dolphin (*Stenella attenuata*).	Coastal, shelf, slope	Regular	Massachusetts to Florida	NA/3,333 (Western North Atlantic stock).	NL	NC
Striped dolphin (*Stenella coeruleoalba*).	Off continental shelf, convergence zones, upwelling.	Regular	Canada to Caribbean	NA/54,807 (Western North Atlantic stock).	NL	NC
Spinner dolphin (*Stenella longirostris*).	Mainly nearshore	Rare	Maine to Caribbean	NA/NA (Western North Atlantic stock)/11,441 (Northern Gulf of Mexico stock)/1,250,000 [16] (eastern tropical Pacific Ocean).	NL	NC
Clymene dolphin (*Stenella clymene*).	Coastal, shelf, slope	Rare	North Carolina to Florida	NA/NA (Western North Atlantic stock—6,086 in 2003)/129 (Northern Gulf of Mexico stock).	NL	NC
Short-beaked common dolphin (*Delphinus delphis*).	Shelf, pelagic, seamounts	Regular	Canada to Georgia	NA/173,486 (Western North Atlantic stock).	NL	NC

TABLE 2—THE HABITAT, OCCURRENCE, RANGE, ABUNDANCE, AND CONSERVATION STATUS OF MARINE MAMMALS THAT MAY OCCUR IN OR NEAR THE PROPOSED SEISMIC SURVEY AREA IN THE NORTHWEST ATLANTIC OCEAN OFF THE EASTERN SEABOARD—Continued

[See text and Table 3 in USGS's IHA application for further details]

Species	Habitat	Occurrence	Range in Atlantic Ocean	Population estimate in the North Atlantic region/ stock/other [3]	ESA [1]	MMPA [2]
Rough-toothed dolphin (*Steno bredanensis*).	Pelagic	Rare	New Jersey to Florida	NA/271 (Western North Atlantic stock).	NL	NC
Risso's dolphin (*Grampus griseus*).	Shelf, slope, seamounts	Regular	Canada to Florida	NA/18,250 (Western North Atlantic stock).	NL	NC
Melon-headed whale (*Peponocephala electra*).	Deep waters off shelf	Rare	North Carolina to Florida	NA/NA (Western North Atlantic stock)/2,235 (Northern Gulf of Mexico stock)/45,000 [16] (eastern tropical Pacific Ocean).	NL	NC
Pygmy killer whale (*Feresa attenuata*).	Pelagic	Rare	NA	NA/NA (Western North Atlantic stock)/152 (Northern Gulf of Mexico stock)/39,000 [16] (eastern tropical Pacific Ocean).	NL	NC
False killer whale (*Pseudorca crassidens*).	Pelagic	Rare	NA	NA/NA/777 in 2003–2004 (Northern Gulf of Mexico stock).	NL	NC
Killer whale (*Orcinus orca*).	Pelagic, shelf, coastal	Rare	Arctic to Caribbean	NA/NA (Western North Atlantic stock)/28 (Northern Gulf of Mexico stock)/At least ~92,500 [16] Worldwide.	NL	NC
Short-finned pilot whale (*Globicephala macrorhynchus*).	Mostly pelagic, high relief	Regular	Massachusetts to Florida	780,000 [12]/21,515 short-finned pilot whale 26,535 long-finned pilot whale (Western North Atlantic stock).	NL	NC
Long-finned pilot whale (*Globicephala melas*).	Mostly pelagic	Regular	Canada to South Carolina	NL	NC	
Harbor porpoise (*Phocoena phocoena*).	Shelf, coastal, pelagic	Rare	Canada to North Carolina	~500,000 [13]/79,883 (Gulf of Maine/Bay of Fundy stock).	NL	NC
Pinnipeds:						
Harbor seal (*Phoca vitulina concolor*).	Coastal	Rare	Canada to North Carolina	NA/70,142 (Western North Atlantic stock).	NL	NC
Gray seal (*Halichoerus grypus*).	Coastal, pelagic	Rare	Canada to North Carolina	NA/331,000 (Western North Atlantic stock).	NL	NC
Harp seal (*Phoca groenlandica*).	Ice whelpers, pelagic	Rare	Canada to New Jersey	8.6 to 9.6 million [14]/7.1 million (Western North Atlantic stock).	NL	NC
Hooded seal (*Cystophora cristata*).	Ice whelpers, pelagic	Rare	Canada to Caribbean	600,000/592,100 (Western North Atlantic stock).	NL	NC

NA = Not available or not assessed.
[1] U.S. Endangered Species Act: EN = Endangered, T = Threatened, DL = Delisted, NL = Not listed.
[2] U.S. Marine Mammal Protection Act: D = Depleted, NC = Not Classified.
[3] NMFS Marine Mammal Stock Assessment Reports.
[4] Best estimate for western North Atlantic 1992 to 1993 (IWC, 2014).
[5] Best estimate for North Atlantic 2002 to 2007 (IWC, 2014).
[6] Estimate for the Northeast Atlantic in 1989 (Cattanach *et al.,* 1993).
[7] Best estimate for North Atlantic 2007 (IWC, 2014) .
[8] Central and Northeast Atlantic 2001 (Pike *et al.,* 2009).
[9] North Atlantic (Whitehead, 2002).
[10] Eastern North Atlantic (NAMMCO, 1995).
[11] North Atlantic (Reeves et al., 1999).
[12] *Globicephala* spp. combined, Central and Eastern North Atlantic (IWC, 2014).
[13] North Atlantic (Jefferson *et al.,* 2008).
[14] Northwest Atlantic (DFO, 2012).
[15] Northwest Atlantic (Andersen et al., 2009).
[16] Jefferson *et al.* (2008).

Further detailed information regarding the biology, distribution, seasonality, life history, and occurrence of these marine mammal species in the proposed project area can be found in sections 3 and 4 of USGS's IHA application. NMFS has reviewed these data and determined them to be the best available scientific information for the purposes of the proposed IHA.

Potential Effects of the Specified Activity on Marine Mammals

This section includes a summary and discussion of the ways that the types of stressors associated with the specified activity (e.g., seismic airgun operation, vessel movement, gear deployment) have been observed to impact marine mammals. This discussion may also include reactions that we consider to rise to the level of a take and those that we do not consider to rise to the level of take (for example, with acoustics), we may include a discussion of studies that showed animals not reacting at all to sound or exhibiting barely measureable avoidance). This section is intended as a background of potential effects and does not consider either the specific manner in which this activity would be carried out or the mitigation that would be implemented, and how either of those would shape the anticipated impacts from this specific activity. The ''Estimated Take by Incidental Harassment'' section later in this document will include a quantitative analysis of the number of individuals that are expected to be taken by this activity. The ''Negligible Impact Analysis'' section will include the analysis of how this specific activity would impact marine mammals and will consider the content of this section, the ''Estimated Take by Incidental Harassment'' section, the ''Proposed Mitigation'' section, and the ''Anticipated Effects on Marine Mammal Habitat'' section to draw conclusions regarding the likely impacts of this activity on the reproductive success or survivorship of individuals and from that on the affected marine mammal populations or stocks.

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms have been derived using auditory evoked potentials, anatomical modeling, and other data, Southall *et al.* (2007) designate ''functional hearing groups'' for marine mammals and estimate the lower and upper frequencies of functional hearing groups'' for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- Low-frequency cetaceans (13 species of mysticetes): Functional hearing is estimated to occur between approximately 7 Hz and 30 kHz;
- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): Functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;
- High-frequency cetaceans (eight species of true porpoises, six species of river dolphins, *Kogia* spp., the franciscana [*Pontoporia blainvillei*], and four species of cephalorhynchids): Functional hearing is estimated to occur between approximately 200 Hz and 180 kHz; and
- Phocid pinnipeds in water: Functional hearing is estimated to occur between approximately 75 Hz and 100 kHz;
- Otariid pinnipeds in water: Functional hearing is estimated to occur between approximately 100 Hz and 40 kHz.

As mentioned previously in this document, 38 marine mammal species (34 cetacean and 4 pinniped species) are likely to occur in the proposed seismic survey area. Of the 34 cetacean species likely to occur in USGS's proposed action area, 7 are classified as low-frequency cetaceans (i.e., North Atlantic right, humpback, minke, Bryde's, sei, fin, and blue whale), 24 are classified as mid-frequency cetaceans (i.e., sperm, Cuvier's, True's, Gervais', Sowerby's, Blainville's, Northern bottlenose, melon-headed, pygmy killer, false killer, killer, short-finned, and long-finned whale, bottlenose, Atlantic white-sided, Fraser's, Atlantic spotted, pantropical spotted, striped, spinner, Clymene, short-beaked common, rough-toothed, and Risso's dolphin), and 3 are classified as high-frequency cetaceans (i.e., pygmy sperm and dwarf sperm whale and harbor porpoise) (Southall *et al.,* 2007). A species' functional hearing group is a consideration when we analyze the effects of exposure to sound on marine mammals.

Acoustic stimuli generated by the operation of the airguns, which introduce sound into the marine environment, may have the potential to cause Level B harassment of marine mammals in the proposed survey area. The effects of sounds from airgun operations might include one or more of the following: Tolerance, masking (of natural sounds including inter- and intra-specific calls), behavioral disturbance, 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; Wright *et al.,* 2007; Tyack, 2009). Permanent hearing impairment, in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall *et al.,* 2007). Although the possibility cannot be entirely excluded, it is unlikely that the proposed project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. Based on the available data and studies described here, some behavioral disturbance is expected. A more comprehensive review of these issues can be found in the NSF/USGS PEIS (2011) and L–DEO's ''Draft Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September to October 2014.''

Tolerance

Richardson *et al.* (1995) defines tolerance as the occurrence of marine mammals in areas where they are exposed to human activities or man-made noise. In many cases, tolerance develops by the animal habituating to the stimulus (i.e., the gradual waning of responses to a repeated or ongoing stimulus) (Thorpe, 1963; Richardson, *et al.,* 1995), but because of ecological or physiological requirements, many marine animals may need to remain in areas where they are exposed to chronic stimuli (Richardson, *et al.,* 1995).

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Several studies have shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response (Malme *et al.,* 1985; Richardson *et al.,* 1986; Ljungblad *et al.,* 1988; McCauley *et al.,* 2000a). That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of the marine mammal group. Although various baleen and toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times marine mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales and pinnipeds are quite variable and depend on factors such as species, age, and previous exposures of the animal to human-generated sound.

Masking

The term masking refers to the inability of a subject to recognize the occurrence of an acoustic stimulus as a result of the interference of another acoustic stimulus (Clark *et al.,* 2009). Introduced underwater sound may, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson *et al.,* 1995).

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited. Because of the intermittent nature and low duty cycle of seismic airgun pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in some situations, reverberation occurs for much or the entire interval between pulses (e.g., Simard *et al.,* 2005; Clark and Gagnon, 2006) which could mask calls. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls can usually be heard between the seismic pulses (e.g., Richardson *et al.,* 1986; McDonald *et al.,* 1995; Greene *et al.,* 1999; Nieukirk *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a,b, 2006; and Dunn and Hernandez, 2009). However, Clark and Gagnon (2006) reported that fin whales in the North Atlantic Ocean went silent for an extended period starting soon after the onset of a seismic survey in the area. Similarly, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles *et al.,* 1994). However, more recent studies found that they continued calling in the presence of seismic pulses (Madsen *et al.,* 2002; Tyack *et al.,* 2003; Smultea *et al.,* 2004; Holst *et al.,* 2006; and Jochens *et al.,* 2008). Dilorio and Clark (2009) found evidence of increased calling by blue whales during operations by a lower-energy seismic source (i.e., sparker). Dolphins and porpoises commonly are heard calling while airguns are operating (e.g., Gordon *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a, b; and Potter *et al.,* 2007). The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking.

Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior through shifting call frequencies, increasing call volume, and increasing vocalization rates. For example, blue whales are found to increase call rates when exposed to noise from seismic surveys in the St. Lawrence Estuary (Dilorio and Clark, 2009). The North Atlantic right whales exposed to high shipping noise increased call frequency (Parks *et al.,* 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller *et al.,* 2000). In general, NMFS expects the masking effects of seismic pulses to be minor, given the normally intermittent nature of seismic pulses.

Behavioral Disturbance

Marine mammals may behaviorally react to sound when exposed to anthropogenic noise. Disturbance includes a variety of effects, including (but not limited to) subtle to conspicuous changes in behavior, movement, and displacement (Nowacek *et al.,* 2007; Tyack, 2009). Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson *et al.,* 1995; Wartzok *et al.,* 2004; Southall *et al.,* 2007; Weilgart, 2007). These behavioral reactions are often shown as: Changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (e.g., pinnipeds flushing into the water from haul-outs or rookeries). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder, 2007; Weilgart, 2007).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects growth, survival, and/or reproduction. Some of these significant behavioral modifications include:

• Change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);

• Habitat abandonment due to loss of desirable acoustic environment; and

• Cessation of feeding or social interaction.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Richardson *et al.,* 1995; Southall *et al.,* 2007). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically-important manner.

Baleen Whales—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable (reviewed in Richardson *et al.,* 1995; Gordon *et al.,* 2004). 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 (*Eschrichtius robustus*) and bowhead (*Balaena mysticetus*) whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals (Richardson, *et al.,* 1995). 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).

Studies of gray, bowhead, and humpback whales have shown that seismic pulses with received levels of 160 to 170 dB re 1 μPa (rms) seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed (Malme *et al.,* 1986, 1988; Richardson *et al.,* 1995). In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 4 to 15 km (2.2 to 8.1 nmi) from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other strong behavioral reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and studies have shown that some species of baleen whales, notably bowhead, gray, and humpback whales, at times, show strong avoidance at received levels lower than 160 to 170 dB re 1 μPa (rms).

Researchers have studied the responses of humpback whales to seismic surveys during migration, feeding during the summer months, breeding while offshore from Angola, and wintering offshore from Brazil. McCauley *et al.* (1998, 2000a) studied the responses of humpback whales off western Australia to a full-scale seismic survey with a 16-airgun array (2,678 in ^{3}) and to a single airgun (20 in^3) with source level of 227 dB re 1 μPa (p-p). In the 1998 study, they documented that avoidance reactions began at 5 to 8 km (2.7 to 4.3 nmi) from the array, and that those reactions kept most pods approximately 3 to 4 km (1.6 to 2.2 nmi) from the operating seismic boat. In the 2000 study, they noted localized displacement during migration of 4 to 5 km (2.2 to 2.7 nmi) by traveling pods and 7 to 12 km (3.8 to 6.5 nmi) by more sensitive resting pods of cow-calf pairs. Avoidance distances with respect to the single airgun were smaller but consistent with the results from the full array in terms of the received sound levels. The mean received level for initial avoidance of an approaching airgun was 140 dB re 1 μPa (rms) for humpback pods containing females, and at the mean closest point of approach distance from the received level was 143 dB re 1 μPa (rms). The initial avoidance response generally occurred at distances of 5 to 8 km (2.7 to 4.3 nmi) from the airgun array and 2 km (1.1 nmi) from the single airgun. However, some individual humpback whales, especially males, approached within distances of 100 to 400 m (328 to 1,312 ft), where the maximum received level was 179 dB re 1 μPa (rms) (McCauley *et al.,* 1998, 2000b).

Data collected by observers during several seismic surveys in the Northwest Atlantic showed that sighting rates of humpback whales were significantly greater during non-seismic periods compared with periods when a full array was operating (Moulton and Holst, 2010). In addition, humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods (Moulton and Holst, 2010).

Humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64–L (100 in^3) airgun (Malme *et al.,* 1985). Some humpbacks seemed ''startled'' at received levels of 150 to 169 dB re 1 μPa. Malme *et al.* (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 dB re 1 μPa (rms). However, Moulton and Holst (2010) reported that humpback whales monitored during seismic surveys in the Northwest Atlantic had lower sighting rates and were most often seen swimming away from the vessel during seismic periods compared with periods when airguns were silent.

Studies have suggested that South Atlantic humpback whales in the South Atlantic Ocean wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel *et al.,* 2004). The evidence for this was circumstantial and subject to alternative explanations (IAGC, 2004). Also, the evidence was not consistent with subsequent results from the same area of Brazil (Parente *et al.,* 2006), or with direct studies of humpbacks exposed to seismic surveys in other areas and seasons. After allowance for data from subsequent years, there was ''no observable direct correlation'' between strandings and seismic surveys (IWC, 2007: 236).

Reactions of migrating and feeding (but not wintering) gray whales to seismic surveys have been studied. Malme *et al.* (1986, 1988) studied the responses of feeding Eastern North Pacific gray whales to pulses from a single 100 in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50 percent of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa (rms). 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 North Pacific gray whales feeding off Sakhalin Island, Russia (Wursig *et al.,* 1999; Gailey *et al.,* 2007; Johnson *et al.,* 2007; Yazvenko *et al.,* 2007a, b), along with data on gray whales off British Columbia (Bain and Williams, 2006).

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses (Stone, 2003; MacLean and Haley, 2004; Stone and Tasker, 2006), and calls from blue and fin whales have been localized in areas with airgun operations (e.g., McDonald *et al.,* 1995; Dunn and Hernandez, 2009; Castellote *et al.,* 2010). Sightings by observers on seismic vessels off the United Kingdom from 1997 to 2000 suggest that, during times of good sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting vs. silent (Stone, 2003; Stone and Tasker, 2006). However, these whales tended to exhibit localized avoidance, remaining significantly further (on average) from the airgun array during seismic operations compared with non-seismic periods (Stone and Tasker, 2006). Castellote *et al.* (2010) reported that singing fin whales in the Mediterranean moved away from an operating airgun array.

Ship-based monitoring studies of baleen whales (including blue, fin, sei, minke, and humpback whales) in the Northwest Atlantic found that overall, this group had lower sighting rates during seismic vs. non-seismic periods (Moulton and Holst, 2010). Baleen whales as a group were also seen significantly farther from the vessel during seismic compared with non-seismic periods, and they were more often seen to be swimming away from the operating seismic vessel (Moulton and Holst, 2010). Blue and minke whales were initially sighted significantly farther from the vessel during seismic operations compared to non-seismic periods; the same trend was observed for fin whales (Moulton and Holst, 2010). Minke whales were most often observed to be swimming away from the vessel when seismic operations were underway (Moulton and Holst, 2010).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A in

Malme *et al.,* 1984; Richardson *et al.,* 1995; Allen and Angliss, 2010). The Western North Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year (Johnson *et al.,* 2007). Similarly, bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years (Richardson *et al.,* 1987; Allen and Angliss, 2010). The history of coexistence between seismic surveys and baleen whales suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects.

Toothed Whales—There is little systematic information available about reactions of toothed whales to noise pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above have been reported for toothed whales. However, there are recent systematic studies on sperm whales (e.g., Gordon *et al.,* 2006; Madsen *et al.,* 2006; Winsor and Mate, 2006; Jochens *et al.,* 2008; Miller *et al.,* 2009). There is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone, 2003; Smultea *et al.,* 2004; Moulton and Miller, 2005; Bain and Williams, 2006; Holst *et al.,* 2006; Stone and Tasker, 2006; Potter *et al.,* 2007; Hauser *et al.,* 2008; Holst and Smultea, 2008; Weir, 2008; Barkaszi *et al.,* 2009; Richardson *et al.,* 2009; Moulton and Holst, 2010).

Seismic operators and Protected Species Observers (PSOs) on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (e.g., Goold, 1996a,b,c; Calambokidis and Osmek, 1998; Stone, 2003; Moulton and Miller, 2005; Holst *et al.,* 2006; Stone and Tasker, 2006; Weir, 2008; Richardson *et al.,* 2009; Barkaszi *et al.,* 2009; Moulton and Holst, 2010). Some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing (e.g., Moulton and Miller, 2005). Nonetheless, small toothed whales more often tend to head away, or to maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (e.g., Stone and Tasker, 2006; Weir, 2008; Barry *et al.,* 2010; Moulton and Holst, 2010). In most cases, the avoidance radii for delphinids appear to be small, on the order of one km (0.5 nmi) or less, and some individuals show no apparent avoidance. Based on observations from seismic surveys off the United Kingdom, small odontocetes exhibited greater avoidance to operating airguns than previously reported (Stone *et al.,* 2003; Gordon *et al.,* 2004; Stone and Tasker, 2006). The observer data also indicated that small odontocetes were feeding less and were interacting with the vessel less during active seismic surveys. Captive bottlenose dolphins and beluga whales (*Delphinapterus leucas*) exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran *et al.,* 2000, 2002, 2005). However, the animals tolerated high, received levels of sound before exhibiting aversive behaviors.

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

Most studies of sperm whales exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses (e.g., Stone, 2003; Moulton *et al.,* 2005, 2006a; Stone and Tasker, 2006; Weir, 2008). In most cases the whales do not show strong avoidance, and they continue to call. However, controlled exposure experiments in the Gulf of Mexico indicate that foraging behavior was altered upon exposure to airgun sound (Jochens *et al.,* 2008; Miller *et al.,* 2009; Tyack, 2009).

There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. However, some northern bottlenose whales remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys (Gosselin and Lawson, 2004; Laurinolli and Cochrane, 2005; Simard *et al.,* 2005). Most beaked whales are illusive and tend to avoid approaching vessels of other types (e.g., Wursig *et al.,* 1998). They may also dive for an extended period when approached by a vessel (e.g., Kasuya, 1986), although it is uncertain how much longer such dives may be as compared to dives by undisturbed beaked whales, which also are often quite long (Baird *et al.,* 2006; Tyack *et al.,* 2006). Based on a single observation, Aguilar-Soto *et al.* (2006) suggested that foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels. In any event, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel, although this has not been documented definitively. In fact, Moulton and Holst (2010) reported 15 sightings of beaked whales during seismic studies in the Northwest Atlantic; seven of those sightings were made at times when at least one airgun was operating. There was little evidence to indicate that beaked whale behavior was affected by airgun operations; sighting rates and distances were similar during seismic and non-seismic periods (Moulton and Holst, 2010).

There are indications that some beaked whales may strand when naval exercises involving mid-frequency sonar operation are ongoing nearby (e.g., Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; NOAA and USN, 2001; Jepson *et al.,* 2003; Hildebrand, 2005; Barlow and Gisiner, 2006; see also the ''Stranding and Mortality'' section in this notice). These strandings are apparently a disturbance response, although auditory or other injuries or other physiological effects may also be involved. Whether beaked whales would ever react similarly to seismic surveys is unknown. Seismic survey sounds are quite different from those of the sonar in operation during the above-cited incidents.

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids and Dall's porpoises, seem to be confined to a smaller radius than has been observed for the more responsive of some mysticetes. However, other data suggest that some odontocete species, including harbor porpoises, may be more responsive than might be expected given their poor low-frequency hearing. Reactions at longer distances may be particularly likely when sound propagation conditions are conducive to transmission of the higher frequency components of airgun sound to the animals' location (DeRuiter *et al.,* 2006; Goold and Coates, 2006; Tyack *et al.,* 2006; Potter *et al.,* 2007).

Pinnipeds—Information on the reaction of pinniped species to pulsed seismic airgun sounds is limited. Based on early observations, pinnipeds appear to be quite tolerant of pulsed sounds. Other reports indicate that pinnipeds were tolerant of loud, pulsed sounds when they were strongly attracted to an area for feeding or reproductive purposes (Mate and Harvey, 1987; Reeves *et al.,* 1996). In most recent studies, avoidance of pinnipeds during seismic surveys has been reported as being relatively small, within 100 to few hundred meters. Many seals remained within 100 to 200 m (328.1 to 656.2 ft) of the survey tracklines while an operating seismic survey passed (Harris *et al.,* 2001; Moulton and Lawson, 2002). Other observations made during seismic surveys in the Chukchi and Beaufort Seas reported that pinnipeds (i.e., ringed seals [*Phoca hispida*]) were observed less when seismic airguns were operating than when they were silent (Miller *et al.,* 2005). In Puget Sound, sighting distances for harbor seals and California sea lions (Zalophus californianus) tended to be larger when airguns were operating (Calambokidis and Osmek, 1998). Previous telemetry work suggests that avoidance and other behavioral reactions may be stronger than evident to date from visual studies (Thompson *et al.,* 1998). Overall, behavioral reactions from pinnipeds to pulsed seismic sounds are variable. It is expected that localized avoidance of operating seismic airguns may occur; however, it cannot be guaranteed that these species would fully avoid an operating seismic vessel during active surveys.

Hearing Impairment and Other Physical Effects

Exposure to high intensity sound for a sufficient duration may result in auditory effects such as a noise-induced threshold shift—an increase in the auditory threshold after exposure to noise (Finneran, Carder, Schlundt, and Ridgway, 2005). Factors that influence the amount of threshold shift include the amplitude, duration, frequency content, temporal pattern, and energy distribution of noise exposure. The magnitude of hearing threshold shift normally decreases over time following cessation of the noise exposure. The amount of threshold shift just after exposure is called the initial threshold shift. If the threshold shift eventually returns to zero (i.e., the threshold returns to the pre-exposure value), it is called temporary threshold shift (TTS) (Southall *et al.,* 2007).

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

Temporary Threshold Shift—TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound. Available data on TTS in marine mammals are summarized in Southall *et al.* (2007). Table 1 (above) presents the estimated distances from the *Langseth's* airguns at which the received energy level (per pulse, flat-weighted) would be expected to be greater than or equal to 180 or 190 dB re 1 μPa (rms).

To avoid the potential for injury (i.e., Level A harassment), NMFS (1995, 2000) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 and 190 dB re 1 μPa (rms), respectively. The established 180 and 190 dB (rms) criteria are not considered to be the levels above which TTS might occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. NMFS also assumes that cetaceans and pinnipeds exposed to levels exceeding 160 dB re 1 μPa (rms) may experience Level B harassment.

For toothed whales, researchers have derived TTS information for odontocetes from studies on the bottlenose dolphin and beluga. The experiments show that exposure to a single impulse at a received level of 207 kPa (or 30 psi, p-p), which is equivalent to 228 dB re 1 Pa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran *et al.,* 2002). For the one harbor porpoise tested, the received level of airgun sound that elicited onset of TTS was lower (Lucke *et al.,* 2009). If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (*cf.* Southall *et al.,* 2007). Some cetaceans apparently can incur TTS at considerably lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies to which baleen whales are most sensitive are assumed to be lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison, 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales than those of odontocetes (Southall *et al.,* 2007).

Permanent Threshold Shift—When PTS occurs, there is physical damage to the sound receptors in the ear. In severe cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985). There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that 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.,* 2008). 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.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals (Southall *et al.,* 2007). PTS might occur at a received sound level at least several dBs above that inducing mild TTS if the animal were exposed to strong sound pulses with rapid rise times. Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as airgun pulses as received close to the source) is at least 6 dB higher than the

TTS threshold on a peak-pressure basis, and probably greater than 6 dB (Southall *et al.,* 2007).

Given the higher level of sound necessary to cause PTS as compared with TTS, it is considerably less likely that PTS would occur. Baleen whales generally avoid the immediate area around operating seismic vessels, as do some other marine mammals. Some pinnipeds show avoidance reactions to airguns, but their avoidance reactions are generally not as strong or consistent as those of cetaceans, and occasionally they seem to be attracted to operating seismic vessels (NMFS, 2010).

Non-auditory Physiological Effects—Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007). Studies examining such effects are limited. However, resonance effects (Gentry, 2002) and direct noise-induced bubble formations (Crum *et al.,* 2005) are implausible in the case of exposure to an impulsive broadband source like an airgun array. If seismic surveys disrupt diving patterns of deep-diving species, this might perhaps result in bubble formation and a form of the bends, as speculated to occur in beaked whales exposed to sonar. However, there is no specific evidence of this upon exposure to airgun pulses.

In general, very little is known about the potential for seismic survey sounds (or other types of strong underwater sounds) to cause non-auditory physical effects in marine mammals. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.,* 2007), or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. 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.

Stranding and Mortality—When a living or dead marine mammal swims or floats onto shore and becomes ''beached'' or incapable of returning to sea, the event is termed a ''stranding'' (Geraci *et al.,* 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding under the MMPA is that ''(A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance.''

Marine mammals are known to strand for a variety of reasons, such as infectious agents, biotoxicosis, starvation, fishery interaction, ship strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series. However, the cause or causes of most strandings are unknown (Geraci *et al.,* 1976; Eaton, 1979; Odell *et al.,* 1980; Best, 1982). Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Chroussos, 2000; Creel, 2005; DeVries *et al.,* 2003; Fair and Becker, 2000; Foley *et al.,* 2001; Moberg, 2000; Relyea, 2005a, 2005b; Romero, 2004; Sih *et al.,* 2004).

Strandings Associated with Military Active Sonar—Several sources have published lists of mass stranding events of cetaceans in an attempt to identify relationships between those stranding events and military active sonar (Hildebrand, 2004; IWC, 2005; Taylor et al., 2004). For example, based on a review of stranding records between 1960 and 1995, the International Whaling Commission (2005) identified ten mass stranding events and concluded that, out of eight stranding events reported from the mid-1980s to the summer of 2003, seven had been coincident with the use of mid-frequency active sonar and most involved beaked whales.

Over the past 12 years, there have been five stranding events coincident with military mid-frequency active sonar use in which exposure to sonar is believed to have been a contributing factor to strandings: Greece (1996); the Bahamas (2000); Madeira (2000); Canary Islands (2002); and Spain (2006). Refer to Cox *et al.* (2006) for a summary of common features shared by the strandings events in Greece (1996), Bahamas (2000), Madeira (2000), and Canary Islands (2002); and Fernandez *et al.,* (2005) for an additional summary of the Canary Islands 2002 stranding event. USGS would not be using military sonars; therefore, NMFS does not expect these potential effects to marine mammals.

Potential for Stranding from Seismic Surveys—Marine mammals close to underwater detonations of high explosives can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.,* 1993; Ketten, 1995). However, explosives are no longer used in marine waters for commercial seismic surveys or (with rare exceptions) for seismic research. These methods have been replaced entirely by airguns or related non-explosive pulse generators. Airgun pulses are less energetic and have slower rise times, and there is no specific evidence that they can cause serious injury, death, or stranding even in the case of large airgun arrays. However, the association of strandings of beaked whales with naval exercises involving mid-frequency active sonar (non-pulse sound) and, in one case, the co-occurrence of an L–DEO seismic survey (Malakoff, 2002; Cox *et al.,* 2006), has raised the possibility that beaked whales exposed to strong ''pulsed'' sounds could also be susceptible to injury and/or behavioral reactions that can lead to stranding (e.g., Hildebrand, 2005; Southall *et al.,* 2007).

Specific sound-related processes that lead to strandings and mortality are not well documented, but may include:

(1) Swimming in avoidance of a sound into shallow water;

(2) A change in behavior (such as a change in diving behavior) that might contribute to tissue damage, gas bubble formation, hypoxia, cardiac arrhythmia, hypertensive hemorrhage or other forms of trauma;

(3) A physiological change such as a vestibular response leading to a behavioral change or stress-induced hemorrhagic diathesis, leading in turn to tissue damage; and

(4) Tissue damage directly from sound exposure, such as through acoustically-mediated bubble formation and growth or acoustic resonance of tissues.

Some of these mechanisms are unlikely to apply in the case of impulse sounds. However, there are indications that gas-bubble disease (analogous to ''the bends''), induced in supersaturated tissue by a behavioral response to acoustic exposure, could be a pathologic mechanism for the strandings and mortality of some deep-diving cetaceans exposed to sonar. The evidence for this remains circumstantial and associated with exposure to naval mid-frequency sonar, not seismic surveys (Cox *et al.,* 2006; Southall *et al.,* 2007).

Seismic pulses and mid-frequency sonar signals are quite different, and some mechanisms by which sonar sounds have been hypothesized to affect beaked whales are unlikely to apply to airgun pulses. Sounds produced by airgun arrays are broadband impulses with most of the energy below one kHz. Typical military mid-frequency sonar emits non-impulse sounds at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time. A further difference between seismic surveys and naval exercises is that naval exercises can involve sound sources on more than one vessel. Thus, it is not appropriate to expect that the same effects to marine mammals would result from military sonar and seismic surveys. However, evidence that sonar signals can, in special circumstances, lead (at least indirectly) to physical damage and mortality (e.g., Balcomb and Claridge, 2001; NOAA and USN, 2001; Jepson *et al.,* 2003; Fernández *et al.,* 2004, 2005; Hildebrand 2005; Cox *et al.,* 2006) suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity sound.

There is no conclusive evidence of cetacean strandings or deaths at sea as a result of exposure to seismic surveys, but 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. 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, there was a stranding of two Cuvier's beaked whales in the Gulf of California, Mexico, when the L–DEO vessel R/V *Maurice Ewing* was operating a 20 airgun (8,490 in^3) array in the general area. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth, 2002; Yoder, 2002). Nonetheless, the Gulf of California incident plus the beaked whale strandings near naval exercises involving use of mid-frequency sonar suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales until more is known about effects of seismic surveys on those species (Hildebrand, 2005). No injuries of beaked whales are anticipated during the proposed study because of:

(1) The high likelihood that any beaked whales nearby would avoid the approaching vessel before being exposed to high sound levels, and

(2) Differences between the sound sources operated by L–DEO and those involved in the naval exercises associated with strandings.

Potential Effects of Other Acoustic Devices

Multi-Beam Echosounder

USGS would operate the Kongsberg EM 122 multi-beam echosounder from the source vessel during the planned study. Sounds from the multi-beam echosounder are very short pulses, occurring for 2 to 15 ms once every 5 to 20 s, depending on water depth. Most of the energy in the sound pulses emitted by this multi-beam echosounder is at frequencies near 12 kHz, and the maximum source level is 242 dB re 1 μPa (rms). The beam is narrow (1 to 2°) in fore-aft extent and wide (150°) in the cross-track extent. Each ping consists of eight (in water greater than 1,000 m deep) or four (in water less than 1,000 m deep) successive fan-shaped transmissions (segments) at different cross-track angles. Any given mammal at depth near the trackline would be in the main beam for only one or two of the nine segments. Also, marine mammals that encounter the Kongsberg EM 122 are unlikely to be subjected to repeated pulses because of the narrow fore–aft width of the beam and would receive only limited amounts of pulse energy because of the short pulses. Animals close to the ship (where the beam is narrowest) are especially unlikely to be ensonified for more than one 2 to 15 ms pulse (or two pulses if in the overlap area). Similarly, Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when a multi-beam echosounder emits a pulse is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pulses that might result in sufficient exposure to cause TTS.

Navy sonars that have been linked to avoidance reactions and stranding of cetaceans: (1) Generally have longer pulse duration than the Kongsberg EM 122; and (2) are often directed close to horizontally versus more downward for the multi-beam echosounder. The area of possible influence of the multi-beam echosounder is much smaller—a narrow band below the source vessel. Also, the duration of exposure for a given marine mammal can be much longer for naval sonar. During USGS's operations, the individual pulses would be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes by. Possible effects of a multi-beam echosounder on marine mammals are described below.

Stranding—In 2013, an International Scientific Review Panel 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 multi-beam 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 has 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 to 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).

Masking—Marine mammal communications would not be masked appreciably by the multi-beam echosounder signals given the low duty cycle of the multi-beam echosounder and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of baleen whales, the multi-beam echosounder signals (12 kHz) do not overlap with the predominant frequencies in the calls, which would avoid any significant masking.

Behavioral Responses—Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins *et al.,* 1985), increased vocalizations and no dispersal by pilot whales (Rendell and Gordon, 1999), and the previously-mentioned beachings by beaked whales. During exposure to a 21 to 25 kHz ''whale-finding'' sonar with a source level of 215 dB re 1 µPa, gray whales reacted by orienting slightly away from the source and being deflected from their course by approximately 200 m (656.2 ft) (Frankel, 2005). When a 38 kHz echosounder and a 150 kHz acoustic Doppler current profiler were transmitting during studies in the eastern tropical Pacific, baleen whales showed no significant responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis, 2005).

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 s tonal signals at frequencies similar to those that would be emitted by the multi-beam echosounder used by USGS, and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt *et al.,* 2000; Finneran *et al.,* 2002; Finneran and Schlundt, 2004). The relevance of those data to free-ranging odontocetes is uncertain, and in any case, the test sounds were quite different in duration as compared with those from a multi-beam echosounder.

Hearing Impairment and Other Physical Effects—Given recent stranding events that have been associated with the operation of naval sonar, there is concern that mid-frequency sonar sounds can cause serious impacts to marine mammals (see above). However, the multi-beam echosounder proposed for use by USGS is quite different than sonar used for Navy operations. Pulse duration of the multi-beam echosounder is very short relative to the naval sonar. Also, at any given location, an individual marine mammal would be in the beam of the multi-beam echosounder for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; Navy sonar often uses near-horizontally-directed sound. Those factors would all reduce the sound energy received from the multi-beam echosounder rather drastically relative to that from naval sonar. NMFS believes that the brief exposure of marine mammals to one pulse, or small numbers of signals, from the multi-beam echosounder is not likely to result in the harassment of marine mammals.

Sub-Bottom Profiler

USGS would also operate a sub-bottom profiler from the source vessel during the proposed survey. Sounds from the sub-bottom profiler are very short pulses, occurring for 1 to 4 ms once every few (3 to 6) seconds. Most of the energy in the sound pulses emitted by the sub-bottom profiler is at 3.5 kHz, and the beam is directed downward. The sub-bottom profiler on the *Langseth* has a maximum source level of 204 dB re 1 µPa. Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when a bottom profiler emits a pulse is small—even for a sub-bottom profiler more powerful than that on the *Langseth.* If the animal was in the area, it would have to pass the transducer at close range in order to be subjected to sound levels that could cause TTS.

Masking—Marine mammal communications would not be masked appreciably by the sub-bottom profiler signals given the directionality of the signal and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of most baleen whales, the sub-bottom profiler signals do not overlap with the predominant frequencies in the calls, which would avoid significant masking.

Behavioral Responses—Marine mammal behavioral reactions to other pulsed sound sources are discussed above, and responses to the sub-bottom profiler are likely to be similar to those for other pulsed sources if received at the same levels. However, the pulsed signals from the sub-bottom profiler are considerably weaker than those from the multi-beam echosounder. Therefore, behavioral responses are not expected unless marine mammals are very close to the source.

Hearing Impairment and Other Physical Effects—It is unlikely that the sub-bottom profiler produces pulse levels strong enough to cause hearing impairment or other physical injuries even in an animal that is (briefly) in a position near the source. The sub-bottom profiler is usually operated simultaneously with other higher-power acoustic sources, including airguns. Many marine mammals would move away in response to the approaching higher-power sources or the vessel itself before the mammals would be close enough for there to be any possibility of effects from the less intense sounds from the sub-bottom profiler.

Potential Effects of Vessel Movement and Collisions

Vessel movement in the vicinity of marine mammals has the potential to result in either a behavioral response or a direct physical interaction. Both scenarios are discussed below in this section.

Behavioral Responses to Vessel Movement—There are limited data concerning marine mammal behavioral responses to vessel traffic and vessel noise, and a lack of consensus among scientists with respect to what these responses mean or whether they result in short-term or long-term adverse effects. In those cases where there is a busy shipping lane or where there is a large amount of vessel traffic, marine mammals (especially low frequency specialists) may experience acoustic masking (Hildebrand, 2005) if they are present in the area (e.g., killer whales in Puget Sound; Foote *et al.,* 2004; Holt *et al.,* 2008). In cases where vessels actively approach marine mammals (e.g., whale watching or dolphin watching boats), scientists have documented that animals exhibit altered behavior such as increased swimming speed, erratic movement, and active avoidance behavior (Bursk, 1983; Acevedo, 1991; Baker and MacGibbon, 1991; Trites and Bain, 2000; Williams *et al.,* 2002; Constantine *et al.,* 2003), reduced blow interval (Ritcher *et al.,* 2003), disruption of normal social behaviors (Lusseau, 2003, 2006), and the shift of behavioral activities which may increase energetic costs (Constantine *et al.*, 2003, 2004). A detailed review of marine mammal reactions to ships and boats is available in Richardson *et al.,* (1995). For each of the marine mammal taxonomy groups, Richardson *et al.,* (1995) provides the following assessment regarding reactions to vessel traffic:

Toothed whales—''In summary, toothed whales sometimes show no avoidance reaction to vessels, or even approach them. However, avoidance can occur, especially in response to vessels of types used to chase or hunt the animals. This may cause temporary displacement, but we know of no clear evidence that toothed whales have abandoned significant parts of their range because of vessel traffic.''

Baleen whales—''When baleen whales receive low-level sounds from distant or stationary vessels, the sounds often seem to be ignored. Some whales approach the sources of these sounds. When vessels approach whales slowly and non-aggressively, whales often exhibit slow and inconspicuous avoidance maneuvers. In response to strong or rapidly changing vessel noise, baleen whales often interrupt their normal behavior and swim rapidly away. Avoidance is especially strong when a boat heads directly toward the whale.''

Behavioral responses to stimuli are complex and influenced to varying degrees by a number of factors, such as species, behavioral contexts, geographical regions, source characteristics (moving or stationary, speed, direction, etc.), prior experience of the animal and physical status of the animal. For example, studies have shown that beluga whales' reaction varied when exposed to vessel noise and traffic. In some cases, beluga whales exhibited rapid swimming from ice-breaking vessels up to 80 km (43.2 nmi) away, and showed changes in surfacing, breathing, diving, and group composition in the Canadian high Arctic where vessel traffic is rare (Finley *et al.,* 1990). In other cases, beluga whales were more tolerant of vessels, but responded differentially to certain vessels and operating characteristics by reducing their calling rates (especially older animals) in the St. Lawrence River where vessel traffic is common (Blane and Jaakson, 1994). In Bristol Bay, Alaska, beluga whales continued to feed when surrounded by fishing vessels and resisted dispersal even when purposefully harassed (Fish and Vania, 1971).

In reviewing more than 25 years of whale observation data, Watkins (1986) concluded that whale reactions to vessel traffic were ''modified by their previous experience and current activity: Habituation often occurred rapidly, attention to other stimuli or preoccupation with other activities sometimes overcame their interest or wariness of stimuli.'' Watkins noticed that over the years of exposure to ships in the Cape Cod area, minke whales changed from frequent positive interest (e.g., approaching vessels) to generally uninterested reactions; fin whales changed from mostly negative (e.g., avoidance) to uninterested reactions; fin whales changed from mostly negative (e.g., avoidance) to uninterested reactions; right whales apparently continued the same variety of responses (negative, uninterested, and positive responses) with little change; and humpbacks dramatically changed from mixed responses that were often negative to reactions that were often strongly positive. Watkins (1986) summarized that ''whales near shore, even in regions with low vessel traffic, generally have become less wary of boats and their noises, and they have appeared to be less easily disturbed than previously. In particular locations with intense shipping and repeated approaches by boats (such as the whale-watching areas of Stellwagen Bank), more and more whales had positive reactions to familiar vessels, and they also occasionally approached other boats and yachts in the same ways.''

Although the radiated sound from the *Langseth* would be audible to marine mammals over a large distance, it is unlikely that marine mammals would respond behaviorally (in a manner that NMFS would consider harassment under the MMPA) to low-level distant shipping noise as the animals in the area are likely to be habituated to such noises (Nowacek *et al.,* 2004). In light of these facts, NMFS does not expect the *Langseth's* movements to result in Level B harassment.

Vessel Strike—Ship strikes of cetaceans can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.,* 2004). These species are primarily large, slow moving whales. Smaller marine mammals (e.g., bottlenose dolphin) move quickly through the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist *et al.* (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 kts (24.1 km/hr, 14.9 mph).

USGS's proposed operation of one source vessel for the proposed survey is relatively small in scale compared to the number of commercial ships transiting at higher speeds in the same area on an annual basis. The probability of vessel and marine mammal interactions occurring during the proposed survey is unlikely due to the *Langseth's* slow operational speed, which is typically 4.5 kts (8.5 km/hr, 5.3 mph). Outside of seismic operations, the *Langseth's* cruising speed would be approximately 10 kts (18.5 km/hr, 11.5 mph), which is generally below the speed at which studies have noted reported increases of marine mammal injury or death (Laist *et al.,* 2001).

As a final point, the *Langseth* has a number of other advantages for avoiding ship strikes as compared to most commercial merchant vessels, including the following: The *Langseth's* bridge offers good visibility to visually monitor for marine mammal presence; Protected Species Visual Observers (PSVO) posted during operations would scan the ocean for marine mammals and would be required to report visual sightings of marine mammal presence to crew; and the PSVOs receive extensive training that covers the fundamentals of visual observing for marine mammals and information about marine mammals and their identification at sea. In addition, during airgun operations, a passive acoustic monitoring (PAM) system would be deployed from the *Langseth* that may alert the vessel of the presence of marine mammals in the vicinity of the vessel.

Entanglement

Entanglement can occur if wildlife becomes immobilized in survey lines, cables, nets, or other equipment that is moving through the water column. The proposed seismic survey would require towing of seismic equipment and cables. The large airgun array and hydrophone streamer carries the risk of entanglement for marine mammals. Wildlife, especially slow moving individuals, such as large whales, have a low probability of becoming entangled due to the slow speed of the survey vessel and onboard monitoring efforts. There are no recorded cases of entanglement of marine mammals during the conduct of over 8 years of seismic surveys on the *Langseth.* In May 2011, there was one recorded entanglement of an olive ridley sea turtle (*Lepidochelys olivacea*) in the *Langseth's* barovanes after the conclusion of a seismic survey off Costa Rica. However, the barovanes would not be deployed from the *Langseth* during USGS's proposed seismic survey. There have been cases of baleen whales, mostly gray whales (Heyning, 1990), becoming entangled in fishing lines. The probability for entanglement of marine mammals is considered not significant because of the vessel speed and the monitoring efforts onboard the survey vessel.

The potential effects to marine mammals described in this section of the document do not take into consideration the proposed monitoring and mitigation measures described later in this document (see the ''Proposed Mitigation'' and ''Proposed Monitoring and Reporting'' sections) which, as noted, are designed to effect the least practicable impact on affected marine mammal species and stocks.

Anticipated Effects on Marine Mammal Habitat

The proposed seismic survey is not anticipated to have any permanent impact on habitats used by the marine mammals in the proposed survey area, including the food sources they use (i.e., fish and invertebrates). Additionally, no physical damage to any habitat is anticipated as a result of conducting the proposed seismic survey. While it is anticipated that the specified activity may result in marine mammals avoiding certain areas due to temporary ensonification, this impact to habitat is temporary and was considered in further detail earlier in this document, as behavioral modification. The main impact associated with the proposed activity would be temporarily elevated noise levels and the associated direct effects on marine mammals in any particular area of the proposed project area, previously discussed in this notice. The proposed 2014 and 2015 seismic survey is not operating in a small, defined location. During the proposed 3,165 km (1,709 nmi) and 3,115 km (1,682 nmi) of tracklines in 2014 and 2015, respectively, the vessel would continuously move along the tracklines during the survey. The next section discusses the potential impacts of anthropogenic sound sources on common marine mammal prey in the proposed survey area (i.e., fish and invertebrates).

Anticipated Effects on Fish

One reason for the adoption of airguns as the standard energy source for marine seismic surveys is that, unlike explosives, they have not been associated with large-scale fish kills. However, existing information on the impacts of seismic surveys on marine fish and invertebrate populations is limited. There are three types of potential effects of exposure to seismic surveys: (1) Pathological, (2) physiological, and (3) behavioral. Pathological effects involve lethal and temporary or permanent sub-lethal injury. Physiological effects involve temporary and permanent primary and secondary stress responses, such as changes in levels of enzymes and proteins. Behavioral effects refer to temporary and (if they occur) permanent changes in exhibited behavior (e.g., startle and avoidance behavior). The three categories are interrelated in complex ways. For example, it is possible that certain physiological and behavioral changes could potentially lead to an ultimate pathological effect on individuals (i.e., mortality).

The specific received sound levels at which permanent adverse effects to fish potentially could occur are little studied and largely unknown. Furthermore, the available information on the impacts of seismic surveys on marine fish is from studies of individuals or portions of a population; there have been no studies at the population scale. The studies of individual fish have often been on caged fish that were exposed to airgun pulses in situations not representative of an actual seismic survey. Thus, available information provides limited insight on possible real-world effects at the ocean or population scale. This makes drawing conclusions about impacts on fish problematic because, ultimately, the most important issues concern effects on marine fish populations, their viability, and their availability to fisheries.

Hastings and Popper (2005), Popper (2009), and Popper and Hastings (2009a,b) provided recent critical reviews of the known effects of sound on fish. The following sections provide a general synopsis of the available information on the effects of exposure to seismic and other anthropogenic sound as relevant to fish. The information comprises results from scientific studies of varying degrees of rigor plus some anecdotal information. Some of the data sources may have serious shortcomings in methods, analysis, interpretation, and reproducibility that must be considered when interpreting their results (see Hastings and Popper, 2005). Potential adverse effects of the program's sound sources on marine fish are noted.

Pathological Effects—The potential for pathological damage to hearing structures in fish depends on the energy level of the received sound and the physiology and hearing capability of the species in question. For a given sound to result in hearing loss, the sound must exceed, by some substantial amount, the hearing threshold of the fish for that sound (Popper, 2005). The consequences of temporary or permanent hearing loss in individual fish on a fish population are unknown; however, they likely depend on the number of individuals affected and whether critical behaviors involving sound (e.g., predator avoidance, prey capture, orientation and navigation, reproduction, etc.) are adversely affected.

Little is known about the mechanisms and characteristics of damage to fish that may be inflicted by exposure to seismic survey sounds. Few data have been presented in the peer-reviewed scientific literature. As far as USGS and NMFS know, there are only two papers with proper experimental methods, controls, and careful pathological investigation implicating sounds produced by actual seismic survey airguns in causing adverse anatomical effects. One such study indicated anatomical damage, and the second indicated TTS in fish hearing. The anatomical case is McCauley *et al.* (2003), who found that exposure to airgun sound caused observable anatomical damage to the auditory maculae of pink snapper (*Pagrus auratus*). This damage in the ears had not been repaired in fish sacrificed and examined almost two months after exposure. On the other hand, Popper *et al.* (2005) documented only TTS (as determined by auditory brainstem response) in two of three fish species from the Mackenzie River Delta. This study found that broad whitefish (*Coregonus nasus*) exposed to five airgun shots were not significantly different from those of controls. During both studies, the repetitive exposure to sound was greater than would have occurred during a typical seismic survey. However, the substantial low-frequency energy produced by the airguns (less than 400 Hz in the study by McCauley *et al.* [2003] and less than approximately 200 Hz in Popper *et al.* [2005]) likely did not propagate to the fish because the water in the study areas was very shallow (approximately nine m in the former case and less than two m in the latter). Water depth sets a lower limit on the lowest sound frequency that would propagate (the ''cutoff frequency'') at about one-quarter wavelength (Urick, 1983; Rogers and Cox, 1988).

Wardle *et al.* (2001) suggested that in water, acute injury and death of organisms exposed to seismic energy depends primarily on two features of the sound source: (1) The received peak pressure, and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. According to Buchanan *et al.* (2004), for the types of seismic airguns and arrays involved with the proposed program, the pathological (mortality) zone for fish would be expected to be within a few meters of the seismic source. Numerous other studies provide examples of no fish mortality upon exposure to seismic sources (Falk and Lawrence, 1973; Holliday *et al.,* 1987; La Bella *et al.,* 1996; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b, 2003; Bjarti, 2002; Thomsen, 2002; Hassel *et al.,* 2003; Popper *et al.,* 2005; Boeger *et al.,* 2006).

An experiment of the effects of a single 700 in^3 airgun was conducted in Lake Meade, Nevada (USGS, 1999). The data were used in an Environmental Assessment of the effects of a marine reflection survey of the Lake Meade fault system by the National Park Service (Paulson *et al.,* 1993, in USGS, 1999). The airgun was suspended 3.5 m (11.5 ft) above a school of threadfin shad in Lake Meade and was fired three successive times at a 30 second interval. Neither surface inspection nor diver observations of the water column and bottom found any dead fish.

Some studies have reported, some equivocally, that mortality of fish, fish eggs, or larvae can occur close to seismic sources (Kostyuchenko, 1973; Dalen and Knutsen, 1986; Booman *et al.,* 1996; Dalen *et al.,* 1996). Some of the reports claimed seismic effects from treatments quite different from actual seismic survey sounds or even reasonable surrogates. However, Payne *et al.* (2009) reported no statistical differences in mortality/morbidity between control and exposed groups of capelin eggs or monkfish larvae. Saetre and Ona (1996) applied a 'worst-case scenario' mathematical model to investigate the effects of seismic energy on fish eggs and larvae. They concluded that mortality rates caused by exposure to seismic surveys are so low, as compared to natural mortality rates, that the impact of seismic surveying on recruitment to a fish stock must be regarded as insignificant.

Physiological Effects—Physiological effects refer to cellular and/or biochemical responses of fish to acoustic stress. Such stress potentially could affect fish populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses of fish after exposure to seismic survey sound appear to be temporary in all studies done to date (Sverdrup *et al.,* 1994; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b). The periods necessary for the biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects—Behavioral effects include changes in the distribution, migration, mating, and catchability of fish populations. Studies investigating the possible effects of sound (including seismic survey sound) on fish behavior have been conducted on both uncaged and caged individuals (e.g., Chapman and Hawkins, 1969; Pearson *et al.,* 1992; Santulli *et al.,* 1999; Wardle *et al.,* 2001; Hassel *et al.,* 2003). Typically, in these studies fish exhibited a sharp startle response at the onset of a sound followed by habituation and a return to normal behavior after the sound ceased.

The Minerals Management Service (MMS, 2005) assessed the effects of a proposed seismic survey in Cook Inlet. The seismic survey proposed using three vessels, each towing two, four-airgun arrays ranging from 1,500 to 2,500 in^3. MMS noted that the impact to fish populations in the survey area and adjacent waters would likely be very low and temporary. MMS also concluded that seismic surveys may displace the pelagic fishes from the area temporarily when airguns are in use. However, fishes displaced and avoiding the airgun noise are likely to backfill the survey area in minutes to hours after cessation of seismic survey. Fishes not dispersing from the airgun noise (e.g., demersal species) may startle and move short distances to avoid airgun emissions.

In general, any adverse effects on fish behavior or fisheries attributable to seismic surveys may depend on the species in question and the nature of the fishery (season, duration, fishing method). They may also depend on the age of the fish, its motivational state, its size, and numerous other factors that are difficult, if not impossible, to quantify at this point, given such limited data on effects of airguns on fish, particularly under realistic at-sea conditions.

Anticipated Effects on Invertebrates

The existing body of information on the impacts of seismic survey sound on marine invertebrates is very limited. However, there is some unpublished and very limited evidence of the potential for adverse effects on invertebrates, thereby justifying further discussion and analysis of this issue. The three types of potential effects of exposure to seismic surveys on marine invertebrates are pathological, physiological, and behavioral. Based on the physical structure of their sensory organs, marine invertebrates appear to be specialized to respond to particle displacement components of an impinging sound field and not to the pressure component (Popper *et al.,* 2001).

The only information available on the impacts of seismic surveys on marine invertebrates involves studies of individuals; there have been no studies at the population scale. Thus, available information provides limited insight on possible real-world effects at the regional or ocean scale. The most important aspect of potential impacts concerns how exposure to seismic survey sound ultimately affects invertebrate populations and their viability, including availability to fisheries.

Literature reviews of the effects of seismic and other underwater sound on invertebrates were provided by Moriyasu *et al.* (2004) and Payne *et al.* (2008). The following sections provide a synopsis of available information on the effects of exposure to seismic survey sound on species of decapod crustaceans and cephalopods, the two taxonomic groups of invertebrates on which most such studies have been conducted. The available information is from studies with variable degrees of scientific soundness and from anecdotal information. A more detailed review of the literature on the effects of seismic survey sound on invertebrates is provided in Appendix D of the NSF/USGS PEIS.

Pathological Effects—In water, lethal and sub-lethal injury to organisms exposed to seismic survey sound appears to depend on at least two features of the sound source: (1) The received peak pressure; and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. For the type of airgun array planned for the proposed program, the pathological (mortality) zone for crustaceans and cephalopods is expected to be within a few meters of the seismic source, at most; however, very few specific data are available on levels of seismic signals that might damage these animals. This premise is based on the peak pressure and rise/decay time characteristics of seismic airgun arrays currently in use around the world.

Some studies have suggested that seismic survey sound has a limited pathological impact on early developmental stages of crustaceans (Pearson *et al.,* 1994; Christian *et al.,* 2003; DFO, 2004). However, the impacts appear to be either temporary or insignificant compared to what occurs under natural conditions. Controlled field experiments on adult crustaceans (Christian *et al.,* 2003, 2004; DFO, 2004) and adult cephalopods (McCauley *et al.,* 2000a,b) exposed to seismic survey sound have not resulted in any significant pathological impacts on the animals. It has been suggested that exposure to commercial seismic survey activities has injured giant squid (Guerra *et al.,* 2004), but the article provides little evidence to support this claim. Tenera Environmental (2011b) reported that Norris and Mohl (1983, summarized in Mariyasu *et al.,* 2004) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246 to 252 dB after 3 to 11 minutes.

Andre *et al.* (2011) exposed four species of cephalopods (*Loligo vulgaris, Sepia officinalis, Octopus vulgaris,* and *Ilex coindetii*), primarily cuttlefish, to two hours of continuous 50 to 400 Hz sinusoidal wave sweeps at 157+/−5 dB re 1 µPa while captive in relatively small tanks. They reported morphological and ultrastructural evidence of massive acoustic trauma (i.e., permanent and substantial alterations [lesions] of statocyst sensory hair cells) to the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low frequency sound. The received SPL was reported as 157+/−5 dB re 1 µPa, with peak levels at 175 dB re 1 µPa. As in the McCauley *et al.* (2003) paper on sensory hair cell damage in pink snapper as a result of exposure to seismic sound, the cephalopods were subjected to higher sound levels than they would be under natural conditions, and they were unable to swim away from the sound source.

Physiological Effects—Physiological effects refer mainly to biochemical responses by marine invertebrates to acoustic stress. Such stress potentially could affect invertebrate populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses (i.e., changes in haemolymph levels of enzymes, proteins, etc.) of crustaceans have been noted several days or months after exposure to seismic survey sounds (Payne *et al.,* 2007). It was noted however, that no behavioral impacts were exhibited by crustaceans (Christian *et al.,* 2003, 2004; DFO, 2004). The periods necessary for these biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects—There is increasing interest in assessing the possible direct and indirect effects of seismic and other sounds on invertebrate behavior, particularly in relation to the consequences for fisheries. Changes in behavior could potentially affect such aspects as reproductive success, distribution, susceptibility to predation, and catchability by fisheries. Studies investigating the possible behavioral effects of exposure to seismic survey sound on crustaceans and cephalopods have been conducted on both uncaged and caged animals. In some cases, invertebrates exhibited startle responses (e.g., squid in McCauley *et al.,* 2000a,b). In other cases, no behavioral impacts were noted (e.g., crustaceans in Christian *et al.,* 2003, 2004; DFO 2004). There have been anecdotal reports of reduced catch rates of shrimp shortly after exposure to seismic surveys; however, other studies have not observed any significant changes in shrimp catch rate (Andriguetto-Filho *et al.,* 2005). Similarly, Parry and Gason (2006) did not find any evidence that lobster catch rates were affected by seismic surveys. Any adverse effects on crustacean and cephalopod behavior or fisheries attributable to seismic survey sound depend on the species in question and the nature of the fishery (season, duration, fishing method).

Proposed Mitigation

In order to issue an Incidental Take Authorization (ITA) under section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and the availability of such species or stock for taking for certain subsistence uses (where relevant).

USGS has reviewed the following source documents and has incorporated a suite of appropriate mitigation measures into their project description.

(1) Protocols used during previous NSF and USGS-funded seismic research cruises as approved by NMFS and detailed in the NSF/USGS PEIS;

(2) Previous IHA applications and IHAs approved and authorized by NMFS; and

(3) Recommended best practices in Richardson *et al.* (1995), Pierson *et al.* (1998), and Weir and Dolman (2007).

To reduce the potential for disturbance from acoustic stimuli associated with the proposed activities, USGS and/or its designees have proposed to implement the following mitigation measures for marine mammals:

(1) Planning Phase;

(2) Proposed exclusion zones around the airgun(s);

(3) Power-down procedures;

(4) Shut-down procedures;

(5) Ramp-up procedures; and

(6) Special procedures for situations or species of concern.

Planning Phase—Mitigation of potential impacts from the proposed activities began during the planning phases of the proposed activities. USGS considered whether the research objectives could be met with a smaller source than the full, 36-airgun array (6,600 in^3) used on the *Langseth,* and determined that the standard 36-airgun array with a total volume of approximately 6,600 in^3 was appropriate. USGS also worked with L–DEO and NSF to identify potential time periods to carry out the survey taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals and other protected species), weather conditions, equipment, and optimal timing for other proposed seismic surveys using the *Langseth.* Most marine mammal species are expected to occur in the study area year-round, so altering the timing of the proposed project from spring and summer months likely would result in no net benefits for those species.

Proposed Exclusion Zones—USGS use radii to designate exclusion and buffer zones and to estimate take for marine mammals. Table 1 (presented earlier in this document) shows the distances at which one would expect marine mammal exposures to received sound levels (160 and 180/190 dB) from the 36 airgun array and a single airgun. (The 180 dB and 190 dB level shut-down criteria are applicable to cetaceans and pinnipeds, respectively, as specified by NMFS [2000].) USGS used these levels to establish the exclusion and buffer zones.

If the PSVO detects marine mammal(s) within or about to enter the appropriate exclusion zone, the *Langseth* crew would immediately power-down the airgun array, or perform a shut-down if necessary (see ''Shut-down Procedures''). Table 1 summarizes the calculated distances at which sound levels (160, 180 and 190 dB [rms]) are expected to be received from the 36 airgun array and the single airgun operating in deep water depths. Received sound levels have been calculated by USGS, in relation to distance and direction from the airguns, for the 36 airgun array and for the single 1900LL 40 in^3 airgun, which would be used during power-downs.

Power-down Procedures—A power-down involves decreasing the number of airguns in use to one airgun, such that the radius of the 180 dB or 190 dB zone is decreased to the extent that the observed marine mammal(s) are no longer in or about to enter the exclusion zone for the full airgun array. During a power-down for mitigation, L–DEO would operate one small airgun. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of the seismic vessel in the area; and (b) retain the option of initiating a ramp-up to full operations under poor visibility conditions. In contrast, a shut-down occurs when all airgun activity is suspended.

If the PSVO detects a marine mammal outside the exclusion zone that is likely to enter the exclusion zone, USGS would power-down the airguns to reduce the size of the 180 dB or 190 dB exclusion zone before the animal is within the exclusion zone. Likewise, if a mammal is already within the exclusion zone, when first detected USGS would power-down the airguns immediately. During a power-down of the airgun array, USGS would operate the single 40 in^3 airgun, which has a smaller exclusion zone. If the PSVO detects a marine mammal within or near the smaller exclusion zone around that single airgun (see Table 1), USGS would shut-down the airgun (see next section).

Resuming Airgun Operations After a Power-down—Following a power-down, the *Langseth* will not resume full airgun activity until the marine mammal has cleared the 180 or 190 dB exclusion zone (see Table 1). The PSVO would consider the animal to have cleared the exclusion zone if:

• The PSVO has visually observed the animal leave the exclusion zone, or

• A PSVO has not sighted the animal within the exclusion zone for 15 minutes for species with shorter dive durations (i.e., small odontocetes or pinnipeds), or 30 minutes for species with longer dive durations (i.e., mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales); or

• The vessel has transited outside the original 180 dB or 190 dB exclusion zone after a 10 minute wait period.

The *Langseth* crew would resume operating the airguns at full power after 15 minutes of sighting any species with short dive durations (i.e., small odontocetes or pinnipeds). Likewise, the crew would resume airgun operations at full power after 30 minutes of sighting any species with longer dive durations (i.e., mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales).

Because the vessel would have transited away from the vicinity of the original sighting during the 10 minute period, implementing ramp-up procedures for the full array after an extended power-down (i.e., transiting for an additional 35 minutes from the location of initial sighting) would not meaningfully increase the effectiveness of observing marine mammals approaching or entering the exclusion zone for the full source level and would not further minimize the potential for take. The *Langseth'*s PSVOs would continually monitoring the exclusion zone for the full source level while the mitigation airgun is firing. On average, PSVOs can observe to the horizon (10 km or 5.4 nmi) from the height of the *Langseth'*s observation deck and should be able to state with a reasonable degree of confidence whether a marine mammal would be encountered within this distance before resuming airgun operations at full-power.

Shut-down Procedures—USGS would shut-down the operating airgun(s) if a marine mammal is seen within or approaching the exclusion zone for the single airgun. USGS would implement a shut-down:

(1) If an animal enters the exclusion zone of the single airgun after USGS has initiated a power-down; or

(2) If an animal is initially seen within the exclusion zone of the single airgun when more than one airgun (typically the full airgun array) is operating (and it is not practical or adequate to reduce exposure to less than 180 dB [rms] or 190 dB [rms]).

Considering the conservation status for the North Atlantic right whale, the airguns would be shut-down immediately in the unlikely event that this species is observed, regardless of the distance from the *Langseth*. Ramp-up would only begin if the North Atlantic right whale has not been seen for 30 minutes.

Resuming Airgun Operations After a Shut-down—Following a shut-down in excess of 10 minutes, the *Langseth* crew would initiate a ramp-up with the smallest airgun in the array (40 in^3). The crew would turn on additional airguns in a sequence such that the source level of the array would increase in steps not exceeding 6 dB per five-minute period over a total duration of approximately 30 minutes. During ramp-up, the PSVOs would monitor the exclusion zone, and if they sight a marine mammal, the *Langseth* crew would implement a power-down or shut-down as though the full airgun array were operational.

During periods of active seismic operations, there are occasions when the *Langseth* crew would need to temporarily shut-down the airguns due to equipment failure or for maintenance. In this case, if the airguns are inactive longer than eight minutes, the crew would follow ramp-up procedures for a shut-down described earlier and the PSVOs would monitor the full exclusion zone and would implement a power-down or shut-down if necessary.

If the full exclusion zone is not visible to the PSVO for at least 30 minutes prior to the start of operations in either daylight or nighttime, the *Langseth* crew would not commence ramp-up unless at least one airgun (40 in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the vessel's crew would not ramp-up the airgun array from a complete shut-down at night or during poor visibility conditions (i.e., in thick fog), because the outer part of the zone for that array would not be visible during those conditions.

If one airgun has operated during a power-down period, ramp-up to full power would be permissible at night or in poor visibility, on the assumption that marine mammals would be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. The vessel's crew would not initiate ramp-up of the airguns if a marine mammal is sighted within or near the applicable exclusion zones.

Ramp-up Procedures—Ramp-up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume of the airgun array is achieved. The purpose of a ramp-up is to ''warn'' marine mammals in the vicinity of the airguns, and to provide the time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities. USGS would follow a ramp-up procedure when the airgun array begins operating after a 10 minute period without airgun operations or when a power-down or shut-down has exceeded that period. USGS and L–DEO have used similar periods (approximately 8 to 10 minutes) during previous USGS and L–DEO seismic surveys.

Ramp-up would begin with the smallest airgun in the array (40 in^3). Airguns would be added in a sequence such that the source level of the array would increase in steps not exceeding six dB per five minute period over a total duration of approximately 30 to 35 minutes (i.e., the time it takes to achieve full operation of the airgun array). During ramp-up, the PSVOs would monitor the exclusion zone, and if marine mammals are sighted, USGS would implement a power-down or shut-down as though the full airgun array were operational.

If the complete exclusion zone has not been visible for at least 30 minutes prior to the start of operations in either daylight or nighttime, USGS would not commence the ramp-up unless at least one airgun (40 in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the airgun array would not be ramped-up from a complete shut-down at night or during poor visibility conditions (i.e., in thick fog), because the outer part of the exclusion zone for that array would not be visible during those conditions. If one airgun has operated during a power-down period, ramp-up to full power would be permissible at night or in poor visibility, on the assumption that marine mammals would be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. USGS would not initiate a ramp-up of the airguns if a marine mammal is sighted within or near the applicable exclusion zones.

Use of a Small-Volume Airgun During Turns and Maintenance

For short-duration equipment maintenance activities, USGS would employ the use of a small-volume airgun (i.e., 40 in^3 ''mitigation airgun'') to deter marine mammals from being within the immediate area of the seismic operations. The mitigation airgun would be operated at approximately one shot per minute and would not be operated for longer than three hours in duration. The seismic survey's tracklines are continuous around turns and no mitigation airgun would be necessary. For longer-duration equipment maintenance or repair activities (greater than three hours), USGS would shut-down the seismic equipment and not involve using the mitigation airgun.

During brief transits (e.g., less than three hours), one mitigation airgun would continue operating. The ramp-up procedure would still be followed when increasing the source levels from one airgun to the full airgun array. However, keeping one airgun firing would avoid the prohibition of a ''cold start'' during darkness or other periods of poor visibility. Through use of this approach, seismic operations may resume without the 30 minute observation period of the full exclusion zone required for a ''cold start,'' and without ramp-up if operating with the mitigation airgun for under 10 minutes, or with ramp-up if operating with the mitigation airgun over 10 minutes. PSOs would be on duty whenever the airguns are firing during daylight, during the 30 minute periods prior to ramp-ups.

Special Procedures for Situations or Species of Concern—It is unlikely that a North Atlantic right whale would be encountered during the proposed seismic survey, but if so, the airguns would be shut-down immediately if one is visually sighted at any distance from the vessel because of its rarity and conservation status. The airgun array shall not resume firing (with ramp-up) until 30 minutes after the last documented North Atlantic right whale visual sighting. Concentrations of humpback, sei, fin, blue, and/or sperm whales would be avoided if possible (i.e., exposing concentrations of animals to 160 dB), and the array would be powered-down if necessary. For purposes of this proposed survey, a concentration or group of whales would consist of six or more individuals visually sighted that do not appear to be traveling (e.g., feeding, socializing, etc.).

Mitigation Conclusions

NMFS has carefully evaluated the applicant's proposed mitigation measures and has considered a range of other measures in the context of ensuring that NMFS prescribes the means of effecting the least practicable impact on the affected marine mammal species and stocks and their habitat. NMFS's evaluation of potential measures included consideration of the following factors in relation to one another:

(1) The manner in which, and the degree to which, the successful implementation of the measure is expected 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 mitigation measure(s) prescribed by NMFS should be able to accomplish, have a reasonable likelihood of accomplishing (based on current science), or contribute to the accomplishment of one or more of the general goals listed below:

(1) Avoidance or minimization of injury or death of marine mammal wherever possible (goals 2, 3, and 4 may contribute to this goal).

(2) A reduction in the numbers of marine mammals (total number of number at biologically important time or location) exposed to received levels of airgun operations, or other activities expected to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

(3) A reduction in the number of times (total number or number at biologically important time or location) individuals would be exposed to received levels of airgun operations, or other activities expected to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

(4) A reduction in the intensity of exposures (either total number or number at biologically important time or location) to received levels of airgun operations, or other activities expected to result in the take of marine mammals (this goal may contribute to a, above, or to reducing the severity of harassment takes only).

(5) Avoidance of minimization of adverse effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time.

(6) For monitoring directly related to mitigation—an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Based on NMFS's evaluation of the applicant's proposed measures, as well as other measures considered by NMFS or recommended by the public, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on marine mammal species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an ITA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth ''requirements pertaining to the monitoring and reporting of such taking.'' The MMPA implementing regulations at 50 CFR 216.104 (a)(13) indicate that requests for ITAs must include the suggested means of accomplishing the necessary monitoring and reporting that would result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area. USGS submitted a marine mammal monitoring plan as part of the IHA application. It can be found in Section 13 of the IHA application. The plan may be modified or supplemented based on comments or new information received from the public during the public comment period or from the peer review panel.

Monitoring measures prescribed by NMFS should accomplish one or more of the following general goals:

(1) An increase in the probability of detecting marine mammals, both within the mitigation zone (thus allowing for more effective implementation of the mitigation) and in general to generate more data to contribute to the analyses mentioned below;

(2) An increase in our understanding of how many marine mammals are likely to be exposed to levels of seismic airguns that we associate with specific adverse effects, such as behavioral harassment, TTS or PTS;

(3) An increase in our understanding of how marine mammals respond to stimuli expected to result in take and how anticipated adverse effects on individuals (in different ways and to varying degrees) may impact the population, species, or stock (specifically through effects on annual rates of recruitment or survival) through any of the following methods:

- Behavioral observations in the presence of stimuli compared to observations in the absence of stimuli (need to be able to accurately predict received level, distance from source, and other pertinent information);
- Physiological measurements in the presence of stimuli compared to observations in the absence of stimuli (need to be able to accurately predict receive level, distance from the source, and other pertinent information);
- Distribution and/or abundance comparisons in times or areas with concentrated stimuli versus times or areas without stimuli;

(4) An increased knowledge of the affected species; and

(5) An increase in our understanding of the effectiveness of certain mitigation and monitoring measures.

Proposed Monitoring

USGS proposes to sponsor marine mammal monitoring during the proposed project, in order to implement the proposed mitigation measures that require real-time monitoring, and to satisfy the anticipated monitoring requirements of the IHA. USGS's proposed ''Monitoring Plan'' is described below this section. The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same region. USGS is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-Based Visual Monitoring

PSVOs would be based aboard the seismic source vessel and would watch for marine mammals near the vessel during daytime airgun operations and during any ramp-ups of the airguns at night. PSVOs would also watch for marine mammals near the seismic vessel for at least 30 minutes prior to the start of airgun operations after an extended shut-down (i.e., greater than approximately 10 minutes for this proposed cruise). When feasible, PSVOs would conduct observations during daytime periods when the seismic system is not operating (such as during transits) for comparison of sighting rates and behavior with and without airgun operations and between acquisition periods. Based on PSVO observations, the airguns would be powered-down or shut-down when marine mammals are observed within or about to enter a designated exclusion zone.

During seismic operations in the northwest Atlantic Ocean off the Eastern Seaboard, at least five PSOs (four PSVOs and one Protected Species Acoustic Observer [PSAO]) would be based aboard the *Langseth.* USGS would appoint the PSOs with NMFS's concurrence. Observations would take place during ongoing daytime operations and nighttime ramp-ups of the airguns. During the majority of seismic operations, two PSVOs would be on duty from the observation tower (i.e., the best available vantage point on the source vessel) to monitor marine mammals near the seismic vessel. Use of two simultaneous PSVOs would increase the effectiveness of detecting animals near the source vessel. However, during meal times and bathroom breaks, it is sometimes difficult to have two PSVOs on effort, but at least one PSVO would be on duty. PSVO(s) would be on duty in shifts no longer than 4 hours in duration.

Two PSVOs would also be on visual watch during all daytime ramp-ups of the seismic airguns. A third PSAO would monitor the PAM equipment 24 hours a day to detect vocalizing marine mammals present in the action area. In summary, a typical daytime cruise would have scheduled two PSVOs on duty from the observation tower, and a third PSAO on PAM. Other ship's crew would also be instructed to assist in detecting marine mammals and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew would be given additional instruction on how to do so.

The *Langseth* is a suitable platform for marine mammal observations. When stationed on the observation platform, the eye level would be approximately 21.5 m (70.5 ft) above sea level, and the PSVO would have a good view around the entire vessel. During daytime, the PSVO(s) would scan the area around the vessel systematically with reticle binoculars (e.g., 7 x 50 Fujinon), Big-eye binoculars (25 x 150), and with the naked eye. During darkness or low-light conditions, night vision devices (monoculars) and a forward looking infrared (FLIR) camera would be available, when required. Laser range-finding binoculars (Leica LRF 1200 laser rangefinder or equivalent) would be available to assist with distance estimation. Those are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly; that is done primarily with the reticles in the binoculars.

When marine mammals are detected within or about to enter the designated exclusion zone, the airguns would immediately be powered-down or shut-down if necessary. The PSVO(s) would continue to maintain watch to determine when the animal(s) are outside the exclusion zone by visual confirmation. Airgun operations would not resume until the animal is confirmed to have left the exclusion zone, or if not observed after 15 minutes for species with shorter dive durations (small odontocetes and pinnipeds) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

Vessel-Based Passive Acoustic Monitoring

Vessel-based, towed PAM would complement the visual monitoring program, when practicable. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. PAM can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The PAM system would serve to alert visual observers (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals call, but it does not depend on good visibility. It would be monitored in real-time so that the PSVOs can be advised when cetaceans are acoustically detected.

The PAM system consists of both hardware (i.e., hydrophones) and software (i.e., Pamguard). The ''wet end'' of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. The tow cable is 250 m (820.2 ft) long, and the hydrophones are fitted in the last 10 m (32.8 ft) of cable. A depth gauge is attached to the free end of the cable, and the cable is typically towed at depths 20 m (65.6 ft) or less. The array would be deployed from a winch located on the back deck. A deck cable would connect from the winch to the main computer laboratory where the acoustic station, signal conditioning, and processing system would be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the Pamguard software. The PAM system, which has a configuration of 4 hydrophones, can detect a frequency bandwidth of 10 Hz to 200 kHz.

One PSAO, an expert bioacoustician (in addition to the four PSVOs) with primary responsibility for PAM, would be onboard the *Langseth*. The expert bioacoustician would design and set up the PAM system and be present to operate, oversee, and troubleshoot any technical problems with the PAM system during the proposed survey. The towed hydrophones would ideally be monitored by the PSAO 24 hours per day while within the proposed seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating. However, PAM may not be possible if damage occurs to the array or back-up systems during operations. The primary PAM streamer on the *Langseth* is a digital hydrophone streamer. Should the digital streamer fail, back-up systems should include an analog spare streamer and a hull-mounted hydrophone. One PSAO would monitor the acoustic detection system by listening to the signals from two channels via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans. The PSAO monitoring the acoustical data would be on shift for no greater than six hours at a time. All PSOs are expected to rotate through the PAM position, although the expert PSAO (most experienced) would be on PAM duty more frequently.

When a vocalization is detected while visual observations (during daylight) are in progress, the PSAO would contact the PSVO immediately, to alert him/her to the presence of cetaceans (if they have not already been seen), and to allow a power-down or shut-down to be initiated, if required. When bearings (primary and mirror-image) to calling cetacean(s) are determined, the bearings would be relayed to the PSVO(s) to help him/her sight the calling animal. During non-daylight hours, when a cetacean is detected by acoustic monitoring and may be close to the source vessel, the *Langseth* crew would be notified immediately so that the proper mitigation measure may be implemented.

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

PSO Data and Documentation

PSVOs would record data to estimate the numbers of marine mammals exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data would be used to estimate numbers of animals potentially 'taken' by harassment. They would also provide information needed to order a power-down or shut-down of the airguns when a marine mammal is within or near the appropriate exclusion zone. Observations would also be made during daytime periods when the *Langseth* is underway without seismic operations. There would also be opportunities to collect baseline biological data during the transits to, from, and through the study area.

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

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

The data listed under (2) 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.

All observations and ramp-ups, power-downs, or shut-downs would be recorded in a standardized format. The PSVOs would record this information onto datasheets. During periods between watches and periods when operations are suspended, those data would be entered into a laptop computer running a custom electronic database. The accuracy of the data entry would be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures would allow initial summaries of data to be prepared during and shortly after the field program, and would facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations would provide:

1. The basis for real-time mitigation (airgun power-down or shut-down).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS.
3. Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted.
4. Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

Proposed Reporting

USGS would submit a comprehensive report to NMFS and NSF within 90 days after the end of phase 1 in 2014 and another comprehensive report to NMFS and NSF within 90 days after the end of phase 2 in 2015 for the proposed cruise. The report would describe the proposed operations that were conducted and sightings of marine mammals within the vicinity of the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, and all marine mammal sightings (i.e., dates, times, locations, activities, associated seismic survey activities, and associated PAM detections). The report would minimally include:

- Summaries of monitoring effort—total hours, total distances, and distribution of marine mammals through the study period accounting for Beaufort sea state and wind force, and other factors affecting visibility and detectability of marine mammals;
- Analyses of the effects of various factors influencing detectability of

marine mammals including Beaufort sea state and wind force, number of PSOs, and fog/glare;

- Species composition, occurrence, and distribution of marine mammals sightings including date, water depth, numbers, age/size/gender, and group sizes; and analyses of the effects of seismic operations;
- Sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability);
- Initial sighting distances versus airgun activity state;
- Closest point of approach versus airgun activity state;
- Observed behaviors and types of movements versus airgun activity state;
- Numbers of sightings/individuals seen versus airgun activity state; and
- Distribution around the source vessel versus airgun activity state.

The report would also include estimates of the number and nature of exposures that could result in ''takes'' of marine mammals by harassment or in other ways. After the report is considered final, it would be publicly available on the NMFS, USGS and NSF Web sites at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#iha, http://woodshole.er.usgs.gov/project-pages/environmental_compliance/index.html,* and *http://www.nsf.gov/geo/oce/encomp/index.jsp.*

Notification of Injured or Dead Marine Mammals—In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by the authorization (if issued), such as an injury, serious injury, or mortality (e.g., ship-strike, gear interaction, and/or entanglement), the USGS shall immediately cease the specified activities and immediately report the incident to the Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@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 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 source 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 animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

USGS shall not resume its activities until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with USGS to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. The USGS may not resume their activities until notified by NMFS via letter, email, or telephone.

In the event that USGS discovers an injured or dead marine mammal, and the lead 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 NMFS describes in the next paragraph), the USGS would immediately report the incident to the Incidental Take Program Supervisor, Permits and Conservation Division, Office of Protected Resources, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov,* the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866–755–6622) and/or by email to the Greater Atlantic Regional Stranding Coordinator (*Mendy.Garron@noaa.gov*), and the NMFS Southeast Region Marine Mammal Stranding Network (877–433–8299) and/or by email to the Southeast Regional Stranding Coordinator (*Blair.Mase@noaa.gov*) and Southeast Regional Stranding Program Administrator (*Erin.Fougeres@noaa.gov*). The report must include the same information identified in the paragraph above this section. Activities may continue while NMFS reviews the circumstances of the incident. NMFS would work with the USGS to determine whether modifications in the activities are appropriate.

In the event that USGS discovers an injured or dead marine mammal, and the lead PSO 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), the USGS would report the incident to the Incidental Take Program Supervisor, Permits and Conservation Division, Office or Protected Resources, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov,* the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866–755–6622), and/or by email to the Greater Atlantic Regional Stranding Coordinator (*Mendy.Garron@ noaa.gov*), and the NMFS Southeast Region Marine Mammal Stranding Network (877–433–8299), and/or by email to the Southeast Regional Stranding Coordinator (*Blair.Mase@noaa.gov*) and Southeast Regional Stranding Program Administrator (*Erin.Fougeres@noaa.gov*), within 24 hours of the discovery. The USGS would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

Estimated Take by Incidental Harassment

Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as: Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

TABLE 3—NMFS'S CURRENT UNDERWATER ACOUSTIC EXPOSURE CRITERIA

Impulsive (non-explosive) sound		
Criterion	Criterion definition	Threshold
Level A harassment (injury)	Permanent threshold shift (PTS) (Any level above that which is known to cause TTS).	180 dB re 1 μPa-m (root means square [rms]) (cetaceans). 190 dB re 1 μPa-m (rms) (pinnipeds).
Level B harassment	Behavioral disruption (for impulsive noise)	160 dB re 1 μPa-m (rms).
Level B harassment	Behavioral disruption (for continuous noise)	120 dB re 1 μPa-m (rms).

Level B harassment is anticipated and proposed to be authorized as a result of the proposed marine seismic survey in the northwest Atlantic Ocean off the Eastern Seaboard. Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the seismic airgun array are expected to result in the behavioral disturbance of some marine mammals. There is no evidence that the planned activities for which USGS seeks the IHA could result in injury, serious injury, or mortality. The required mitigation and monitoring measures would minimize any potential risk for injury, serious injury, or mortality.

The following sections describe USGS's methods to estimate take by incidental harassment and present the applicant's and NMFS's estimates of the numbers of marine mammals that could be affected during the proposed seismic program in the northwest Atlantic Ocean. The estimates are based on a consideration of the number of marine mammals that could be harassed by seismic operations with the 36 airgun array to be used. The length of the proposed 2D seismic survey area in 2014 is approximately 3,165 km (1,704 nmi) and in 2015 is approximately 3,115 km (1,682 nmi) in the U.S. ECS region of the Eastern Seaboard in the Atlantic Ocean, as depicted in Figure 1 of the IHA application. For estimating take and other calculations, the 2015 tracklines are assumed to be identical in length to the 2014 tracklines (even though they are slightly shorter).

USGS assumes that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the multi-beam echosounder and sub-bottom profiler would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the multi-beam echosounder and sub-bottom profiler given their characteristics (e.g., narrow, downward-directed beam) and other considerations described previously. Such reactions are not considered to constitute ''taking'' (NMFS, 2001). Therefore, USGS provided no additional allowance for animals that could be affected by sound sources other than airguns.

Density estimates for marine mammals within the vicinity of the proposed study area are limited. Density data for species found along the East Coast of the U.S. generally extend slightly outside of the U.S. EEZ. The proposed study area, however, is well beyond the U.S. EEZ, and is well off the continental shelf break. The proposed survey lines for the proposed 2014 survey are located in the far eastern portion of the proposed study area, primarily within the area where little to no density data are currently available. It was determined that the best available information for density data (for those species where density data existed) of species located off the U.S. East Coast was housed at the Strategic Environmental and Development Program (SERDP)/National Aeronautics and Space Administration (NASA)/NOAA Marine Animal Model Mapper and OBIS–SEAMAP database. Within this database, the model outputs for all four seasons from the U.S. Department of the Navy Operating Area (OPAREA) Density Estimates (NODE) for the Northeast OPAREA and Southeast OPAREA (Department of the Navy 2007a, 2007b) were used to determine the mean density (animals per square kilometer) for 19 of the 38 marine mammals with the potential to occur in the proposed study area. Those species include fin, minke, Atlantic spotted, bottlenose, long-finned and short-finned pilot, pantropical spotted, Risso's, short-beaked common, striped, sperm, rough-toothed, dwarf and pygmy sperm, Sowerby's, Blainville's, Gervais', True's, and Cuvier's beaked whales. Within the NODE document, the density calculations and models both took into account detection probability ($f[0]$) and availability (g[0]) biases. Model outputs for each season are available in the database. The data from the NODE summer density models, which include the months of June, July, and August, were used as the 2014 survey is proposed to take place between late August and early September. Of the seasonal NODE density models available, it is expected that the summer models are the most accurate and robust as the survey data used to create all of the models were obtained during summer months. The models for the winter, spring, and fall are derived from the data collected during the summer surveys, and therefore are expected to be less representative of actual species density during those seasons.

For those species of marine mammals that did not have density model outputs within the SERDP/NASA/NOAA and OBIS–SEAMAP database, or for those species with density outputs that did not extend into the proposed study area at all (i.e., all four pinniped species and sei whale), but for which OBIS sightings data within or adjacent to the proposed study area exist, the requested take authorization for the mean group size of the species of marine mammal is included. The mean group sizes were determined based on data reported from the Cetacean and Turtle Assessment Program (CeTAP) surveys (CeTAP, 1982).

The estimated numbers of individuals potentially exposed to sound during the proposed 2014 to 2015 survey are presented below and are based on the 160 dB (rms) criterion currently used for all cetaceans and pinnipeds. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently to be considered ''taken by harassment.'' Table 4 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 greater than or equal to 160 dB (rms) during the seismic survey if no animals moved away from the survey vessel. The requested take authorization is given in the middle (fourth from the left) column of Table 4. For species for which densities were unavailable as described above, but for which there were Ocean Biogeographic Information System (OBIS) sightings within or adjacent to the proposed study area, USGS has included a requested take authorization for the mean group size for the species.

It should be noted that unlike previous USGS, NSF, and L–DEO seismic surveys aboard the *Langseth,* the proposed survey would be conducted as almost one continuous line. Therefore, the ensonified area for the proposed seismic survey does not include a contingency factor (typically increased 25% to accommodate turns, lines that may need to be repeated, equipment testing, etc.) in line-kilometers. As typical during offshore ship surveys, inclement weather and equipment malfunctions are likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated exclusion zones would result in a power-down and/or shut-down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to 160 dB (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.

The number of different individuals that could be exposed to airgun sounds with received levels greater than or equal to 160 dB (rms) on one or more occasions can be estimated by considering the total marine area that would be within the 160 dB (rms) 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. In many seismic surveys, this total marine area includes overlap, as seismic surveys are often conducted in parallel survey lines where the ensonified areas of each survey line would overlap. The proposed tracklines in 2014 and 2015 would not have overlap as the individual line segments do not run parallel to each other. The entire survey could be considered one continual survey line with slight turns (no more than 120 degrees) between each line segment. During the proposed seismic survey, the vessel would continue on the extensive survey line path, not staying within a smaller defined area as most seismic surveys often do. The numbers of different individuals potentially exposed to greater than or equal to 160 dB (rms) were calculated by multiplying the expected species density (for those marine mammal species that had density data available) times the total anticipated area to be ensonified to that level during airgun operations (3,165 km of survey lines). The total area expected to be ensonified was determined by multiplying the total trackline distance (3,165 km times the width of the swath of the 160 dB buffer zone (2 times 5.78 km). Using this approach, a total of 36,600 km^2 (10,671 nmi^2) would fall within the 160 dB isopleth throughout the proposed survey in 2014. The proposed survey in 2015 is expected to ensonify an almost identical area (to within 2%); therefore, the same ensonified area of 36,600 km^2 (10,671 nmi^2) was used for calculation purposes since the number of estimated takes would be very similar for each of the two years. The number of estimated takes for the proposed survey in 2015 may need to be seasonally adjusted if the activity takes place in the late spring or early summer. Because it is uncertain at this time whether the 2015 survey would be scheduled in the spring (March, April, and May) or summer (June, July, and August) months, estimated takes were calculated for both seasons. For purposes of conservatively estimating the number of takes, the higher density (for spring or summer) was used for each species since it is not known at this time which season the 2015 proposed survey would take place in the April to August 2015 timeframe. If the 2015 survey occurred in the spring rather than summer, the density data suggests that takes would likely be higher for only the humpback whale, beaked whales, and bottlenose dolphin, and takes would likely be fewer for nine species (i.e., sperm whale, short-finned and long-finned pilot whales, Atlantic spotted, pantropical spotted, striped, Clymene, short-beaked common, and Risso's dolphin), and unchanged for the remaining species.

TABLE 4—ESTIMATED DENSITIES OF MARINE MAMMAL SPECIES AND ESTIMATES OF POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO SOUND LEVELS ≥160 DB DURING USGS'S PROPOSED SEISMIC SURVEY IN THE NORTHWEST ATLANTIC OCEAN OFF THE EASTERN SEABOARD, AUGUST TO SEPTEMBER 2014 AND APRIL TO AUGUST 2015

Species	Density spring/summer (#/km^2) [1]	Calculated take authorization 2014/2015 [i.e., estimated number of individuals exposed to sound levels ≥160 dB re 1 μPa] [2]	Requested take authorization (includes increase to average group size) [3]	Abundance (regional population/stock) [4]	Approximate percentage of estimated of regional population/stock (for requested take) [5]	Population trend [6]
Mysticetes:						
North Atlantic right whale.	NA	0/0	3 + 3 = 6	455/455	1.32/1.32	Increasing.
Humpback whale	0.0010170/0	0/38	38 + 3 = 41	11,600/823	0.35/4.98	Increasing.
Minke whale	0.0000350/ 0.0000360	2/2	2 + 2 = 4	138,000/20,741	0.0014/0.0096	NA.
Bryde's whale	NA	0/0	3 + 3 = 6	NA/NA	NA/NA	NA.
Sei whale	NA	0/0	3 + 3 = 6	10,300/357	0.06/1.68	NA.
Fin whale	0.000060/ 0.000610	3/3	3 + 3 = 6	26,500/3,522	0.02/0.17	NA.
Blue whale	NA	0/0	2 + 2 = 4	855/440	0.47/0.91	NA.
Odontocetes:						
Sperm whale	0.0019050/ 0.0022510	83/83	83 + 83 = 166	13,190/2,288	1.26/7.26	NA.
Pygmy sperm whale.	0.0008850/ 0.008970	33/33	33 + 33 = 66	NA/3,785	NA/1.74	NA.

TABLE 4—ESTIMATED DENSITIES OF MARINE MAMMAL SPECIES AND ESTIMATES OF POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO SOUND LEVELS ≥160 dB DURING USGS'S PROPOSED SEISMIC SURVEY IN THE NORTHWEST ATLANTIC OCEAN OFF THE EASTERN SEABOARD, AUGUST TO SEPTEMBER 2014 AND APRIL TO AUGUST 2015—Continued

Species	Density spring/ summer (#/km²)[1]	Calculated take authorization 2014/2015 [i.e., estimated number of individuals exposed to sound levels ≥160 dB re 1 μPa][2]	Requested take authorization (includes increase to average group size)[3]	Abundance (regional population/ stock)[4]	Approximate percentage of estimated of regional population/stock (for requested take)[5]	Population trend[6]
Dwarf sperm whale	0.0008850/ 0.0008970	33/33	33 + 33 = 66	NA/3,785	NA/1.74	NA.
Northern bottlenose whale.	NA	0/0	2 + 2 = 4	40,000/NA	0.01/NA	NA.
Cuvier's beaked whale.	0.0021370/ 0.0022870	84/84	84 + 84 = 168	NA/6,532	NA/1.29	NA.
Mesoplodon spp. (i.e., True's, Gervais', Sowerby's, and Blainville's beaked whale.				NA/7,092	NA/2.37	NA.
Bottlenose dolphin	0.0069560/ 0.0066470	244/255	244 + 255 = 499	NA/77,532	NA/0.64	NA.
Atlantic white-sided dolphin.	NA	0/0	54 + 54 = 108	10,000 to 100,000s/ 48,819.	1.08/0.22	NA.
Fraser's dolphin	NA	0/0	100 + 100 = 200	NA/NA	NA/NA	NA.
Atlantic spotted dolphin.	0.0285700/ 0.0288400	1,056/1,056	1,056 + 1,056 = 2,112.	NA/44,715	NA/4.72	NA.
Pantropical spotted dolphin.	0.0194900/ 0.0197600	724/724	724 + 724 = 1,448	NA/3,333	NA/43.44	NA.
Striped dolphin	0.1330000/ 0.1343000	4,916/4,916	4,916 + 4,916 = 9,832.	NA/54,807	NA/17.94	NA.
Spinner dolphin	NA	0/0	65 + 65 = 130	NA/NA	NA/NA	NA.
Clymene dolphin	0.0093110/0	0/341	70 + 341 = 411	NA/NA	NA/NA	NA.
Short-beaked common dolphin.	0.0053940/ 0.0055320	203/203	203 + 203 = 406	NA/173,486	NA/0.23	NA.
Rough-toothed dolphin.	0.004200/ 0.0004260	16/16	16 + 16 = 32	NA/271	NA/11.81	NA.
Risso's dolphin	0.0092150/ 0.0093180	342/342	342 + 342 = 684	NA/18,250	NA/3.75	NA.
Melon-headed whale.	NA	0/0	100 + 100 = 200	NA/NA	NA/NA	NA.
Pygmy killer whale	NA	0/0	25 + 25 = 50	NA/NA	NA/NA	NA.
False killer whale	NA	0/0	15 + 15 = 30	NA/NA	NA/NA	NA.
Killer whale	NA	0/0	7 + 7 = 14	NA/NA	NA/NA	NA.
Short-finned pilot whale.	0.0108000/ 0.0190400	697/697	697 + 697 = 1,394	780,000/21,515	0.18/6.48	NA.
Long-finned pilot whale.	0.0108000/ 0.0190400	697/697	697 + 697 = 1,394	780,000/26,535	0.18/5.25	NA.
Harbor porpoise	NA	0/0	5 + 5 = 10	500,000/79,883	0.002/0.01	NA.
Pinnipeds:						
Harbor seal	NA	0/0	0 + 0 = 0	NA/70,142	NA/NA	NA.
Gray seal	NA	0/0	0 + 0 = 0	NA/331,000	NA/NA	Increasing.
Harp seal	NA	0/0	0 + 0 = 0	8.6 to 9.6 million/7.1 million.	NA/NA	NA.
Hooded seal	NA	0/0	0 + 0 = 0	600,000/592,100	NA/NA	NA.

NA = Not available or not assessed.
[1] OBIS–SERDP–Navy NODE 2007a and 2007b (for those species where density data is available).
[2] Calculated take is estimated density multiplied by the 160 dB ensonified area.
[3] Requested take authorization was increased to group size for species for which densities were not available but that have been sighted near the proposed survey area (CeTAP, 1984).
[4] Stock sizes are best populations from NMFS Stock Assessment Reports where available (see Table 2 in above).
[5] Requested takes expressed as percentages of the larger regional population and NMFS Stock Assessment Reports, where available.
[6] Based on NMFS Stock Assessment Reports.

Applying the approach described above, approximately 36,600 km² would be within the 160 dB isopleth on one or more occasions during the proposed survey in 2014. The proposed survey in 2015 is expected to ensonify an almost identical area (to within 2%); therefore an ensonified area of 36,600 km² was used for the proposed surveys in 2014 and 2015. Because this approach does not allow for turnover in the marine 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 and pinnipeds would move away or toward the trackline as the *Langseth* approaches in response to increasing sound levels before the levels reach 160 dB (rms). Another way of interpreting the estimates that follow is that they represent the number of individuals that are expected (in the absence of a seismic program) to occur in the waters that would be exposed to greater than or equal to 160 dB (rms).

Encouraging and Coordinating Research

USGS would coordinate the planned marine mammal monitoring program associated with the seismic survey with other parties that may have interest in this area and specified activity. USGS would coordinate with applicable U.S. agencies (e.g., NMFS), and would comply with their requirements.

Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

Section 101(a)(5)(D) of the MMPA also requires NMFS to determine that the authorization would not have an unmitigable adverse effect on the availability of marine mammal species or stocks for subsistence use. There are no relevant subsistence uses of marine mammals implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Analyses and Preliminary Determinations

Negligible Impact

Negligible impact is ''an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival'' (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (i.e., population-level effects). An estimate of the number of Level B harassment takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be ''taken'' through behavioral harassment, NMFS must consider other factors, such as the likely nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), as well as the number and nature of estimated Level A harassment takes, the number of estimated mortalities, and effects on habitat.

In making a negligible impact determination, NMFS evaluated factors such as:

(1) The number of anticipated injuries, serious injuries, or mortalities;

(2) The number, nature, and intensity, and duration of Level B harassment (all relatively limited); and

(3) The context in which the takes occur (i.e., impacts to areas of significance, impacts to local populations, and cumulative impacts when taking into account successive/contemporaneous actions when added to baseline data);

(4) The status of stock or species of marine mammals (i.e., depleted, not depleted, decreasing, increasing, stable, impact relative to the size of the population);

(5) Impacts on habitat affecting rates of recruitment/survival; and

(6) The effectiveness of monitoring and mitigation measures.

As described above and based on the following factors, the specified activities associated with the marine seismic survey are not likely to cause PTS, or other non-auditory injury, serious injury, or death. The factors include:

(1) The likelihood that, given sufficient notice through relatively slow ship speed, marine mammals are expected to move away from a noise source that is annoying prior to its becoming potentially injurious;

(2) The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the operation of the airgun(s) to avoid acoustic harassment;

(3) The potential for temporary or permanent hearing impairment is relatively low and would likely be avoided through the implementation of the required monitoring and mitigation measures (including power-down and shut-down measures); and

(4) The likelihood that marine mammal detection ability by trained PSOs is high at close proximity to the vessel.

Table 4 of this document outlines the number of requested Level B harassment takes that are anticipated as a result of these activities. The type of Level B (behavioral) harassment that could result from the proposed action are described in the ''Potential Effects of the Specified Activity on Marine Mammals'' section above, and include tolerance, masking, behavioral disturbance, TTS, PTS, and non-auditory or physiological effects.

For the marine mammal species that may occur within the proposed action area, there are no known designated or important feeding and/or reproductive areas. Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (i.e., 24 hr cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). While seismic operations are anticipated to occur on consecutive days, the estimated duration of the survey would last no more than a total of 36 days (a 17 to 18 day leg in August to September 2014 and a 17 to 18 day leg in April to August 2015). Additionally, the seismic survey would be increasing sound levels in the marine environment in a relatively small area surrounding the vessel (compared to the range of the animals). The seismic surveys would not take place in areas of significance for marine mammal feeding, resting, breeding, or calving and would not adversely impact marine mammal habitat. Furthermore, the vessel would be constantly travelling over distances, and some animals may only be exposed to and harassed by sound for less than a day.

NMFS's practice has been to apply the 160 dB re 1 μPa (rms) received level threshold for underwater impulse sound levels to determine whether take by Level B harassment occurs. Southall *et al.* (2007) provide a severity scale for ranking observed behavioral responses of both free-ranging marine mammals and laboratory subjects to various types of anthropogenic sound (see Table 4 in Southall *et al.* [2007]). NMFS has preliminarily determined, provided that the aforementioned mitigation and monitoring measures are implemented, the impact of conducting a marine seismic survey in the northwest Atlantic Ocean off of the Eastern Seaboard, August to September 2014 and April to August 2015, may result, at worst, in a modification in behavior and/or low-level physiological effects (Level B harassment) of certain species of marine mammals. No injuries, serious injuries, or mortalities are anticipated to occur as a result of USGS's planned marine seismic survey, and none are proposed to be authorized by NMFS.

While behavioral modifications, including temporarily vacating the area during the operation of the airgun(s), may be made by these species to avoid the resultant acoustic disturbance, the availability of alternate areas within these areas for species and the short and sporadic duration of the research activities, have led NMFS to preliminary determine that the taking by Level B harassment from the specified activity would have a negligible impact on the affected species in the specified geographic region. Due to the nature, degree, and context of Level B (behavioral) harassment anticipated and described (see ''Potential Effects on Marine Mammals'' section above) in this notice, the activity is not expected to impact rates of annual recruitment or survival for any affected species or stock, particularly given the NMFS and the applicant's proposal to implement mitigation and monitoring measures that would minimize impacts to marine mammals. Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the total marine mammal take from USGS's proposed marine seismic survey would have a negligible impact on the affected marine mammal species or stocks.

Small Numbers

As mentioned previously, NMFS estimates that 34 species of marine mammals under its jurisdiction could be potentially affected by Level B harassment over the course of the IHA. The population estimates for the marine mammal species that may be taken by Level B harassment are provided in Table 4 of this document. No takes of pinnipeds are expected due to a lack of species observations within the proposed study area, the great distance offshore, and the deep water depths of the proposed study area. It should be noted that the stock populations for each marine mammal species in the NMFS Stock Assessment Reports are generally for species populations in U.S. waters, which may underestimate actual population sizes for species that have ranges that would include waters outside the U.S. EEZ.

NMFS has regional population and/or stock abundance estimates for the northwest Atlantic Ocean for 26 of the species under its jurisdiction that could potentially be affected by Level B harassment over the course of the IHA. The estimate of the number of individual cetaceans by species for which NMFS has such data that could be exposed to seismic sounds with received levels greater than or equal to 160 dB re 1 μPa (rms) during the proposed survey in 2014 and 2015 is as follows: 6 North Atlantic right, 41 humpback, 4 minke, 6 sei, 6 fin, 4 blue, and 166 sperm whales, which would represent 1.32/1.32, 0.353/4.96, 0.0014/0.0096, 0.058/1.68, 0.02/0.17, 0.468/0.909, and 1.259/7.255% of the affected regional populations/stocks, respectively. In addition, 4 northern bottlenose, 168 Cuvier's and *Mesoplodon* (i.e., True's, Gervais', Sowerby's, and Blainville's beaked whales), 66 dwarf sperm, and 66 pygmy sperm whales could be taken by Level B harassment during the proposed seismic survey, which would represent 0.01/unknown, unknown/1.286, unknown/2.369, unknown/1.744, and unknown/1.744% of the regional populations/stocks, respectively. Most of the cetaceans potentially taken by Level B harassment are delphinids; of the delphinids for which NMFS has regional population or stock abundance estimates for the northwest Atlantic Ocean, 499 bottlenose, 108 Atlantic white-sided, 2,112 Atlantic spotted, 1,448 pantropical spotted, 9,832 striped, 406 short-beaked common, 32 rough-toothed, and 684 Risso's dolphins could be taken by Level B harassment during the proposed seismic survey, which would represent unknown/0.644, 1.08/0.221, unknown/4.723, unknown/43.444, unknown/17.939, unknown/0.234, unknown/11.808, and unknown/3.748% of the regional populations/stocks, respectively. Of the remaining species for which NMFS has regional population or stock abundance estimates for the northwest Atlantic Ocean, 1,394 short-finned and 1,394 long-finned pilot whales, and 10 harbor porpoises could be taken by Level B harassment during the proposed seismic survey, which would represent 0.178/6.479, 0.178/5.253, and 0.002/0.013% of the regional population/stocks, respectively.

NMFS makes its small numbers determination on the numbers of marine mammals that would be taken relative to the populations of the affected species or stocks. NMFS calculates the number of animals as a percentage of the stock population for marine mammals in the U.S. EEZ. For USGS's proposed survey, approximately 80% in 2014 and 90% in 2015 of the tracklines occur within International Waters (i.e., the high seas) and are outside of the U.S. EEZ; therefore, the regional population is more applicable for NMFS's small numbers determinations as most of the ensonified area and estimated takes are further than 200 nmi from the U.S. coastline. The requested take estimates represented as a percentage of the stock in Table 4 (above) should be reduced to 20% and 10% of the calculated levels based on the amount of activity (i.e., 80% and 90%) planned to occur outside of the U.S. EEZ in 2014 and 2015. Using the approach of calculating the number of requested take estimates within the U.S. EEZ (20% in 2014 and 10% in 2015), the take estimates provided in the preceding paragraph should change as follows (rounding up): 2 North Atlantic right, 9 humpback, 2 minke, 2 sei, 2 fin, 2 blue, and 26 sperm whales, which would represent 0.44, 1.09, <0.01, 0.56, 0.06, 0.46, and 1.14% of the affected stocks, respectively; 26 Cuvier's and *Mesoplodon* (i.e., True's, Gervais', Sowerby's, and Blainville's beaked whales), 11 dwarf sperm, and 11 pygmy sperm whales, which would represent 0.4, 0.37, 0.29, and 0.29% of the affected stocks, respectively; 75 bottlenose, 17 Atlantic white-sided, 318 Atlantic spotted, 218 pantropical spotted, 1,476 striped, 62 short-beaked common, 6 rough-toothed, and 104 Risso's dolphins could be taken by Level B harassment during the proposed seismic survey, which would represent 0.1, 0.04, 0.71, 6.54, 2.69, 0.04, 2.21, and 0.57% of the affected stocks, respectively; and 210 short-finned and 210 long-finned pilot whales, and 2 harbor porpoises, which would represent 0.98, 0.79, and <0.01% of the affected stocks, respectively. No takes of pinnipeds are expected within the proposed study area. The requested take estimates represent a small number relative to the affected species' with a known regional population or stock size (i.e., all for which data are available are less than 6.54% of the regional populations).

No known current regional population or stock abundance estimates for the northwest Atlantic Ocean are available for the eight remaining species under NMFS's jurisdiction that could potentially be affected by Level B harassment over the course of the IHA. These species include the Bryde's whale, Fraser's, spinner, and Clymene dolphins, and the melon-headed, pygmy killer, false killer, and killer whales. Therefore, NMFS is using older abundance estimates or abundance estimates from other areas such as the northern Gulf of Mexico stock, regional ocean basins (e.g., eastern tropical Pacific Ocean), or global summation to aid its small numbers determination for these species. These abundance estimates are considered the best available information.

Bryde's whales are distributed worldwide in tropical and sub-tropical waters and their occurrence in the proposed study area is rare. In the western North Atlantic Ocean, Bryde's whales are reported from off the southeastern U.S. and southern West Indies to Cabo Frio, Brazil (Leatherwood and Reeves, 1983). No stock of Bryde's whales has been identified in U.S. waters off the Atlantic coast. The northern Gulf of Mexico population is considered a separate stock and has a best abundance estimate of 33 animals. In addition, there are estimated to be 20,000 to 30,000 animals in the North Pacific Ocean. Based on all of these factors, NMFS finds that the requested take estimate of 6 Bryde's whales represents a small number relative to the affected species' population size.

Fraser's dolphins are distributed worldwide in tropical waters and their occurrence in the proposed study area is rare. There is no abundance estimates for either the western North Atlantic or the northern Gulf of Mexico stocks. The western North Atlantic population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock. The numbers of Fraser's dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it is rarely seen in any surveys. The population size for Fraser's dolphins is unknown; however, about 289,000 animals occur in the eastern tropical Pacific Ocean (Jefferson *et al.,* 2008). The estimated number of requested takes for 200 Fraser's dolphins represents 0.06% of the eastern tropical Pacific Ocean population. Fraser's dolphins are distributed worldwide in tropical waters and their occurrence in the proposed study area is rare. Based on all these factors, NMFS finds that the requested take estimate represents a small number relative to the affected species' population size.

Spinner dolphins are found in all tropical and sub-tropical oceans and their occurrence in the proposed study area is rare. The western North Atlantic population of spinner dolphins is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock. The numbers of spinner dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock since it was rarely seen in any of the surveys. The best abundance estimate available for northern Gulf of Mexico spinner dolphins is 11,441 animals. The estimated number of requested takes of 130 spinner dolphins represents 1.13% of the northern Gulf of Mexico stock. Based on all of these factors, NMFS finds that the requested take estimates represents a small number relative to the affected species' population size.

The Clymene dolphin is endemic to tropical and sub-tropical waters of the Atlantic, including the Caribbean Sea and Gulf of Mexico (Jefferson and Curry, 2003; Jefferson *et al.,* 2008). This species prefer warm waters and records extend from southern Brazil and Angola and north to Mauritania and New Jersey off the U.S. east coast (Jefferson *et al.,* 2008). Their occurrence in the proposed study area is rare. The abundance estimate for the Clymene dolphin in the western North Atlantic was 6,086 in 203; this estimate is older than eight years and is considered unreliable (Wade and Angliss, 1997; Mullin and Fulling, 2003). However, this abundance estimate is the first and only estimate to date for this species in the U.S. Atlantic EEZ and represents the best abundance estimate. The estimated numbers of requested takes of 411 Clymene dolphins represent 6.75% of the western North Atlantic 2003 stock or 318.6% of the northern Gulf of Mexico stock. Based on all of these factors, NMFS finds that the requested take estimate represents a small number relative to the affected species' population or stock size.

Melon-headed whales are distributed worldwide in tropical to sub-tropical waters and their occurrence in the proposed study area is rare. The western North Atlantic population is provisionally being considered a separate stock from the northern Gulf of Mexico stock, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock. The numbers of melon-headed whales off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys. The best abundance estimate available for northern Gulf of Mexico melon-headed whales is 2,235 animals. The estimated number of requested takes of 200 melon-headed whales represents 8.94% of the northern Gulf of Mexico stock. Based on all of these factors, NMFS finds that the requested take estimate represents a small number relative to the affected species' population or stock size.

The pygmy killer whale is distributed worldwide in tropical to sub-tropical waters and their occurrence in the proposed study area is rare. The western North Atlantic population of pygmy killer whales is provisionally being considered one stock for management purposes. The numbers of pygmy killer whales off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys. The best abundance estimate available for the northern Gulf of Mexico pygmy killer whale is 152 animals. In addition, there are estimated to be 39,000 pygmy killer whales in the eastern tropical Pacific Ocean. The estimated number of requested takes of 50 pygmy killer whales represents 32.89% of the northern Gulf of Mexico stock, and 0.13% of the eastern tropical Pacific Ocean. Based on all of these factors, NMFS finds that the requested take estimate represents a small number relative to the affected species' population or stock size.

The false killer whale is distributed worldwide throughout warm temperate and tropical oceans and their occurrence in the proposed study area is rare. No stock has been identified for false killer whales in U.S. waters off the Atlantic coast. The Gulf of Mexico population is provisionally being considered one stock for management purposes, although there is currently no information to differentiate this stock from the Atlantic Ocean stock. The current population size for the false killer whale in the northern Gulf of Mexico is unknown because they survey data is more than 8 years old; however, the most recent abundance estimate pooled from 2004 to 2004 was 777 animals (Wade and Angliss, 1997; Mullin, 2007). The estimated number of requested takes of 30 false killer whales represents 3.86% of the northern Gulf of Mexico stock. Based on all of these factors, NMFS finds that the requested take estimate represents a small number relative to the affected species' population or stock size.

Killer whales are characterized as uncommon or rare in waters of the U.S. Atlantic EEZ (Katona *et al.,* 1988). Their distribution extends from the Arctic ice-edge to the West Indies, often in offshore and mid-ocean areas. There are estimated to be at least approximately 92,500 killer whales worldwide. The size of the western North Atlantic stock population off the eastern U.S. coast is unknown. The northern Gulf of Mexico population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the Atlantic Ocean stock. The best abundance estimate available for northern Gulf of Mexico killer whales is 28 animals. The estimated number of requested takes of 14 killer whales represents 0.02% of the worldwide population, and 50% of the northern Gulf of Mexico stock. Based on all of these factors, NMFS finds that the requested take estimate represents a small number relative to the affected species' population or stock size.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration of the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that small numbers of marine mammals would be taken relative to the populations of the affected species or stocks. See Table 4 for the requested authorized take number of marine mammals.

Endangered Species Act

Of the species of marine mammals that may occur in the proposed survey area, several are listed as endangered under the ESA, including the North Atlantic right, humpback, sei, fin, blue, and sperm whales. Under section 7 of the ESA, USGS has initiated formal consultation with the NMFS, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, on this proposed seismic survey. NMFS's Office of Protected Resources, Permits and Conservation Division, has initiated formal consultation under section 7 of the ESA with NMFS's Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, to obtain a Biological Opinion evaluating the effects of issuing the IHA on threatened and endangered marine mammals and, if appropriate, authorizing incidental take. NMFS would conclude formal section 7 consultation prior to making a determination on whether or not to issue the IHA. If the IHA is issued, USGS, in addition to the mitigation and monitoring requirements included in the IHA, would be required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS's Biological Opinion issued to both USGS and NMFS's Office of Protected Resources.

National Environmental Policy Act

With USGS's complete application, USGS provided NMFS a ''Draft Environmental Assessment for Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards,'' prepared by RPS Evan-Hamilton, Inc., in association with YOLO Environmental, Inc., GeoSpatial Strategy Group, and Ecology and Environment, Inc., on behalf of USGS. The EA analyzes the direct, indirect, and cumulative environmental impacts of the proposed specified activities on marine mammals including those listed as threatened or endangered under the ESA. Prior to making a final decision on the IHA application, NMFS would either prepare an independent EA, or, after review and evaluation of the USGS EA for consistency with the regulations published by the Council of Environmental Quality (CEQ) and NOAA Administrative Order 216–6, Environmental Review Procedures for Implementing the National Environmental Policy Act, adopt the EA and make a decision of whether or not to issue a Finding of No Significant Impact (FONSI).

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to USGS for conducting the high-energy marine seismic survey in the northeast Atlantic Ocean off the Eastern Seaboard, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. The proposed IHA language is provided below:

The NMFS hereby authorizes the U.S. Geological Survey, Pacific Coastal and Marine Geology Science Center, Mail Stop 999, 345 Middlefield Road, Menlo Park, California 94025, Lamont-Doherty Earth Observatory of Columbia University, P.O. Box 1000, 61 Route 9W, Palisades, New York 10964–8000, and National Science Foundation, Division of Ocean Sciences, 4201 Wilson Boulevard, Suite 725, Arlington, Virginia 22230 (herein referred to USGS) under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a high-energy marine geophysical (seismic) survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) in the northeast Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015:

1. This Authorization is valid from August 15, 2014 through August 14, 2015.

2. This Authorization is valid only for the *Langseth's* specified activities associated with seismic survey operations as described in USGS's IHA application and ''Draft Environmental Assessment for Seismic Reflection Scientific Surveys During 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards'' that shall occur in the following specified geographic area (bounded by the following geographical coordinates):

40.5694° North, –66.5324° West;
38.5808° North, –61.7105° West;
29.2456° North, –72.6766° West;
33.1752° North, –75.8697° West;
39.1583° North, –72.8697° West;

The proposed activities for 2014 will generally occur within the outer portions of the study area. The proposed activities for 2015 will in-fill more of the study area. Water depths range from approximately 1,450 to 5,400 m (see Figure 1 and 2 of the IHA application); no survey lines will extend to water depths less than 1,000 m. The tracklines proposed for both 2014 and 2015 would be in International Waters (approximately 80% in 2014 and 90% in 2015) and in the U.S. EEZ, as specified in USGS's Incidental Harassment Authorization application and the associated USGS Environmental Assessment.

3. *Species Authorized and Level of Takes*

(a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the northeast Atlantic off the Eastern Seaboard:

(i) *Mysticetes*—see Table 4 for authorized species and take numbers.

(ii) *Odontocetes*—see Table 4 for authorized species and take numbers.

(iii) If any marine mammal species are encountered during seismic activities that are not listed in Table 4 for authorized taking and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 μPa (rms), then the USGS must alter speed or course or shut-down the airguns to avoid take.

(b) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3(a) above or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

4. The methods authorized for taking by Level B harassment are limited to the following acoustic sources without an amendment to this Authorization:

(a) A 36 airgun array with a total volume of 6,600 cubic inches (in^3) (or smaller);

(b) A multi-beam echosounder; and

(c) A sub-bottom profiler.

5. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov.*

6. *Mitigation and Monitoring Requirements*

The USGS is required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

(a) Utilize two, NMFS-qualified, vessel-based PSVO (except during meal times and restroom breaks, when at least one PSVO shall be on watch) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during ramp-ups of airguns day or night.

(i) The *Langseth's* vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSVOs shall have access to reticle binoculars (7 x 50 Fujinon), big-eye binoculars (25 x 150), optical range finders, and night vision devices.

(iii) PSVO shifts shall last no longer than 4 hours at a time.

(iv) When feasible, PSVOs shall also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavioral reactions during, between, and after airgun operations.

(v) PSVOs shall conduct monitoring while the airgun array and streamer(s) are being deployed or recovered from the water.

(b) PSVOs shall 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; and

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

(iii) The data listed under Condition 6(c)(ii) shall 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.

Passive Acoustic Monitoring

(c) Utilize the 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 NMFS-qualified PSO and/or expert bioacoustician (i.e., PSAO) shall monitor the PAM at all times in shifts no longer than 6 hours. An expert bioacoustician shall design and set up the PAM system and be present to operate to oversee PAM, and available when technical issues occur during the survey.

(d) Do and record the following when an animal is detected by the PAM:

(i) Notify the on-duty PSVO(s) immediately of the presence 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. The acoustic detection can also be recorded for further analysis.

Buffer and Exclusion Zones

(e) Establish a 160 dB re 1 μPa (rms) buffer zone as well as 180 and 190 dB re 1 μPa (rms) exclusion zone for marine mammals before the 2-string airgun array (6,600 in^3) is in operation; and a 180 and 190 dB re 1 μPa (rms) exclusion zone before a single airgun (40 in^3) is in operation, respectively. See Table 1 (above) for distances and exclusion zones.

Visual Monitoring at the Start of Airgun Operations

(f) Visually observe the entire extent of the exclusion zone (180 dB re 1 μPa [rms] for cetaceans; see Table 1 [above] for distances) using NMFS-qualified PSVOs, for at least 30 minutes prior to starting the airgun array (day or night).

(i) If the PSVO observes a marine mammal within the exclusion zone, USGS must delay the seismic survey until the marine mammal(s) has left the area. If the PSVO sees a marine mammal that surfaces, then dives below the surface, the PSVO shall wait 30 minutes. If the PSVO sees no marine mammals during that time, he/she should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or within the exclusion zone, the airguns may not resume airgun operations.

(iii) If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), USGS may start the second airgun, and subsequent airguns, without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the exclusion zone (in accordance with Condition 6[h] below).

Ramp-Up Procedures

(g) Ramp-up procedures at the start of seismic operations or after a shut-down—Implement 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 more than 10 minutes, which means starting with the smallest airgun first and adding airguns 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 PSVOs shall monitor the 180 and 190 dB exclusion zone for cetaceans and pinnipeds, respectively, and if marine mammals are sighted within or about to enter the relevant exclusion zone, a power-down, or shut-down shall be implemented as though the full array were operational. Therefore, initiation of ramp-up procedures from a shut-down or at the beginning of seismic operations requires that the PSVOs be able to view the full exclusion zone as described in Condition 6(m) (below).

Power-Down Procedures

(h) Power-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 1, above). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun, which reduces the exclusion zone to the degree that the animal(s) is no longer in or about to enter it for the full airgun array. 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.

(i) Following a power-down, if the marine mammal approaches the small designated exclusion zone, the airguns must then be completely shut-down. Airgun activity shall not resume until the PSVO has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

(j) Following a power-down and subsequent animal departure, the airgun operations may resume at full power. Initiation requires that PSVOs can effectively monitor the full exclusion zones described Condition 6(g). If the PSVO(s) sees a marine mammal within or about to enter the relevant zones, when a course/speed alteration, power-down, or shut-down will be implemented.

Shut-Down Procedures

(k) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 1, above). A shut-down means all operating airguns are shut-down (i.e., turned off).

(l) Following a shut-down, if the PSVO has visually confirmed that the animal has departed the relevant exclusion zone (and is not likely to return) within a period less than or equal to 10 minutes after the shut-down, the airgun operations may resume at full power. If the PSVO has not observed the marine mammal(s) exiting the exclusion zone, the airgun operations shall not resume for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales). Following a shut-down, the *Langseth* may resume following ramp-up procedures described in Condition 6(h).

Speed or Course Alteration

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

Survey Operations at Night

(n) Marine seismic surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(o) 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 relevant exclusion zone cannot be effectively monitored by the PSO(s) on duty.

Mitigation Airgun

(p) Use of small-volume airgun (i.e., mitigation airgun) during turns and maintenance shall be operated at approximately one shot per minute and would not be operated for longer than three hours in duration. During turns or brief transits between seismic tracklines, one airgun will continue operating.

Special Procedures for Situations or Species of Concern

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

(r) Concentrations of humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) will be avoided if possible (i.e., exposing concentrations of animals to 160 dB), and the array will be powered-down if necessary. 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.).

7. Reporting Requirements

The USGS is required to:

(a) Submit a draft comprehensive report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Langseth'*s cruise in the northwest Atlantic Ocean off the Eastern Seaboard after the end of phase 1 in 2014 and another draft comprehensive report after the end of phase 2 in 2015. 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 power-downs and shut-downs), 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 (based on visual observation) at received levels greater than or equal to 160 dB re 1 µPa (rms) and/or 180 dB re 1 µPa (rms) for cetaceans and 190 dB re 1 µPa (rms) for pinnipeds with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeled values for the 36 airgun array) to the seismic activity at received levels greater than or equal to 160 dB re 1 µPa (rms) and/or 180 dB re 1 µPa (rms) for cetaceans and 190 dB re 1 µPa (rms) for pinnipeds 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 Biological Opinion's Incidental Take Statement (ITS); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report shall 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, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report shall be considered to be the final report.

Reporting Prohibited Take

8. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization (if issued), such as an injury (Level A harassment), serious injury, or mortality (e.g., ship-strike, gear interaction, and/or entanglement), USGS shall immediately cease the specified activities and 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

Howard.Goldstein@noaa.gov and the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866–755–6622 (*Mendy.Garron@noaa.gov*), and 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:

(a) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

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

Reporting an Injured or Dead Marine Mammal With an Unknown Cause of Death

In the event that USGS discovers an injured or dead marine mammal, and the lead 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 described in the next paragraph), USGS 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 *Howard.Goldstein@noaa.gov,* and the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866–755–6622) and/or by email to the NMFS Greater Atlantic Regional Stranding Coordinator (*Mendy.Garron@noaa.gov*), and the NMFS Southeast Region Marine Mammal Stranding Network (877–433–8299) and/or by email to the Southeast Regional Stranding Coordinator (*Blair.Mase@noaa.gov*) and Southeast Regional Stranding Program Administrator (*Erin.Fougeres@noaa.gov*). The report must include the same information identified in Condition 8(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with USGS to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

In the event that USGS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), USGS 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 *Howard.Goldstein@noaa.gov,* and the NMFS Greater Atlantic Marine Mammal Stranding Network (866–755–622), and/or by email to the Greater Atlantic Regional Stranding Coordinator (*Mendy.Garron@noaa.gov*), and the NMFS Southeast Regional Stranding Network (877–433–8299), and/or by email to the Southeast Stranding Coordinator (*Blair.Mase@noaa.gov*) and Southeast Regional Stranding Program Administrator (*Erin.Fourgeres@noaa.gov*), within 24 hours of the discovery. USGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

Endangered Species Act (ESA) Biological Opinion and Incidental Take Statement (ITS)

9. USGS is required to comply with the Terms and Conditions of the ITS corresponding to NMFS's ESA Biological Opinion issued to both USGS and NMFS's Office of Protected Resources, Permits and Conservation Division.

10. A copy of this Authorization and the ITS must be in the possession of all contractors and PSOs operating under the authority of this Incidental Harassment Authorization.

Request for Public Comments

NMFS requests comments on our analysis, the draft authorization, and any other aspect of the notice of proposed IHA for USGS's proposed marine seismic survey in the Atlantic Ocean off the Eastern Seaboard. Please include with your comments any supporting data or literature citations to help inform our final decision on USGS's request for an MMPA authorization. Concurrent with the publication of this notice in the **Federal Register,** NMFS is forwarding copies of this application to the Marine Mammal Commission and its Committee of Scientific Advisors.

Dated: June 16, 2014.

Perry F. Gayaldo,

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

[FR Doc. 2014–14426 Filed 6–20–14; 8:45 am]

BILLING CODE 3510–22–P

15 APPENDIX G: COMMENTS RECEIVED IN RESPONSE TO NMFS FR NOTICE

23 July 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 the U.S. Geological Survey (USGS), Lamont-Doherty Earth Observatory (LDEO), and 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 the east coast of the United States. The Commission also has reviewed the National Marine Fisheries Service's (NMFS) 23 June 2014 notice announcing receipt of the application and proposing to issue the authorization, subject to certain conditions (79 Fed. Reg. 35642).

Some issues raised in previous letters regarding geophysical surveys reflect Commission concerns that apply more broadly to incidental take authorization applications beyond USGS's proposed application. The Commission has recommended numerous times 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 of 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 USGS's application.

BACKGROUND

USGS, with LDEO as the operator, proposes to conduct a high-energy, 2D geophysical survey in the U.S. exclusive economic zone (EEZ) and international waters of the northwest Atlantic Ocean from New England to Florida. The purpose of the proposed survey is to identify the outer limits of the U.S. continental shelf and study the sudden mass transport of sediments down the continental shelf that may pose significant tsunami-related hazards to Atlantic and Caribbean coastal communities. The survey would be conducted in waters estimated to be 1,400 to greater than 5,400 m in depth with approximately 3,165 km of tracklines during both phase I (up to 18 days in August–September 2014) and phase II (up to 18 days between April and August 2015). LDEO would use the R/V *Marcus G. Langseth*, owned by NSF, to operate a 36-airgun array (nominal source levels 236 to 265 dB re 1μPa (peak-to-peak)) at 9 m depth. The *Langseth* also would tow one hydrophone streamer, 8,000 m in length, 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 34 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. In addition, USGS would shut down the airguns immediately if and when a North Atlantic right whale is sighted, regardless of the distance from the *Langseth*. Ramp-up procedures would not be initiated until the right whale has not been seen at any distance for 30 minutes. Further, USGS would 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).

Staff members from NMFS, NSF, USGS, LDEO, 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.

RATIONALE AND RECOMMENDATIONS

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 USGS- and NSF-funded geophysical research. These concerns date back to 2010 (please refer to the Commission's 12 March, 19 April, and 24 June 2013 and 31 March 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[1]). LDEO also has noted the model is most directly applicable to deep water (> 1,000 m). 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. 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.

LDEO has stated that the model for deep water 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 Appendix A of the environmental assessment for the proposed survey 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. Furthermore, the estimated exclusion zones for the proposed survey (36-airgun array towed at 9 m in depth) are smaller[2] than previously authorized and the buffer zones are larger[3] 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[4]. All these shortcomings reinforce the Commission's ongoing concerns regarding the estimation of exclusion and buffer zones for USGS- and NSF-funded geophysical surveys.

Those concerns are based primarily on the failure to verify the use of LDEO's model under the specific environmental conditions that would be encountered with each survey. For that reason, the Commission has recommended that NMFS or the relevant entity estimate exclusion and buffer zones using either empirical measurements from the particular survey site <u>or</u> a model that accounts

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[1] Diebold et al. (2010) also presented data on the 18-airgun array from the Gulf of Mexico.
[2] 286 vs. 400 m for the 190-dB re 1 μPa threshold and 927 vs. 940 m for the 180-dB re 1 μPa threshold.
[3] 5,780 vs. 3,850 m for the 160-dB re 1 μPa threshold.
[4] 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.

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[5] (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 but 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 indicated that NSF, LDEO, and other relevant entities (USGS, Scripps Institution of Oceanography (Scripps)) are providing sufficient scientific justification for their take estimates. The Commission disagrees with this conclusion, given that the estimates are based on LDEO's model or empirical measurements in the Gulf of Mexico, while recent activities would occur in areas such as the North Atlantic and the Antarctic. Environmental conditions in waters off New Jersey (up to 1,500 m in depth) indicate a surface duct at 50 m, in-water refraction, and bathymetry and sediment characteristics that reflect sound in summer. Further, conditions near the mid-Atlantic ridge (up to 5,000 m in depth) indicate a pronounced sound channel at approximately 1,000 m depth and a downward-refracting stratified surface layer in summer, with nearly identical sound speed profiles in spring and fall[6]. 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[7].

In a recent sound exposure modeling workshop that was attended by numerous entities (including NMFS, NSF, LDEO, USGS, and the Commission), experts confirmed that sound speed profiles and bathymetry/sediment characteristics were the most important factors affecting

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[5] 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.

[6] NSF and USGS's PEIS included environmental data from the continental shelf close to the proposed survey.

[7] 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.

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 concerned that the LDEO model is not based on best available science and does not support its continued use. For all of these reasons, the Commission recommends that NMFS (1) require USGS, LDEO, and NSF to re-estimate the proposed exclusion and buffer zones and associated takes of marine mammals using site-specific parameters (including sound speed profiles, bathymetry, and sediment characteristics at a minimum) for the proposed incidental harassment authorization and (2) impose the same requirement for all future incidental harassment authorizations submitted by USGS, LDEO, NSF, Scripps, Antarctic Support Contract (ASC), or any other related entity.

In 2011[8], 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 able to implement 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. USGS, LDEO, NSF, and related entities (ASC, Scripps) should be held to that same standard. NMFS recently indicated that it does not, and does not believe it is appropriate to, prescribe the use of any particular modeling package (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.

NMFS further indicated that based on empirical data (which illustrate the LDEO model's conservative exposure estimates for the Gulf of Mexico and preliminarily 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 survey off New Jersey, NMFS increased the exclusion zone radii by a factor of 50 percent (equivalent to approximately a 3-dB difference in received level at the zone edge) to be additionally precautionary (79 Fed. Reg. 38499). The Commission must question, if NMFS really believes the LDEO model is based on best available science, why it then extended the exclusion zones to be precautionary and if NMFS felt the need to be precautionary and extend the exclusion zones, why it did not then also extend the buffer zones and thus the estimated numbers of takes of marine mammals.

Density estimates

In estimating the numbers of potential takes for the proposed incidental harassment authorization, USGS used density data from the Ocean Biogeographic Information System Spatial

[8] The record of decision was signed in 2012.

Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP), specifically data originating from Navy Operating Area Density Estimates (NODE). USGS considered those estimates to be the best available data. However, those data apply only to the U.S. EEZ, which comprises only 20 percent of the proposed survey area in 2014 and 10 percent in 2015. It is unclear if USGS assumed the densities in areas outside the U.S. EEZ to be 0, if it applied the densities estimated for waters within the EEZ to those other areas, or if it did some permutation of those two methods[9]. In any case, the densities could have been underestimated.

Although NMFS indicated in the *Federal Register* notice for the proposed authorization that the OBIS-SEAMAP data were determined to be the best available information for density data, the Commission understands that NMFS subsequently determined that the data from the Navy's Atlantic Fleet Training and Testing Navy Marine Species Density Database (AFTT NMSDD) are superior and are now considered the best available. Therefore, the Commission understands that NMFS intends to use the AFTT NMSDD data to re-estimate the numbers of marine mammals that could be taken during the proposed survey. The Commission agrees that the AFTT NMSDD data are preferable and should be used to re-estimate the numbers of takes for all marine mammal species and used for the analyses required under both the MMPA and the Endangered Species Act (the ESA). Furthermore, the Commission recommends that the same methods be used to determine the densities for the analyses conducted under the MMPA and ESA.

For some species, the estimated numbers of takes may increase if the AFTT NMSDD data are used. It remains unclear whether any such increases in those estimates would change NMFS's proposed findings as to whether only "small numbers" of marine mammals would be taken or whether such takes would have a "negligible impact" on the affected species and stocks. This is particularly true because NMFS has yet to develop a clear policy setting forth more explicit criteria and/or thresholds for making those determinations, as recommended by the Commission. Such guidance would be particularly useful in a case like this, in which up to 43 percent of the pantropical spotted dolphin stock in the area, or perhaps even more[10], could be taken incidentally during the proposed survey activities. The Commission notes that NMFS, in its proposed authorization, estimated that 6.54 percent of the pantropical spotted dolphin stock would be affected– however, that estimate is based only on the portions of the survey that will occur within the U.S. EEZ. As previously stated, most of the proposed survey would occur in waters outside the EEZ and should be accounted for in both the authorization and the supporting analyses. Is NMFS suggesting that the taking prohibition of the MMPA does not apply to takes by U.S. citizens on the high seas outside the U.S. EEZ or that an incidental take authorization somehow is not needed for activities engaged in by U.S. citizens in those waters? Clearly the taking prohibition applies (see section 102(a)(1)), and, as such, an authorization is needed[11]. Further, that authorization can be issued only if the overall

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[9] USGS's application and environmental assessment indicated the model outputs of all four seasons from the NODE data were used to determine the mean density. However, in further correspondence, USGS indicated that areas beyond the U.S. EEZ were essentially classified as "no data", and median densities were calculated from only areas that had data within the EEZ. Curiously, if one obtains data from the OBIS-SEAMAP website and uses either of those two methods, the data in Table 4 of the *Federal Register* notice (and the relevant tables in the application and environmental assessment) are not reproducible and in some cases are underestimates of the OBIS-SEAMAP data.

[10] Based on the OBIS-SEAMAP data, those takes likely will increase when the takes are re-estimated using the AFTT NMSDD data.

[11] For previous incidental harassment authorizations for LDEO surveys conducted only in international waters of the North Atlantic, NMFS based its small numbers determination on the abundance of the regional population, most of

impact of the taking would be negligible and involve only small numbers of marine mammals. Accordingly, the Commission recommends that NMFS make its small numbers and negligible impact determinations based on the total numbers of marine mammals to be taken for the entire survey (including the combined 2014 and 2015 survey legs), both in the U.S. EEZ and in international waters. 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). As previously noted, clearer policies would be especially helpful for reviewing the proposed authorization, and the Commission encourages NMFS to complete its policy development as quickly as possible and awaits a meeting to engage in that policy process.

Under section 101(a)(5)(D)(iii) of the MMPA an incidental harassment authorization can be issued only after notice in the *Federal Register* and opportunity for public comment. However, that public review opportunity is meaningful only if the proposed authorization contains accurate information and the relevant analyses. If, subsequent to publication, substantive changes are made to the underlying information or NMFS's analyses, re-publication with a new comment opportunity is appropriate. In this instance, it appears that NMFS's published analyses were not based on the best available information and that it may have significantly underestimated the likely numbers of takes for at least some of the marine mammal species and stocks that occur in the proposed survey area. That being the case, the Commission recommends that NMFS publish a revised proposed authorization in the *Federal Register* with updated estimated numbers of takes and small numbers and negligible impact analyses to provide a more informed public comment opportunity. Further, the Commission recommends that, to the extent possible, NMFS strive to identify and incorporate any substantive changes that might be made in a proposed incidental harassment authorization prior to publication in the *Federal Register*.

Monitoring measures

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—

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which originated from NMFS's stock assessment reports (see Tables 2 in 78 Fed. Reg. 10142 and 78 Fed. Reg. 22249 for the Mid-Atlantic Ridge survey).

> 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[12] 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 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 USGS, LDEO, NSF, and other relevant entities (e.g., 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.

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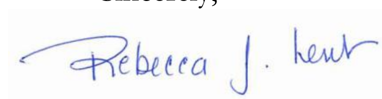
[12] The Commission also questions whether the cited regulation is even the relevant one upon which NMFS should be relying. It merely specifies what applicants should be suggesting when applying for an incidental take authorization. NMFS has an independent responsibility under the MMPA to specify monitoring and reporting requirements that are sufficient for it determine that the statutory requirements are being met.

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, Ph.D.
Executive Director

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July 23, 2014

Via electronic mail sent to ITP.Goldstein@noaa.gov
Ms. 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

RE: Comments on the National Marine Fisheries Service Incidental Harassment Authorization for the Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey in the Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015 (RIN 0648-XD214)

Dear Ms. Harrison:

Clean Ocean Action (COA) submits the following comments in response to the National Marine Fisheries Service (NMFS) request for comments for the proposed incidental harassment authorization (IHA) for the takes of marine mammals incidental to a marine geophysical survey in the Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015 (RIN 0648-XD214).[1]

The United States Geological Survey (USGS), Lamont-Doherty Earth Observatory of Columbia University (L-DEO), and the National Science Foundation propose to conduct a 2-D seismic vessel survey in the Atlantic Ocean off the Eastern Seaboard between August and September 2014 and April and August 2015 to identify the outer limits of the United States continental shelf and study potential tsunami-related hazards ("Proposed Project"). The Proposed Project includes the use of an array of 36 airguns with a total volume of approximately 6,600 in^3, in conjunction with a multibeam echosounder and a sub-bottom profiler. The nominal source levels of the airgun arrays range from 236 to 265 decibels (dB) re: 1 µPa (peak-to-peak), and airguns would fire every 20 to 24 seconds, 24 hours a day, for a17 to 18 day period set to commence on August 15, 2014. Similar survey activities will also be conducted in an as yet unconfirmed timeframe between April and August 2015. The area to be surveyed is an irregularly shaped region of the Atlantic Ocean continental shelf that is positioned between 241 km (130 nmi) and 648.2 km (350 nmi) from the coast of the United States.

[1] 79 Fed. Reg. at 35642 (Monday, June 23, 2014) (hereafter "NMFS IHA").

NMFS issued its proposed IHA for takes of 19,497 marine mammals by harassment under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA). The Proposed Project is subject to regulations under the National Environmental Policy Act (NEPA) and must also request a Section 7 Consultation under the Endangered Species Act (ESA)[2] and an Essential Fish Habitat assessment under the Magnuson-Stevens Fishery Conservation and Management Act.[3]

For the reasons detailed herein, Clean Ocean Action urges denial of the NMFS IHA on the grounds that a full Environmental Impact Statement (EIS) should be completed and the potential impacts to marine mammals are incompatible with the goals, mandates, and prohibitions of the MMPA. A full EIS is necessary to remedy issues of incomplete information, inadequate assessment of impacts, and insufficient evaluation of alternatives and mitigation measures. Importantly, the Proposed Project should not be conducted during the spring and summer months, which are the peak of marine mammal (and other marine species) feeding, breeding, and/or calving activity off the mid-Atlantic coast. Moreover, NMFS should ensure that best available science and regulatory review are incorporated into the EIS and IHA, require stronger mitigation measures, and consider different times of year for the Proposed Project.

II. NOAA must prepare a specific EIS because there are significant environmental impacts from the Proposed Project

For the reasons discussed below, we strongly urge NMFS to prepare an EIS for this project prior to the further consideration of the issuance of an IHA. We understand that an EA was drafted in May 2014 for this project; this document tiers to a Programmatic EIS that was finalized in 2011. Given the broad scope of this PEIS and the restricted scope of the May 2014 EA, an updated EIS would provide information necessary to making an informed decision about issuance of the IHA. Specifically, an EIS would include complete scientific substantiation for the project, a thorough analysis of all direct, indirect, and cumulative environmental impacts (including use of the acoustic guidelines that NOAA recently drafted and received comments on, which account for best available science), and in-depth consideration of a full range of alternatives to the project. Moreover, to meet its NEPA obligations, the NEPA document must be made available for public review and comment.[4]

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[2] Section 7 of the ESA (16 U.S.C. 1531 et seq.) outlines the procedures for Federal interagency cooperation to conserve federally-listed species and designated critical habitats.

[3] Public Law (P.L.) 94-265, as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479). EFH Guidelines at 50 CFR 600.05-600.930 outline the process to satisfy EFH consultation under Section 305(b)(2)-(4)) of the MSA.

[4] *See, e.g. Anderson v. Evans*, 314 F.3d 1006, 1016 (9th Cir. 2002) ("the public must be given an opportunity to comment on draft EAs and EISs").

A. Purpose of NEPA and EA and trigger for an EIS

NEPA's fundamental purposes are to guarantee that: (1) agencies take a hard look at the environmental consequences of their actions before these actions occur; and (2) agencies make the relevant information available to the public so that it may also play a role in both the decision-making process and the implementation of that decision.[5] To assure transparency and thoroughness, agencies also must "to the fullest extent possible...[e]ncourage and facilitate public involvement" in decision-making.[6] Despite the fact that a draft Environmental Assessment (EA) was released in May 2014, the public was not offered an opportunity to comment on the Proposed Project until the issuance of the proposed IHA on June 23, 2014, less than two months before the study was scheduled to begin.

The purpose of an EA is to assist the agency in determining whether the project may significantly affect the environment and therefore require a full EIS.[7] An agency may avoid preparing a full EIS if the agency: (1) prepares an environmental assessment identifying and analyzing the action's environmental effects; and (2) makes a finding of no significant impact, which presents the agency's reasons for concluding that the action's environmental effects are not significant.[8] NEPA requires federal agencies to prepare an EIS for all "major federal actions significantly affecting the quality of the human environment."[9] A full EIS is required if "substantial questions are raised as to whether a project...may cause significant degradation of some human environmental factor."[10] To trigger this requirement, the plaintiff "need *not show* that significant effects will *in fact* occur;" but rather, "raising substantial questions whether a project may have a significant environmental effect is sufficient."[11]

Whether an action may have "significant" impacts on the environment is determined by considering the "context" and "intensity" of the action.[12] "Context" means the significance of the project "must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality."[13] Intensity of the action is

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[5] See, e.g. 40 C.F.R. § 1500.1.
[6] 40 C.F.R. §1500.2(d
[7] 42 U.S.C. §4332(2)(C); 40C.F.R. §1508.9.
[8] 40 C.F.R. §§ 150l.4(b), (e); 1508.9; 1508.1.3.
[9] 42 U.S.C. § 4332(2)(C); see also 40 C.F.R. § 1501.4. The Act defines the "human environment" as including "the natural and physical environment and the relationship of people with that environment…This means that economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment." 40 C.F.R. § 1508.14.
[10] *Idaho Sporting Congress v. Thomas*, 137 F.3d 1146, 1149-50 (9th Cir. 1998).
[11] *Id*. (emphases in original).
[12] 40 C.F.R. § 1508.27.
[13] Id. § 1508.27(a).

determined by considering the following factors: (1) impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial; (2) the degree to which the proposed action affects public health or safety; (3) unique characteristics of the geographic area such as proximity to ecologically critical areas; (4) the degree to which the effects on the quality of the human environment are likely to be highly controversial; (5) the degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks; (6) the degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration; (7) whether the action is related to other actions with individually insignificant but cumulatively significant impacts; (8) the degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources; (9) the degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the federal Endangered Species Act; (10) whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.[14] The presence of one or more significant effects can trigger the need for a full EIS.[15] Based on the nature of potential impacts to marine life from the Proposed Project and the incomplete analysis of such impacts in the EA (discussed further below), a full EIS must be prepared for this study and the issuance of an IHA before this process is completed would be premature. Furthermore, given that the EA drafted for the Proposed Project tiers to a Programmatic EIS that was finalized in 2011, an updated EIS would provide information necessary to making an informed decision about issuance of the IHA.

B. Potential impacts from sound-producing sources other than seismic airguns were not evaluated.

Neither the NMFS IHA nor the EA upon which it relies have offered any meaningful evaluation of the potential impacts that other sound-producing sources used in the Proposed Project may have on marine species. Of particular concern, the NMFS IHA indicates that a high-frequency Kongsberg EM 122 multibeam echosounder will operate concurrently with airgun operations. The multibeam echosounder produces sound in the 10.5 to 13.0 kHz frequency range, which is within the optimal hearing spectrum for many odontocete species that may occur in the study area. A 12-kHz multibeam echosounder system operated by an Exxon survey vessel off the

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[14] 40 C.F.R. § 1508.27(b)(1)-(10).

[15] S*ee, e.g. Nat'l Parks & Conserv. Ass'n. v. Babbitt*, 241 F.3d 722, 731 (9th Cir. 2001) (either of two significance factors considered by the court "may be sufficient to require preparation of an EIS in appropriate circumstances"); *Anderson v. Evans*, 350 F.3d 815, 835 (9th Cir. 2003) (presence of one or more factors can necessitate preparation of a full EIS).

coast of Madagascar was implicated by an independent scientific review panel (ISRP) in the mass-stranding of approximately 100 melon-headed whales (*Peponocephala electra*) in 2008.[16] The report of the ISRP stated, "all other possible factors considered were determined by the ISRP to be unlikely causes for the initial behavioral response."[17]

Furthermore, a 2002 seismic expedition in the Gulf of California, also lead by L-DEO, employed a similar multibeam sonar system with a center frequency of 15.5 kHz and source levels of 237 dB. Beaked whale strandings observed in the area of the survey in September 2002 may have been linked to the use of this technology – a federal judge responded by ordering the ship to cease operations.[18]

Based on the correlation between these previous stranding events and the use of multibeam sonar technology, it is imperative that NMFS fully assess the potential for this source to impact marine mammals both on its own and in concert with seismic airgun blasts.

C. The analysis of alternatives in the EA was incomplete.

The "heart" of the NEPA process is an agency's duty to consider "alternatives to the proposed action" and to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources."[19] The CEQ regulations require NMFS to "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated."[20] "A 'viable but unexamined alternative renders [the] environmental impact statement inadequate.'"[21]

The EA does not devote sufficient discussion to alternatives, including alternative times of year and additional mitigation and monitoring activities. In its discussion of the No Action alternative, the EA does not adequately qualify the benefits of the No Action alternative, in which the Proposed Project would not proceed and 19,497 marine mammals would not be subject to harassment, in relation to the costs. The "Alternative Action" alternative does not

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[16] 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.
[17] Id.
[18] 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., Fernandez, 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.C., Palka, D., Ponganis, P., Rommel, S., Rowles, T., Taylor, B., Tyack, P., Wartzok, D., Gisiner, R., Mead, J., and Benner, L. 2006. Understanding the impacts of anthropogenic sound on beaked whales. *Journal of Cetacean Resource Management* **7**: 177-187.
[19] 42 U.S.C. §§ 4332(2)(C)(iii), 4332(2)(E).
[20] 40 C.F.R. § 1502.14(a).
[21] *Muckleshoot Indian Tribe v. U.S. Forest Serv.*, 177 F.3d 800, 814 (9th Cir. 1999) (quoting *Citizens for a Better Henderson v. Hodel*, 768 F.2d 1051, 1057 (9th Cir. 1985)).

actually evaluate any alternate times of year to conduct the survey, which are important considerations that deserve full assessment given the magnitude of marine mammal takes during the proposed study periods.

The two legs of the Proposed Project are planned to take place between the spring and late summer (August to September 2014 and April to August 2015). This timeframe is of critical importance to many cetacean species that may occur in the study area, including several endangered species. The critically endangered North Atlantic right whale migrates northward to the waters off New England and the Bay of Fundy in the spring and summer months, and is also feeding and nursing during this time period.[22] Other species known to feed, breed, and/or calve in the area of the Proposed Project during this timeframe include the Minke whale,[23] Bryde's whale,[24] sei whale,[25] fin whale,[26] blue whale,[27] sperm whale,[28] pygmy sperm whale,[29] dwarf sperm whale,[30] northern bottlenose whale,[31] bottlenose dolphin,[32] Atlantic white-sided dolphin, Atlantic spotted dolphin, pantropical spotted dolphin,[33] striped dolphin, spinner dolphin,[34] Clymene dolphin,[35] short-beaked common dolphin,[36] Risso's dolphin,[37] melon-

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[22] NOAA Fisheries, Office of Protected Resources. North Atlantic Right Whales (*Eubalaena glacialis*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northatlantic.htm.
[23] NOAA Fisheries, Office of Protected Resources. Minke Whale (*Balaenoptera acutorostrata*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/minkewhale.htm.
[24] NOAA Fisheries, Office of Protected Resources. Bryde's Whale (*Balaenoptera edeni*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/brydeswhale.htm.
[25] NOAA Fisheries, Office of Protected Resources. Sei Whale (*Balaenoptera borealis*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/seiwhale.htm.
[26] NOAA Fisheries, Office of Protected Resources. Fin Whale (*Balaenoptera physalus*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm.
[27] NOAA Fisheries, Office of Protected Resources. Blue Whale (*Balaenoptera musculus*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bluewhale.htm.
[28] NOAA Fisheries, Office of Protected Resources. Sperm Whales (*Physeter macrocephalus*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm.
[29] NOAA Fisheries, Office of Protected Resources. Pygmy Sperm Whale (*Kogia breviceps*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/pygmyspermwhale.htm.
[30] NOAA Fisheries, Office of Protected Resources. Dwarf Sperm Whale (*Kogia sima*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/dwarfspermwhale.htm.
[31] NOAA Fisheries, Office of Protected Resources. Northern Bottlenose Whale (*Hyperoodon ampullatus*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/northernbottlenosewhale.htm.
[32] NOAA Fisheries, Office of Protected Resources. Bottlenose Dolphin (*Tursiops truncatus*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bottlenosedolphin.htm.
[33] NOAA Fisheries, Office of Protected Resources. Pantropical Spotted Dolphin (*Stenella attenuata*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spotteddolphin_pantropical.htm.
[34] NOAA Fisheries, Office of Protected Resources. Spinner Dolphin (*Stenella longitrostris*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spinnerdolphin.htm.
[35] NOAA Fisheries, Office of Protected Resources. Clymene Dolphin (*Stenella clymene*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/clymenedolphin.htm.
[36] NOAA Fisheries, Office of Protected Resources. Short-Beaked Common Dolphin (*Delphinus delphis*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/commondolphin_shortbeaked.htm.

headed whale,[38] false killer whale,[39] killer whale,[40] and short-finned pilot whale.[41] Based on the high frequency of vital behaviors that take place in the spring and summer months, it is prudent for NMFS to assess alternate times of year for the Proposed Project, especially during the winter, when many species may be located outside of the survey area.

Should it be determined that the Proposed Project must continue as planned for the summer of 2014 and spring/summer of 2015, we urge NMFS to consider alternatives with stronger mitigation measures including pre-survey observations, aerial surveys, larger exclusion zones and lower sound thresholds, suspension of activities in low light and night conditions (or at the very least, requiring visual observers equipped with night-vision technologies during these conditions), post-survey monitoring, and other methods to detect marine mammals beyond visual observation and acoustic monitoring.

II. NMFS must ensure that its IHA complies with the MMPA.

The MMPA places a "moratorium on the taking" of marine mammals.[42] 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. Furthermore, NMFS must provide for the monitoring and reporting of such takings and must prescribe methods and means of affecting the "least practicable adverse impact" on the species or stock and their habitat.[43]

A. Scientific evidence supports marine mammal harassment below the 160-dB Level B threshold and potential for injury below the 180/190-dB Level A threshold

The proposed IHA uses the single sound pressure level of 160 dB re 1 µPa (RMS) as a threshold for behavioral, sub-lethal take in all marine mammal species affected by the proposed survey.[44] This approach does not reflect the best available science, and the choice of threshold is not sufficiently conservative in several important respects. In fact, five of the world's leading biologists and bioacousticians working in this field recently characterized the 160-dB threshold

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[37] NOAA Fisheries, Office of Protected Resources. Risso's Dolphin *(Grampus griseus)*. Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rissosdolphin.htm.

[38] NOAA Fisheries, Office of Protected Resources. Melon-headed Whale (*Peponocephala electra*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/melonheadedwhale.htm.

[39] NOAA Fisheries, Office of Protected Resources. False Killer Whale (*Pseudorca crassidens*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/falsekillerwhale.htm.

[40] NOAA Fisheries, Office of Protected Resources. Killer Whale (*Orcinus orca*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/killerwhale.htm.

[41] NOAA Fisheries, Office of Protected Resources. Short-finned Pilot Whale (*Globicephala macrorhynchus*). Available at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/pilotwhale_shortfinned.htm.

[42] 16 U.S.C. § 1371(a).

[43] 16 U.S.C. § 1371(a)(5)(A) & (D).

[44] 79 Fed. Reg. at 14801.

as "overly simplified, scientifically outdated, and artificially rigid."[45] Furthermore, NMFS has released draft acoustic guidance that is currently being finalized; these guidelines should be incorporated into take estimations.

Using a single sound pressure level of 160-dB for harassment represents a major step backward from recent programmatic authorizations. For Navy sonar activity, for example, NMFS has incorporated linear risk functions into its analysis, which endeavor to account for risk and individual variability and to reflect the potential for take at relatively low source levels.[46]

Furthermore, current scientific literature establishes that behavioral disruption can occur at substantially lower received levels for some marine mammal species, including these that will be impacted by the Proposed Project. For example, the startup of a seismic survey has been shown to cause endangered fin and humpback whales to stop vocalizing – a behavior essential to breeding and foraging.[47] Similarly, a low-frequency, high-amplitude fish shoal imaging device was recently found to silence humpback whales at a distance of up to 200 kilometers, where received levels ranged from 5 to 22 dB above ambient noise levels.[48] Groups of humpback whales in the wild have been observed to exhibit avoidance behaviors at a distance of two kilometers from a small airgun array; the received levels in these trials were 159 dB re: 1 μPa^2 peak-to-peak.[49] Blue whale behavioral changes in response to a small airgun array have also been monitored. Researchers tracked a blue whale traveling and vocalizing in the vicinity of a vessel firing a four-gun array with a source level of 215 dB re: 1 μPa^2 peak-to-peak and noted that at a distance of 10 kilometers from the vessel (where the received level was estimated to be 143 dB re: 1 μPa^2 peak-to-peak), the whale ceased vocalizations for an hour and noticeably changed course.[50] The literature also shows that harbor porpoises are acutely sensitive to a range of anthropogenic sounds, including airguns. They have been observed to engage in avoidance responses 50 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

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[45] Clark, C., Mann, D., Miller, P., Nowacek, D., and Southall, B., Comments on Arctic Ocean Draft Environmental Impact Statement at 2 (Feb. 28, 2012); *see* 40 C.F.R. § 1502.22.

[46] *See, e.g.*, 74 Fed. Reg. 4844, 4844-4885 (Jan. 27, 2009).

[47] Clark, C.W., and Gagnon, G.C. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. (IWC Sci. Comm. Doc. IWC/SC/58/E9); *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).

[48] 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).

[49] McCauley, R.D., Jenner, M.N., Jenner, C., McCabe, K.A., and Murdoch, J. 1998. The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey: Preliminary results of observations above a working seismic vessel and experimental exposures. *Appea Journal*: 692-706.

[50] McDonald, M.A., Hildebrand, J.A., and Webb, S.C. 1995. Blue and fin whale observed on a seafloor array in the Northeast Pacific. *Journal of the Acoustical Society of America* **98**: 712-721.

at very low received levels, well below 120 dB.**[51]** Cuvier's beaked whales exhibited alarming behavioral impacts when exposed to sonar at low received levels of 89-127dB re: 1 μPa.[52]

Furthermore, evidence in the scientific literature has indicated that temporary threshold shifts (TTS) can occur in cetaceans at source levels lower than proposed for this survey. As NMFS itself cites, a recent study involved the exposure of a captive harbour porpoise to one airgun firing on three occasions at an average source level of 201 dB re: 1 μPa^2 peak-to-peak.[53] In addition to avoidance behavior exhibited by the animal during the trials, the researchers estimated through modeling that the onset of TTS that did not fully subside until *55 hours after exposure*.[54] Moreover, NMFS cannot rationally assume that other marine mammals will not incur injury at noise levels below those in the Proposed Project. The Lucke *et al.* study demonstrates that TTS can occur at different levels for different species of cetaceans. Moreover, controlled exposure trials in which harbor seals were exposed to small airguns firing for one hour at source levels ranging from 215 to 224 dB re: 1 μPa^2 peak-to-peak revealed dramatic physiological and behavioral responses, including a fright response evidenced by significant drops in heart rate; decreased stomach temperatures indicating a cessation of feeding; and rapid swimming away from the noise source.[55] Thus, NMFS cannot assume that TTS and even permanent threshold shifts (PTS) would be unlikely for marine mammals in the area of this Proposed Project.

A number of other recent studies indicate that anthropogenic sound can induce PTS at lower levels than anticipated.**[56]** New data indicate that mid-frequency cetaceans have greater

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[51] *See, 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).

[52] DeRuiter, S.L., Southall, B.L., Calambokidis, J., Zimmer, W.M.X., Sadykova, D., Falcone, E.A., Friedlaender, A.S., Joseph, J.E., Moretti, D., Schoor, G.S., Thomas, L., and Tyack, P.L. 2013. First direct measurements of behavioural responses by Cuvier's beaked whales to mid-frequency active sonar. *Biology Letters* **9**: 20130223 1 (2013).

[53] Lucke, Klaus, Siebert, U., Lepper, P. a, & Blanchet, M.-A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *The Journal of the Acoustical Society of America*, 125(6): 4060-70.

[54] Lucke, K., Siebert, U., Lepper, P.A., and Blanchet, M.-A. 2009. 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. Emphasis added.

[55] Thompson, D., Sjoberg, M., Bryant, M.E., Lovell, P., and Bjorge, A. 1998. Behavioral and physiological responses of harbour (*Phoca vitulina*) and grey (*Halichoerus grypus*) seals to seismic surveys. Report to European Commission of BROMMAD Project. MAS2 C7940098.

[56] Kastak, D., Mulsow, J., Ghoul, A., and Reichmuth, C. 2008. Noise-induced permanent threshold shift in a harbor seal [abstract], *Journal of the Acoustical Society of America* **123**: 2986; Kujawa, S.G., and Liberman, M.C. 2009. Adding insult to injury: cochlear nerve degeneration after "temporary" noise-induced hearing loss, *Journal of Neuroscience* **29**: 14077-14085.

sensitivity to sounds within their best hearing range than was previously thought.[57] NMFS must also consider that even behavioral disturbance can amount to a Level A take if it interferes with essential life functions. For example, TTS can impair reproductive success and fitness that would constitute harm or Level A harassment. Beaked whales are sensitive to noise, and it is not necessarily the auditory damage that causes the injury. Sounds cause beaked whales to change their behavior, including panic response and rapid surfacing, which results in an injury similar to decompression sickness ("the bends").[58]

Although the proposed IHA NMFS cites many studies that show low-frequency sounds in general and seismic surveys in particular can have significant behavioral impacts to marine mammals well below 160 dB,[59] NMFS nonetheless continues to rely upon a Level B harassment threshold of 160 dB. Additionally, in light of the best available science, NMFS cannot rationally defend its conclusion that the proposed survey will not lead to any Level A impacts and will have no more than negligible impacts on these species or stocks. As such, NMFS should modify its threshold estimates; this would in turn lead to larger exclusion zones around the survey and may significantly increase the estimated number of marine mammal takes incidental to the Proposed Project.

III. NMFS must take best available science and the precautionary principle into account.

Several experts in marine mammal bioacoustics have underscored our extremely limited understanding of the potential auditory and behavioral impacts to marine mammals from the use of seismic airguns and other sound-producing technologies. Darlene R. Ketten, a marine biologist and neuro-anatomist at the Woods Hole Oceanographic Institution, has written, "[a]t this time we have insufficient data to accurately predetermine the underwater acoustic impact for anthropogenic sources."[60] Other published scientists have noted, "[g]iven the current state of knowledge…the risk of seismic sources causing hearing damage to marine mammals cannot be dismissed as negligible."[61] Scientists have also commented on the variability in how a seismic source could affect a marine mammal based on the orientation of the source relative to

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[57] See discussion in Wood, J., Southall, B.L. and Tollit, D.J. 2012. PG&E offshore 3-D Seismic Survey Project EIR – Marine Mammal Technical Draft Report. SMRU Ltd.; Marine Mammal Commission, Marine Mammals and Noise: A Sound Approach to Research Management, Report to Congress, at 46 (March 2007).

[58] 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., Fernandez, 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.C., Palka, D., Ponganis, P., Rommel, S., Rowles, T., Taylor, B., Tyack, P., Wartzok, D., Gisiner, R., Mead, J., and Benner, L. 2006. Understanding the impacts of anthropogenic sound on beaked whales. *Journal of Cetacean Resource Management* **7**: 177-187.

[59] 79 Fed. Reg. at 14787.

[60] Ketten, D.R. Marine Mammal Auditory Systems: A Summary of Audiometric and Anatomical Data and Implications for Underwater Acoustic Impacts. Polarforschung, 72. Jahrgung, Nr. 2/3, pp. 79-92.

[61] Gordon, J.C.D., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R., and Thompson, D. 2004. A Review of the Effects of Seismic Survey on Marine Mammals. *Marine Technology Society Journal* **37**: 14-32.

the animal, which is not considered in the Proposed Project. A 2004 review paper on the effects of seismic surveys on marine mammals stated, "[m]arine mammals will be distributed in a variety of positions relative to a seismic array and the signal they receive may have a complicated and variable nature."[62] A study of the environmental implications of marine seismic surveys conducted in Australia published in 2000 concluded, "[i]t was believed slight differences in the orientations of receivers to each array, alignments and depths of array components and of functioning air guns within each array contributed to the measured differences. Again this exemplified the difficulty of predicting the received air gun level for a specific air gun array."[63]

Because of this high degree of uncertainty in our understanding of impacts to marine mammals from airgun sources, compounded by the variability in the level of impact based on the position of the source relative to a marine mammal, NMFS should be precautionary in its assessment of incidental takes. Precaution and use of the best available science are fundamental tenets of the Obama Administration's National Ocean Policy. One of the Principles in the 2010 Final Recommendations of the Interagency Ocean Policy Task Force report urges the use of best available science and the precautionary approach: "Decisions affecting the ocean…should be informed by and consistent with the best available science. Decision-making will also be guided by a precautionary approach as reflected in the Rio Declaration of 1992."[64] Responsible application of the precautionary principle to the NMFS IHA would reasonably have led to the denial of marine mammal takes incidental to the Proposed Project.

IV. NMFS's take estimates for marine mammals for which no population or stock data are available are speculative and may be significant underestimations.

The NMFS IHA acknowledges that "No known current regional population or stock abundance estimates for the northwest Atlantic Ocean are available for…eight…species under NMFS's jurisdiction that could potentially be affected by Level B harassment over the course of the IHA,"[65] and yet still determines that takes of these species will be negligible. These species include the Bryde's whale, Fraser's dolphin, spinner dolphin, Clymene dolphin, melon-headed whale, pygmy killer whale, false killer whale, and killer whale. NMFS has assigned take

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[62] Id.

[63] McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.P., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K. 2000. Marine seismic surveys – A study of environmental implications. *Appea Journal* 692-708.

[64] The White House Council on Environmental Quality. Final Recommendations Of The Interagency Ocean Policy Principle 15 of the Rio Declaration 1992 reads, "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."

[65] 79 Fed. Reg. at 35671.

estimates for these species based on old data or on population or stock abundance from other oceanic regions, without further indication of how these data were applied to the Proposed Project area. In total, takes of over 1,000 individuals from these eight species are authorized. In the absence of any data from the region in which the survey is to take place, it is not clear how these takes were assigned and what, if any, measures would be taken during the survey if it is determined that take numbers for these animals were significantly miscalculated.

V. Conclusion

For the reasons detailed above, Clean Ocean Action urges denial of the NMFS IHA. The Proposed Project threatens serious harm to numerous species of marine mammals and is therefore contrary to the goals, mandates, and prohibitions of the MMPA. Furthermore, a full EIS should be completed prior to the consideration of the IHA, to remedy issues of incomplete information, inadequate assessment of impacts, and insufficient evaluation of alternatives and mitigation measures. Importantly, the Proposed Project should not be conducted during the spring and summer months, which are the peak of marine mammal (and other marine species) feeding, breeding, and/or calving activity off the mid-Atlantic. Moreover, NMFS should ensure that best available science and regulatory review are incorporated into the EIS and IHA, require stronger mitigation measures, and consider different times of year for the Proposed Project.

Sincerely,

Cindy Zipf
Executive Director
Clean Ocean Action

Cassandra Ornell
Staff Scientist
Clean Ocean Action

By Electronic Mail

July 23, 2014

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Re: **Comments on the proposed Incidental Harassment Authorization (IHA) for USGS Atlantic Seismic Survey**

Dear Ms. Harrison:

On behalf of our organizations and our more than a million members, we write to submit comments on the proposed Incidental Harassment Authorization (IHA) for the take of marine mammals related to a proposed U.S. Geological Survey, Lamont-Doherty Earth Observatory of Columbia University (L-DEO), and National Science Foundation (NSF) (collectively hereafter USGS) geophysical seismic survey in the Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015. 79 Fed. Reg. 35642 (June 23, 2014).

Our organizations are profoundly concerned about NMFS's intention to permit high-intensity seismic surveys in this large Atlantic region—spanning from Massachusetts to South Carolina and covering more than 6,300 km of track lines—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.

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 USGS's proposed action would degrade the acoustic environment along a significant swath of the Eastern Seaboard. To conduct the survey, USGS plans to tow an array of 36 high-volume airguns behind its ship, firing intense impulses of compressed air—almost as loud as explosives—roughly every 20 seconds, 24 hours per day, for weeks on end. In addition, USGS 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 and sensitive species across most of the U.S. east coast, including the highly endangered right whale.

The MMPA dictates that, before permitting this action, 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. Shockingly, the survey does not identify or attempt to avoid any biologically important habitat within the activity's vast survey area. Instead, NMFS relies on mitigation that the Courts have rightly described in other contexts as "woefully inadequate and ineffectual."

As a result of the near-total failure to consider site-specific data, the survey lines directly overrun several areas of established heightened biological significance. For example, the survey runs alongside Georges Bank, which is among the most diverse, productive, and trophically complex marine temperate areas in the world. In addition, the survey plans to blast through the southern portion of established mating and foraging grounds of the last North Atlantic right whales, among the most imperiled large whales on the planet; runs across a number of bio-rich canyons and seamounts off the mid-Atlantic states; crisscrosses an area of probable importance to beaked whales, one of the species identified as most sensitive to sound; and will be sounding its airguns for days through loggerhead sea turtle critical habitat. 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 USGS withdraw its application, and that—at minimum—USGS revise its proposed mitigation measures in the ways discussed below, including by redrawing its survey lines to reflect well-established areas of heightened biological significance, and by providing meaningful site-specific analysis.

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 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

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[1] National Research Council, *Ocean Noise and Marine Mammals* (2003).

[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).

given the acoustic and behavioral characteristics of its calls.[7] As discussed further below, the exposure levels implicated in all of these 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

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[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).

[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., and Yan, H.Y., Effects of boat engine noise on

predominantly low-frequency 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 is twofold: (1) to identify the outer limits of the U.S. continental shelf, also referred to as the ECS as defined by Article 76 of the Convention of the Law of the Sea; and (2) to study the sudden mass transport of sediments down the continental shelf as submarine landslides that may pose tsunamigenic (i.e. tsunami-related) hazards. The first concerns us because of its implications for expanded oil and gas exploration in the region, and the second offers little to substantiate its immediate need.

First, the study is designed to establish the outer limits of the U.S. continental shelf, also referred to as the Extended Continental Shelf (ECS), as defined by Article 76 of the Convention of the Law of the Sea. The ECS is key in determining any entitlement of the U.S. to sovereign rights in the area beyond 200 nautical miles. One of the primary uses of such a determination is to establish mineral rights. This study coincides precisely with the Obama administration's recent release of its Environmental Impact Statement on oil and gas exploration off the East Coast, which gave the green-light to begin related seismic exploration. Within months, the Bureau of Ocean Energy Management will start issuing permits for seismic exploration, letting industry troll from New Jersey to Florida with arrays of high-powered airguns. That exploration overlaps with the southern half of this proposed study area. Any consideration of this study – and in particular the cumulative impact assessment – must include consideration of the fact that this study's underlying purpose may be to increase the area in the Mid-Atlantic that is open to oil and gas exploration and drilling and, therefore, must include an analysis of longer-term related

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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).

effects on marine species and habitat of the various sources of increased disruption and harm caused by an influx of oil and gas exploration and drilling in the region.

Second, the study is designed to capture sediment thickness and geologic structure purportedly in order to study the possible risks and triggers of submarine landslides. However, in the cursory 1-page 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, nor any prediction of the actual risk to the Eastern Seaboard of a tsunami-related submarine landslide. 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

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.[18] Incredibly, the proposed IHA does not consider any areas for closure, trackline avoidance, or seasonal planning for any species.[19] More specifically:

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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] Nor does the proposed IHA consider state-specific and regional efforts to identify such areas and species of heightened concern. For example, the study makes no mention of the recent work done in New York State to identify what they refer to as the Species of Greatest Conservation need (SGCN). This effort was conducted by the

1. Time-area restrictions for marine mammals

The study area includes important marine mammal habitat that was not considered for time-area restrictions.[20]

(a.) Georges Bank

Georges Bank is a region rich with marine life, ranging from plankton to marine mammals and is well-recognized as among the most diverse, productive, and trophically complex marine temperate areas in the world.[21] As a result of this abundant food, the edge of Georges Bank is a foraging area for many cetaceans including right whales,[22] humpback whales,[23] sei whales,[24] beaked whales, fin whales,[25]sperm whales,[26] pilot whales, spotted dolphins, striped dolphins, offshore bottlenose dolphins, Risso's dolphins, and common dolphins.[27] There are high densities of foraging cetaceans during all parts of the year, but the summer months (June through October) have the highest densities.[28] Indeed, due to the high densities and diversity of marine mammals, Georges Bank is a popular whale watching location during the summer and early fall.

In addition to cetaceans, Georges Bank contains a high concentration of Illex and Loligo squid, which support important commercial fisheries in this area and are an important food source for mammals and for commercially important species such as tuna and swordfish. Illex are present in this area in largest numbers in the summer months, May through September.

New York Department of Environmental Conservation, Bureau of Marine Resources staff in consultation with regional experts, and it culminated in the compilation and mapping of a list of, e.g., marine deep subtidal SGCN. These species and this effort should have been considered in planning the regional study.

[20] We also would note that while we appreciate the inclusion in the Draft Environmental Assessment of the species-specific distribution and habitat use, these maps do not account for or correct for survey effort over the region. Often, survey effort tends to be concentrated along the shore, and so, the animal occurrence maps run the real risk of over-emphasizing the importance of these waters relative to the deeper waters that make up most of the study area.

[21] Link, J., Overholtz, W., O'Reilly, J., Green, J., Dow, D., Palka, D., et al. (2008). The Northeast U.S. continental shelf Energy Modeling and Analysis exercise (EMAX): Ecological network model development and basic ecosystem metrics. Journal of Marine Systems, 74(1-2), 453-474.

[22] http://www.dfo-mpo.gc.ca/Library/344232.pdf (Table 2-3 (p. 156)). P. 160 says fin whales are there year round. P. 161 says sei whales are found there spring and summer. P. 164 says humpbacks can be seen there in summer. P. 166 discusses sperm whales being there

[23] *See* http://www.nature.com/news/2003/030804/full/news030804-1.html.

[24] *Id.* at p. 161.

[25] *Id.* at p. 160.

[26] *Id.* at pp. 156, 166.

[27] Hamazaki, T. (2002). Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic ocean(from Cape Hatteras, North Carolina, U. S. A. to Nova Scotia, Canada). Marine Mammal Science, 18(4), 920-939; Palka, D. (2006). Summer abundance estimates of cetaceans in US North Atlantic navy operating areas. US Dep. Commer., Northeast Fish. Sci. Cent. Ref. Doc, 06-03; Selzer, L., & Payne, P. (1988). The distribution of white-sided dolphins (Lagenorhynchus acutus) and common dolphins (Delphinus delphis) vs. environmental features of the continental shelf of the northeastern United States. Mar. Mammal Sci, 4, 141-153.

[28] Winn, H. (1982). A characterization of marine mammals and turtles in the Mid-and North Atlantic areas of the US outer continental shelf. Final report. Sponsored by the Bureau of Land Management under contract AA551-CT8-48. 450pp.

On the southern edge of Georges Bank, three undersea canyons – Oceanographer, Gilbert, and Lydonia Canyon – cut into the continental shelf. The three canyons range in depth from approximately 500 feet to 7,700 feet and in length from 22 to 30 miles. However, the full extension of the canyons includes their channels and fan valleys and can be more than twice as long.[29] The canyons support a uniquely diverse set of species (326 species have been identified in the canyons),[30] and the depth, ruggedness, and isolation of the canyons has kept them relatively protected from human impacts while also rendering them extremely vulnerable to disturbance. Endangered sperm whales come to the canyons to forage on squid.[31] Other deep-diving marine mammals, like endangered and highly-depleted North Atlantic right whales, beaked whales, pilot whales and various species of dolphins, have also been observed along the shelf break in the Atlantic Ocean, and it is very likely that they use canyon and seamount productive zones as foraging or migration stops.[32] For example, marks on the seafloor at sites off of Gilbert and Lydonia canyons were inferred to be beaked whale foraging tracks.[33] These distinctive and pristine marine gems require special attention and protection.

Because of the incredibly rich diversity of species that congregate around Georges Bank throughout the year and, most heavily, during the summer months, the survey should be prohibited from entering Georges Bank or the slope waters off Georges Bank, and the survey track lines should be designed to ensure a buffer zone minimally sufficient to minimize potential behavioral impacts on naïve deep-diving whales and disruption of communication with baleen whales.

To the extent that survey lines cut across the three identified canyons – Oceanographer, Gilbert, and Lydonia – the agency should redraw them to avoid overrunning these important foraging waters and to ensure a sufficient buffer between the track line and the canyon.

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[29] Pratt RM. 1967. The seaward extension of submarine canyons off the northeast coast of the United States. Deep Sea Research 14:409-420.

[30] Hecker B, Blechschmidt G, Gibson P. 1980. Epifaunal Zonation and Community Structure in Three Mid- and North Atlantic Canyons. In: Final Report: Canyon Assessment Study in the Mid- and North Atlantic Areas of the US Outer Continental Shelf. Prepared for the U.S. Department of the Interior; Kelly NE, Shea EK, Metaxas A, Haedrich RL, Auster PJ. 2010. Biodiversity of the Deep-Sea Continental Margin Bordering the Gulf of Maine (NW Atlantic): Relationships among Sub-Regions and to Shelf Systems. PLoS ONE 5(11): e13832.
Moore JA, Hartel KE, Galbraith JK, Turnipseed M, Southworth M, Watkins E. 2003. Biodiversity of Bear Seamount, New England Seamount Chain: Results of exploratory trawling. Journal of Northwest Atlantic Fishery Science 31: 363-372.

[31] Hendrickson LC. 2004. Population biology of the northern shortfin squid (Illex illecebrosus) in the Northwest Atlantic Ocean and initial documentation of a spawning area. ICES Journal of Marine Science 61: 252-266; Sperm Whales (Physeter macrocephalus) Species Profile, NOAA Fisheries Office of Protected Resources. Available at http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm.

[32] Kaschner, K. 2007. Air-breathing visitors to seamounts: Marine Mammals. Chapter 12 Section A. Pp 230-238 in Pitcher T.J., Morato T., Hart P.J.B., Clark M.R., Haggan N. and Santos R.S. (eds) Seamounts: Ecology, Conservation and Management. Fish and Aquatic Resources Series, Blackwell, Oxford, UK; North Atlantic Right Whales (Eubalaena glacialis) Species Profile, NOAA Fisheries Office of Protected Resources. Available at http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northatlantic.htm.

[33] Auster PJ, Watling L. 2009. Beaked whale foraging areas inferred by gouges in the seafloor. Marine Mammal Science 26(1): 226-233.

(b.) Mid-Atlantic submarine canyons

As discussed above, submarine canyons support high concentrations and a great diversity of marine wildlife. Physically, they are complex, with outcrops, steep slopes, and different classes of substrates. They also provide a high flux of fine-particle nutrients and often encompass areas of upwelling, which are associated with high biological productivity.

In the mid-Atlantic there are several major submarine canyons, including Norfolk, Washington, Baltimore, Wilmington, Hudson, and Veatch. It is difficult to determine from USGS's application when one of its survey track lines crosses a canyon, but it does appear that the 2014-9 (Phase 1) survey line cuts through Hudson Canyon.

Because of its established importance of this habitat as a biologically rich foraging ground for numerous species of marine mammals and other marine life, the survey line should be redrawn to avoid Hudson Canyon. To the extent that other survey lines cut across these additional identified canyons, the agency should redraw them to avoid overrunning these important foraging waters and to ensure a sufficient buffer between the track line and the canyon.

(c.) Seamounts

Seamounts are rare oases of life in the cold darkness of the deep sea, fostering a remarkable diversity and concentration of marine life. Strong currents and circulation patterns around the seamounts create turbulent waters that enhance mixing of surface and deep water, transport nutrients, and concentrate food supply.[34] The increased production in and around these features echoes up throughout the water column and food chain to create biodiversity "hotspots" in the open ocean.[35]

Bear, Physalia, Mytilus, and Retriever seamounts are underwater mountains that rise as high as 12,000 feet above the ocean floor. At almost 20 miles across, Bear Seamount is the largest of the four, and it rises to the shallowest depth, approximately 3500 feet below the surface. These "biological islands" in the deep sea are ideal incubators for new life, due in large part to their unique topography and current patterns.[36] Currents around these features intensify and form eddies, trapping larvae and other small organisms in a closed loop over each seamount.[37] The substrate on the seamounts varies widely, and – due to the variety of bottom types – many different species can be found living in close proximity to each other, leading scientists to refer

[34] Worm B, Lotze HK, Myers RA. 2003. Predator diversity hotspots in the blue ocean. PNAS 100(17): 9884-9888.
[35] Morato T, Hoyle SD, Allain V, Nicol SJ. 2010. Seamounts are hotspots of pelagic biodiversity in the open ocean. PNAS 107(21): 9707–9711.
[36] Moore JA, Hartel KE, Galbraith JK, Turnipseed M, Southworth M, Watkins E. 2003. Biodiversity of Bear Seamount, New England Seamount Chain: Results of exploratory trawling. Journal of Northwest Atlantic Fishery Science 31: 363-372.
[37] Mills S. 2003. Seamount Coral Communities. NOAA Ocean Explorer Mountains in the Sea. Available at http://oceanexplorer.noaa.gov/explorations/03mountains/background/larvae/larvae.html.

to the seamounts as ocean oases.[38] Six hundred and thirty species have been identified on these seamounts.[39]

Recent studies suggest that this seamount chain – i.e. Bear, Physalia, Mytilus, and Retriever – may act as a dispersal corridor, helping species to cross the Atlantic.[40] This has implications for species resilience, providing a potential mechanism for long-distance dispersal and thus adaptability in the face of changing environmental conditions. It also highlights the interconnectedness of these underwater habitats, underscoring the importance of protecting all four seamounts.

The survey lines currently run across or approach the Bear, Physalia, Mytilus, and Retriever seamounts. **The survey lines should be modified and redesigned to avoid the four seamounts in order to ensure the least practicable impact on marine mammals and should include a buffer zone to minimize marine mammal take.**

(d.) North Atlantic right whale habitat

The cetacean of greatest concern in the region is the North Atlantic right whale, a species that has a minimum population of only about 450 whales and is considered one of the most imperiled large whales on the planet. **In order to protect this species and comply with its obligations under the Endangered Species Act, NMFS must exclude all of the North Atlantic right whale's year-round feeding and mating habitat areas from seismic and vessel activities.** These areas include both designated critical habitat as well as areas that have not yet been designated as critical habitat but are known to be important habitat. As NMFS has repeatedly stated, "the loss of even a single individual [North Atlantic right whale] may contribute to the extinction of the species" and "preventing the mortality of one adult female a year" may alter this outcome.[41]

We would also note, and USGS and NMFS need to account for the fact that right whales are found throughout the region and their movements are not so neatly confined to seasonal and life-cycle-related areas in the way the Draft Environmental Assessment suggests. This need is increased because real-time visual monitoring is very difficult for right whales, especially during

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[38] Moore JA. 2003. Biodiversity on the New England Seamounts. NOAA Ocean Explorer Mountains in the Sea Logs. Available at http://oceanexplorer.noaa.gov/explorations/03mountains/logs/summary/summary.html.
[39] Kelly NE, Shea EK, Metaxas A, Haedrich RL, Auster PJ. 2010. Biodiversity of the Deep-Sea Continental Margin Bordering the Gulf of Maine (NW Atlantic): Relationships among Sub-Regions and to Shelf Systems. PLoS ONE 5(11): e13832.
[40] Moore JA, Vecchione M, Collette BB, Gibbons R, Hartel KE. 2004. Selected fauna of Bear Seamount (New England Seamount chain), and the presence of "natural invader' species. Arch. Fish. Mar. Res. 51 (1-3): 241-250; Moore JA, Auster PJ, Calini D, Heinonen K, Barber K, Hecker B. 2008. False Boarfish Neocyttus helgae in the Western North Atlantic. Bulletin of the Peabody Museum of Natural History 49(1).
[41] *See* 69 Fed. Reg. 30,857, 30,858 (June 1, 2004); *see also* 73 Fed. Reg. 60,173, 60,173 (Oct. 10, 2008); 72 Fed. Reg. 34,632, 34,632 (June 25, 2007); 66 Fed. Reg. 50,390, 50,392 (Oct. 3, 2001).

high sea states, nighttime operations, and other low-visibility conditions, and is further complicated by the size of the impact zone that the monitoring effort would have to cover.[42]

(e.) Other areas identifiable through habitat mapping

NMFS has not attempted any systematic analysis of marine mammal habitat for purposes of establishing time-area closures within the study area.

i. Predictive mapping — 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; and beaked whales and harbor porpoises, whose vulnerability to anthropogenic noise is well recognized.

ii. Persistent oceanographic features — Marine mammal densities are correlated over medium to large scales with persistent ocean features, such as currents, productivity, and surface temperature, as well as with concentrations in other marine species, such as other apex predators and fish.[43] The occurrence of these features is often predictable enough to define core areas of biological importance on a year-round or seasonal basis.[44] Analysis of these features should figure in predictive mapping, but can be used to supplement maps that do not take dynamic features into account.

[42] *E.g.*, Barlow, J., and Gisiner, R., Mitigation and monitoring of beaked whales during acoustic events, *Journal of Cetacean Research and Management* 7: 239-249 (2006); 72 Fed. Reg. 46846, 46875 (Aug. 21, 2007) (SURTASS LFA rulemaking); Dolman, S., Aguilar de 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) (report from European Cetacean Society); 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).

[43] Hyrenbach, K.D., Forney, K.A., and Dayton, P.K. (2000), Marine protected areas and ocean basin management, *Aquatic Conservation: Marine and Freshwater Ecosystems* 10:437-458.

[44] *Id.* ("Design Recommendations for Pelagic MPAs" include the use of persistent oceanographic features like sea temperature to define core areas for protection).

2. Time-area restrictions for sea turtles and fish

The proposed study area overlaps with populations of sea turtles, including green, leatherback, loggerhead, hawksbill, and Kemp's Ridley. The recovery plan for the Northwest Atlantic population of loggerhead sea turtles notes that seismic surveying, among other activities, threaten these populations.[45] And recent analysis of sea turtle hearing confirms that loggerheads and other sea turtles have their greatest acoustic sensitivity below 400 Hz, where much of the energy produced by airguns is concentrated.[46] Given these findings, as well as the global significance of the region for loggerheads, all important habitats for endangered and threatened sea turtles in the area of interest should be avoided. In particular, important foraging and migrating habitat should receive consideration for time-area closure and all critical habitat should be avoided.

For example, the survey area currently cuts through large swaths of recently designated loggerhead *Sargassum* critical habitat.[47] *Sargassum* is a genus of seaweed that lives on the surface water of the open ocean, forming large floating mats. These mats provide essential forage, cover, and transport habitat for post-hatchlings and early juvenile loggerhead sea turtles.[48] Satellite imagery data – referenced in NMFS' own loggerhead critical habitat designation – found *Sargassum* in a widespread area of the Atlantic Ocean from Cape Hatteras and waters there north, and found that the *Sargassum*'s presence was particularly concentrated in the summer months.[49] As NMFS explained in support of its critical habitat designation, the science shows that *Sargassum* production varies by season, and in the Atlantic, has the greatest biomass occurring off the coast after July.[50] The physical forces that aggregate *Sargassum* also aggregate pollutants and debris, making this habitat especially vulnerable.[51]

Important turtle foraging and migrating habitat should receive consideration for time-area closure, and all loggerhead sea turtle critical habitat should be avoided during the summer months when *Sargassum* is present.

Similarly, the proposed IHA should consider excluding important fish habitat areas, including waters above the soft bottom Northeast U.S. Continental Shelf Large Marine Ecosystem (LME), which is considered essential fish habitat (EFH).

B. Failure to Adequately Consider Reasonable Mitigation and Monitoring Measures

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[45] *Id.*

[46] Piniak, W.E.D., Mann, D.A., Eckert, S.A., and Harms, C.A., Amphibious hearing in sea turtles, *in* Popper, A.N., and Hawkins, A., eds., *The Effects of Noise on Aquatic Life* at 83-88 (2012).

[47] *See* http://www.nmfs.noaa.gov/pr/species/turtles/images/loggerhead_critical_habitat_map.jpg.

[48] 79 FR 39883.

[49] 79 FR 39882.

[50] 79 FR 39882.

[51] *Id.*

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 the density of track lines consistent with the purposes of the survey.[52] 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, the California Coastal Commission has required the U.S. Geological Survey to reduce the size of its array for seismic hazards work, and to use alternative seismic technologies to reduce acoustic intensities during earthquake hazard surveys to their lowest practicable level.[53]

2. **Multi-beam echosounder**

NMFS should also require use of an alternative multi-beam echosounder to the one presently proposed. 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; a similar ;[54] 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.[55] 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

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[52] 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).

[53] *See, e.g.*, California Coastal Commission, Staff Recommendation on Consistency Determination No. CD-16-00 (2000) (review of USGS survey off southern California).

[54] Southall, B.L., Rowles, T., Gulland, F., Baird, R. W., and Jepson, P.D. 2013. Final report of the Independent Scientific ReviewPanel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar.

[55] 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).

odontocetes, over a wide spatial scale—and to a far greater extent than has previously been supposed for this category of sound source.[56] 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 USGS 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). Sound source validation has been required of Arctic operators for several years, as part of their IHA compliance requirements, and has proven useful for establishing more accurate, *in situ* measurements of safety zones and for acquiring information on noise propagation.[57]

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.[58] 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.[59] And a number of recent studies suggest that the relationship between temporary and permanent threshold shift may not be as predictable as previously believed.[60]

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

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[56] The point is echoed by Southall et al., Final Report of the Independent Scientific Review Panel.

[57] *See, e.g.*, Burns et al., Expert Panel Review (2010), *supra*; Brower et al., Expert Panel Review (2011), *supra*.

[58] 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).

[59] 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).

[60] 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).

closure areas.[61] 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

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.[62] 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 (it notes that there will be only one observer during meal times and bathroom breaks) – 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.[63] NMFS should require field experience in marine mammal observation of any observer.

Furthermore, the study only requires passive acoustic monitoring ("PAM") as practicable with no further guidance on when monitoring is or isn't practicable. There is no reason why PAM should not be mandated. Furthermore, with only one expert bioacoustician on board, the proposed IHA suggests that he or she would "ideally" monitor the PAM system 24 hours per day. This is wholly unrealistic, and it fails to account for the study design which runs non-stop for weeks on end. No consideration is made of the heightened need for PAM during low visibility or night-time hours.

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[61] *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).

[62] *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).

[63] 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*.

Indeed, 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 governments should accelerate development and use of these technologies through both research and development funding and regulatory engagement.[64]

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.[65] 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.[66]
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.[67] 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;[68] 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

[64] 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.

[65] *Id.*

[66] 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.

[67] 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).

[68] Settlement Agreement, NRDC v. Jewell, Case No. 2: 10-cv-01882 (E.D. La.) (settlement filed June 18, 2013).

method—one that uses software to stagger bursts of airgun fire, in order to reduce the effective source level of the array.[69]

The proposed IHA, however, fails to include any requirement to use or test the use of new technologies in the USGS Atlantic survey.

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."[70] *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.[71] Similarly, a low-frequency, high-amplitude fish mapping device was found to

[69] 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).
[70] Clark, C., Mann, D., Miller, P., Nowacek, D., and Southall, B., Comments on Arctic Ocean Draft Environmental Impact Statement at 2 (Feb. 28, 2012).
[71] 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).

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 received levels than considered here.[72] 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.[73] 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)).[74] 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.[75]

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;[76] 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 (D.Hawaii 2008), in which a Hawaiian

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[72] 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).

[73] 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).

[74] *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).

[75] 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).

[76] High Energy Seismic Survey Team, High energy seismic survey review process and interim operational guidelines for marine surveys offshore Southern California (1999).

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.[77]

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.[78] 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.[79] 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;[80] 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.[81]

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

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[77] *See, e.g.*, 74 Fed. Reg. 4844, 4844-4885 (Jan. 27, 2009).

[78] *See* Expert Panel Review 2011.

[79] *Id.*; *see also* Expert Panel Review 2010.

[80] 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).

[81] 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).

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.[82] 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).[83]

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 use the most biologically conservative method of calculating RMS, following Madsen (2005). (See section IV.C. below for additional detail.)

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[82] By "thresholds," we mean either bright-line thresholds or linear risk functions.

[83] 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).

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.[84] Furthermore, NMFS must provide for the monitoring and reporting of such takings and must prescribe methods and means of effecting the "least practicable adverse impact" on the species or stock and their habitat.[85] 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.

In particular, adverse impacts on North Atlantic right whales are never negligible. USGS has requested authorization to take by harassment six North Atlantic right whales. These whales are critically endangered, with only approximately 450 individuals in existence.[86] NMFS has determined that even one mortality or serious injury, other than natural causes, of a North Atlantic right whale could have harmful population level impacts and impede recovery.[87] At present annual mortality and serious injury of right whales already exceeds this rate from entanglement in fishing gear and ship strikes, as right whales sustain an average of 4 serious injuries and mortalities each year.[88] Interference with feeding or mating that could occur from displacement or disturbance from the proposed survey could be harmful for the right whales.

NMFS has also blatantly disregarded the MMPA's prohibition on allowing the take of more than small numbers of marine mammals.[89] For example, the proposed take for pantropical spotted dolphins is 1,448.[90] This amounts to 43.44% of the stock. Although there is no numerical cut-off for "small numbers,"[91] 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."[92]

NMFS' explanation for how its take authorization is limited to small numbers is irrational. The agency cuts the anticipated take numbers by 80-90% -- by the portion of the project that occurs outside the U.S. EEZ. However, the MMPA clearly prohibits agencies from taking marine mammals on the high seas.[93] Since the take prohibition applies outside the EEZ as well as in U.S. waters, NMFS must make a negligible impact and small numbers determination to authorize take for the populations in both the U.S. EEZ and on the high seas outside the U.S. EEZ. Authorizing

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[84] *See* 16 U.S.C. § 1371(a)(5)(D)(i).
[85] 16 U.S.C. § 1371(a)(5)(A) & (D).
[86] National Marine Fisheries Service, Draft Stock Assessment Reports (North Atlantic right whale) (2013).
[87] 73 Fed. Reg. at 60,176.
[88] *Id.*
[89] 16 U.S.C. § 1371(a)(5)(D)(i).
[90] The potential biological removal for pantropical spotted dolphins is 17. National Marine Fisheries Service, Draft Stock Assessment Reports (2013).
[91] *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.").
[92] *Natural Res. Def. Council v. Evans*, 279 F. Supp. 2d at 1129, 1152 (N.D. Cal. 2003).
[93] 16 U.S.C. § 1372(a)(1) ("it is unlawful for any person . . . .to take any marine mammal on the high seas"); *Ctr. for Biological Diversity v. Nat'l Science Found.*, 2002 U.S. Dist. LEXIS 22315 (N.D. Cal. 2002).

take of marine mammals outside the EEZ without complying with all MMPA take authorization requirements violates the MMPA.[94] Accordingly, NMFS must demonstrate compliance with these standards and may not issue the authorization without fully analyzing and authorizing all take contemplated under this action. Moreover, pantropical spotted dolphins may be quite vulnerable to seismic activities as documented by a 2004 stranding incident for which sonar activities could have been the cause.[95]

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. Some biologists have analogized the increasing levels of noise from human activities to a rising tide of "smog" that is already shrinking the sensory range of marine animals by orders of magnitude from pre-industrial levels.[96] Masking of natural sounds begins when received levels rise above ambient noise at relevant frequencies.[97] 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.[98] Additionally, researchers at

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[94] 16 U.S.C. § 1372(a)(1).

[95] NMFS, Stock Assessment Report for Pantropical Spotted Dolphin (*Stenella atenuata*): Western North Atlantic Stock (Oct. 2007).

[96] *See also* Bode, M., Clark, C.W., Cooke, J., Crowder, L.B., Deak, T., Green, J.E., Greig, L., Hildebrand, J., Kappel, C., Kroeker, K.J., Loseto, L.L., Mangel, M., Ramasco, J.J., Reeves, R.R., Suydam, R., Weilgart, L., Statement to President Barack Obama of Participants of the Workshop on Assessing the Cumulative Impacts of Underwater Noise with Other Anthropogenic Stressors on Marine Mammals (2009); Clark, C., and Southall, B., Turn down the volume in the ocean, *CNN.com*, Jan. 20, 2012, *available at* www.cnn.com/2012/01/19/opinion/clark-southall-marine/index.html; McDonald, M.A., Hildebrand, J.A., and Wiggins, S.M., Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California, *Journal of the Acoustical Society of America* 120: 711-718 (2006).

[97] 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).

[98] 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:

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.[99] 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 effects the accuracy of the agency's take and negligible impact findings.

4. Failure to set proper thresholds for hearing loss

As you know, NMFS is presently revising its criteria for temporary and permanent auditory impacts and, by extension, direct tissue injury.[100] 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, inter alia, 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.[101] None of these considerations, and few of the relevant studies appearing since 2007, appear to be discussed in the IHA.

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 12kHz multi-beam echosounder. This is the same frequency echosounder as 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

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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).

[99] Fleishman, E., and Streever, B., Assessment of cumulative effects of anthropogenic underwater sound: project summary and status, at 2 (2012).

[100] 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).

[101] 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).

essentially discount and ignore such a significant stranding is in stark conflict with NMFS' obligation under the MMPA to ensure the least practicable impact.

6. Failure to Adequately Assess Impacts on the North Atlantic Right Whale

The highly endangered North Atlantic right whale (*Eubalaena glacialis*) is considered to be one of the most endangered species of large whales in the world. Indeed, as NMFS has repeatedly stated, "the loss of even a single individual [North Atlantic right whale] may contribute to the extinction of the species" and "preventing the mortality of one adult female a year" may alter this outcome. 69 Fed. Reg. 30,857, 30,858 (June 1, 2004); *see also* 73 Fed. Reg. 60,173, 60,173 (Oct. 10, 2008); 72 Fed. Reg. 34,632, 34,632 (June 25, 2007); 66 Fed. Reg. 50,390, 50,392 (Oct. 3, 2001).

The affected study area abuts and enters the North Atlantic right whale year-round feeding and mating grounds. As discussed above, a single seismic source can significantly reduce right whale communication range on a population scale. Recent modeling from Cornell and NOAA shows the right whale to be particularly vulnerable to masking effects from airguns and other low-frequency noise given the acoustic and behavioral characteristics of its calls.[102] Seismic surveys in the North and Mid-Atlantic areas could add cumulatively to the high levels of noise that right whales already experience from commercial shipping in their foraging grounds and along their migratory route. The advent of airgun noise on top of these other acoustic intrusions could significantly affect right whale vital rates over large scales. For example, modeling of right whale foraging in the Great South Channel, an area subject to high levels of ship traffic, has found that decrements in the whales' sensory range had a larger impact on food intake than even patch-density distribution, and are likely to compromise fitness in this endangered species.[103]

In addition to the threat of noise impacts to right whales, any expansion of the EEZ and larger opening up of this region to oil and gas exploration and drilling poses the risk of increasing ship strikes, the leading cause of death for right whales. More than half (10 out of 14) of the post-mortem findings for right whales that died from significant trauma in the northwest Atlantic between 1970 and 2002 indicated that vessel collisions were a contributing cause of death (in the cases where presumed cause of death could be determined);[104] and these data are likely to

[102] Clark et al., Acoustic masking in marine ecosystems as a function of anthropogenic sound sources; Clark et al., Acoustic masking in marine ecosystems: intuitions, analysis, and implication.

[103] Mayo, C.S., Page, M., Osterberg, D., and Pershing, A., On the path to starvation: The effects of anthropogenic noise on right whale foraging success, North Atlantic Right Whale Consortium: Abstracts of the Annual Meeting (2008).

[104] Moore, M. J., Knowlton, A.R., Kraus, S.D., McLellan, W.A., and Bonde, R.K., Morphometry, gross morphology and available histopathology in North Atlantic right whale (*Eubalena glacialis*) mortalities (1970-2002), *Journal of Cetacean Research and Management* 6:199-214 (2004).

grossly underestimate the actual number of animals struck, as animals struck but not recovered, or not thoroughly examined, cannot be accounted for.[105]

Further, some types of anthropogenic noise have been shown to induce near-surfacing behavior in right whales, increasing the risk of ship-strike at relatively moderate levels of exposure, as noted in the next section below. It is possible that mid-frequency sub-bottom profilers and the multi-beam echosounder could produce the same effects – increasing the risk to right whales posed by other nearby ships – and both should be treated conservatively.

The study does not include any time-areas closures to reduce impacts on right whales, nor does it provide any quantitative or even detailed qualitative analysis of masking effects or other cumulative, sub-lethal impacts on right whales.

7. Failure to Adequately Assess Cumulative Impacts of the Activity

In its Draft Environmental Assessment – upon which the proposed IHA relies – USGS 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.

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[105] Reeves, R.R., Read, A., Lowry, L., Katona, S.K., and Boness, D.J., Report of the North Atlantic right whale program review, 13–17 March 2006, Woods Hole, Massachusetts (2007) (prepared for the Marine Mammal Commission).

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 USGS 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. USGS 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 NSF seismic survey off New Jersey and any other NSF 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 mid-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. USGS 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.[106] 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.[107] 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

[106] McCauley *et al.*, Marine seismic surveys: analysis and propagation of air-gun signals, and effects of air-gun exposure.

[107] 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).

other commercial species on a similar spatial scale.[108] Impacts on fisheries were found to last for some time beyond the survey period, not fully recovering within 5 days of post-survey monitoring.[109] 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.[110] 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")

USGS 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

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[108] 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).

[109] Engås *et al.*, Effects of seismic shooting.

[110] 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).

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 proposed project area is essential fish habitat for dozens of species. As noted in the EA, about 600 species of fish occur in the survey area It contains essential fish habitat for several highly migratory species, including albacore tuna, big eye tuna, bluefin tuna, skipjack tuna, yellowfin tuna, skipjack, swordfish, blue marlin, longbill spearfish, roundscale spearfish, white marlin, and several species of shark -- thresher, dusky, blue, white tip, bignosee, bigeye thresher, tiger, basking, longfin mako, and angel. There are also several adjacent coastal EFH areas, and the Georges Bank seamounts are unique habitat with rich fish biodiversity.

Some of the fish species with EFH in the project area are imperiled and vulnerable to negative impacts from the project. For example, juvenile and adult Atlantic bluefin tuna have essential fish habitat in the project area, and this imperiled fish uses deep waters from 50 meter isobaths to the extent of the U.S. EEZ along much of the Eastern Seaboard. Atlantic bluefin tuna remain overfished with overfishing occurring despite being at year 16 of a 20 year rebuilding plan. While fishing continues to be the primary threat to Atlantic bluefin tuna, seismic surveys have been linked to declines of tuna species. Muhling et al. (2011) estimated drastic reductions in probabilities of bluefin tuna larval occurrence in current spawning areas in the late spring: 39–61% by 2050 and 93–96% by the end of the 21st century.

White marlin forage from Cape Cod to Cape Hatteras. Juvenile EFH for white marlin extends almost the entire project area from the shelf break out to the U.S. EEZ and much of the area is also EFH for adults. The most recent stock assessment for white marlin suggests that the species has low productivity, has been declining since the beginning of the fishery, and is clearly overfished. White marlin has experienced significant declines in its Atlantic range coincident with its decline in abundance.

Atlantic cod also have EFH adjacent to and partly within the action area. Much of the coastal and offshore waters off New England out to the U.S. EEZ are EFH for Atlantic cod. According to NOAA’s 2013 stock assessment, the Gulf of Maine spawning stock biomass is more than 80% below target levels. The Georges Bank spawning stock biomass currently constitutes only seven percent of the agency’s goal. Moreover, “[r]ecruitment for both stocks has been well below average in nearly every year since the 1980s.”

Dusky and thresher sharks have habitat along the coast and off the continental shelf break. Dusky sharks are considered a species of concern by NMFS and have declined to approximately 15 to 20% of their 1970 abundance levels. Sharks are long-lived and have low fecundity thus making them vulnerable to depletion. Dusky sharks are classified as endangered under the IUCN Redlist.

Thresher sharks in the Atlantic are declining and have declined by about 70% and are considered vulnerable by the IUCN.

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. Ultimately, NMFS should have considered mitigation, alternatives, and recommended conservation actions that would protect essential fish habitat.

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. Listed species affected include blue, fin, humpback, North Atlantic right, sei, and sperm whales. 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 and obtain any take authorizations before authorizing the proposed seismic survey here. Moreover, NMFS should adopt robust mitigation measures such as those described in the alternatives section above to avoid adverse impacts to listed species.

NMFS' reliance on the 160-dB Level B and 180/190 Level A thresholds do not reflect the best available science. As described above, the best available science supports lower thresholds for many marine species. The ESA requires the use of the best available science.

Additionally, NMFS should also evaluate the impact on new sea turtle and potential right whale critical habitat. The survey area occurs partly in newly designated critical habitat for North Atlantic loggerhead sea turtles. This designation includes migratory habitat and overwintering habitat in the nearshore waters, as well as offshore sargassum habitat adjacent to or in the project area. NMFS must therefore evaluate the impact of the proposed activity on loggerhead sea turtles and their habitat. The final critical habitat rule notes that noise pollution is considered an activity that could alter habitat conditions in migratory pathways for the loggerhead sea turtles. The survey area is also located southeast of currently designated Northeast right whale critical habitat – an area which was designated because it represents the species' feeding habitat. Recent studies have further shown that mid-Atlantic coastal areas is a key migratory route between calving and feeding grounds. NMFS has indicated that it intends to amend the current critical habitat to potentially include the coastal area adjacent to the survey area, but has substantially delayed issuing its proposal. See 75 Fed. Reg. 61,690 (Oct. 6, 2010) (indicating the agency had already begun developing the amendment and would publish a proposed rule "in the second half of 2011"). Accordingly, NMFS should consider how the seismic survey may impact habitat that is under consideration for designation for North Atlantic right whales.

In sum, NMFS must fully comply with the ESA and develop a robust biological opinion based on the best available science. We further urge NMFS to establish more stringent mitigation measures to protect ESA-listed species than are currently proposed by the IHA.

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, 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 USGS withdraw its application. At minimum, USGS 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
Senior Policy Analyst
NRDC

Giulia Good Stefani
Project Attorney
NRDC

Miyoko Sakashita
Senior Attorney and Oceans Director
Center for Biological Diversity

/S/ Sharon Young

Sara Young
Marine Scientist
Oceana

Sharon Young
Marine Issues Field Director
The Humane Society of the U.S.

ATTACHMENT 2

NMFS Incidental Harassment Authorization (IHA)

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

AUG 21 2014

Dr. Jonathan R. Childs
Geophysicist
Pacific Coastal and Marine Geology Science Center
U.S. Geological Survey
Mail Stop 999
345 Middlefield Road
Menlo Park, California 94025

Dear Dr. Childs:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the U.S. Geological Survey, Lamont-Doherty Earth Observatory of Columbia University, and National Science Foundation, 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 geophysical survey in the northwest Atlantic Ocean off the Eastern Seaboard during August to September 2014 and April to August 2015.

You are required to comply with the conditions contained in the IHA which have also been included as Terms and Conditions for incidental take of endangered species in the Biological Opinion. In addition, you must submit a report to the National Marine Fisheries Service's (NMFS) Office of Protected Resources within 90 days of the completion of the cruise. The IHA 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 IHA or its requirements, please contact Howard Goldstein, Jeannine Cody, or Jolie Harrison, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Perry Gayaldo

for 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

The National Marine Fisheries Service (NMFS) hereby authorizes the U.S. Geological Survey, Coastal and Marine Geology Program, 12201 Sunrise Valley Drive, Reston, Virginia 20192, Lamont-Doherty Earth Observatory of Columbia University (L-DEO), P.O. Box 1000, 61 Route 9W, Palisades, New York 10964-8000, and National Science Foundation, Division of Ocean Sciences, 4201 Wilson Boulevard, Suite 725, Arlington, Virginia 22230 (herein referred to collectively as USGS) under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a high-energy marine geophysical (seismic) survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) in the northwest Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015.

1. *Effective Dates*

This Authorization is valid from August 21, 2014 through August 20, 2015. The seismic survey is scheduled to occur in two phases; the first phase during August to September 2014 (for approximately 17 to 18 days [not including transit]), and the second phase between April to August 2015 (for approximately 17 to 18 days [not including transit], specific dates to be determined).

2. *Specified Geographic Region*

This Authorization is valid only for the *Langseth*'s specified activities associated with seismic survey operations as specified in the USGS's Incidental Harassment Authorization (IHA) application and the associated *Environmental Assessment for Seismic Reflection Scientific Surveys during 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards* that shall occur in the following specified geographic area (bounded by the following geographical coordinates):

40.5694° North, -66.5324° West;
38.5808° North, -61.7105° West;
29.2456° North, -72.6766° West;
33.1752° North, -75.8697° West;
39.1583° North, -72.8697° West

The activities for 2014 will generally occur within the outer portions of the study area. The activities for 2015 will in-fill more of the study area. Water depths range from approximately 1,450 to 5,400 meters (m) (4,757.2 to 17,716.5 feet [ft]); no survey lines will extend to water depths less than 1,000 m (3,280.8 ft). The tracklines planned for both 2014 and 2015 would be in International Waters (approximately 80% in 2014 and 90% in 2015) and in the U.S. Exclusive

Economic Zone, as specified in USGS's IHA application and the associated USGS Environmental Assessment.

3. *Species Authorized and Level of Takes*

(a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the northwest Atlantic Ocean off the Eastern Seaboard:

(i) Mysticetes – see Table 1 (attached) for authorized species and take numbers.

(ii) Odontocetes – see Table 1 (attached) for authorized species and take numbers.

(iii) If any marine mammal species are encountered during seismic activities that are not listed in Table 1 (attached) for authorized taking and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 decibels (dB) re 1 µPa (rms), then the USGS must alter speed or course, power-down, or shut-down the airguns to avoid take.

(a) (b) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3(a) above or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

4. The methods authorized for taking by Level B harassment are limited to the following acoustic sources without an amendment to this Authorization:

(a) A 36 airgun array with a total volume of 6,600 cubic inches in^3 (or smaller);

(b) A multi-beam echosounder; and

(c) A sub-bottom profiler.

5. *Prohibited Take*

The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, NMFS, at 301-427-8401 and/or by e-mail to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov.

6. *Mitigation and Monitoring Requirements*

The USGS is required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

Protected Species Observers and Visual Monitoring

(a) Utilize two, NMFS-qualified, vessel-based Protected Species Visual Observers (PSVOs) (except during meal times and restroom breaks, when at least one PSVO shall be on watch) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during ramp-ups of airguns day or night.

(i) The *Langseth*'s vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSVOs shall have access to reticle binoculars (7 x 50 Fujinon), big-eye binoculars (25 x 150), optical range finders, night vision devices, and thermal imaging cameras.

(iii) PSVO shifts shall last no longer than 4 hours at a time.

(iv) When feasible, PSVOs shall also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavioral reactions during, between, and after airgun operations.

(v) PSVOs shall conduct monitoring while the airgun array and streamer(s) are being deployed or recovered from the water.

(b) PSVO(s) shall 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; and

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

(iii) The data listed under Condition 6(b)(ii) shall 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.

Passive Acoustic Monitoring

(c) 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 NMFS-qualified Protected Species Observer (PSO) and/or expert bioacoustician (i.e., Protected Species Acoustic Observer [PSAO]) shall monitor the PAM at all times in shifts no longer than 6 hours. An expert 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.

(d) Do and record the following when an animal is detected by the PAM:

(i) Notify the on-duty PSVO(s) immediately of the presence 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. The acoustic detection can also be recorded for further analysis.

Buffer and Exclusion Zones

(e) Establish a 160 dB re 1 µPa (rms) buffer zone as well as 180 and 190 dB re 1 µPa (rms) exclusion zone for marine mammals before the 2-string airgun array (6,600 in^3) is in operation; and a 180 and 190 dB re 1 µPa (rms) exclusion zone before a single airgun (40 in^3) is in operation, respectively. See Table 2 (attached) for distances and exclusion zones.

Visual Monitoring at the Start of Airgun Operations

(f) Visually observe the entire extent of the exclusion zone (180 dB re 1 µPa [rms] for cetaceans; see Table 2 [attached] for distances) using NMFS-qualified PSVOs, for at least 30 minutes prior to starting the airgun array (day or night).

(i) If the PSVO observes a marine mammal within the exclusion zone, USGS must delay the seismic survey until the marine mammal(s) has left the area. If the PSVO sees a marine mammal that surfaces, then dives below the surface, the

PSVO shall wait 30 minutes. If the PSVO sees no marine mammals during that time, he/she should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or within the exclusion zone, the airguns may not be resume airgun operations.

(iii) If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), USGS may start the second airgun, and subsequent airguns, without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the relevant exclusion zone (in accordance with Condition 6[h] below).

Ramp-up Procedures

(g) Ramp-up procedures at the start of seismic operations or after a shut-down - Implement 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 more than 10 minutes, which means start the smallest airgun first and add airguns 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 PSVOs shall monitor the 180 and 190 dB exclusion zone for cetaceans and pinnipeds, respectively, and if marine mammals are sighted within or about to enter the relevant exclusion zone, a power-down, or shut-down shall be implemented as though the full array were operational. Therefore, initiation of ramp-up procedures from a shut-down or at the beginning of seismic operations requires that the PSVOs be able to view the full exclusion zone as described in Condition 6(f) (above).

Power-down Procedures

(h) Power-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun, which reduces the exclusion zone to the degree that the animal(s) is no longer in or about to enter it for the full airgun array. 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.

(i) Following a power-down, if the marine mammal approaches the smaller designated exclusion zone, the airguns must then be completely shut-down. Airgun activity shall not resume until the PSVO has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 minutes for species with shorter dive durations (small odontocetes and pinnipeds) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm [*Physeter macrocephalus*], pygmy sperm [*Kogia breviceps*], dwarf sperm [*Kogia sima*], killer [*Orcinus orca*], and beaked whales).

(j) Following a power-down and subsequent animal departure, the airgun operations may resume at full power. Initiation requires that the PSVOs can effectively monitor the full exclusion zones described in Condition 6(f). If the PSVO(s) sees a marine mammal within or about to enter the relevant zones, then a course/speed alteration, power-down or shut-down will be implemented.

Shut-down Procedures

(k) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). A shut-down means all operating airguns are shut-down (i.e., turned off).

(l) Following a shut-down, if the PSVO has visually confirmed that the animal has departed the relevant exclusion zone (and is not likely to return) within a period less than or equal to 10 minutes after the shut-down, then the airgun operations may resume at full power. If the PSVO has not observed the marine mammal(s) exiting the exclusion zone, the airgun operations shall not resume for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales). Following a shut-down, the *Langseth* may resume airgun operations following ramp-up procedures described in Condition 6(g).

Speed or Course Alteration

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

Survey Operations at Night

(n) Marine seismic surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(o) 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 relevant exclusion zone cannot be effectively monitored by the PSVO(s) on duty.

Mitigation Airgun

(p) Use of small-volume airgun (i.e., mitigation airgun) during turns and maintenance shall be operated at approximately one shot per minute and would not be operated for longer than three hours in duration. During turns or brief transits between seismic tracklines, one airgun will continue operating.

Special Procedures for Situations or Species of Concern

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

(r) Concentrations of humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) will be avoided if possible (i.e., exposing concentrations of animals to 160 dB), and the array will be powered-down if necessary. 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.).

7. <u>Reporting Requirements</u>

The USGS is required to:

(a) Submit a draft comprehensive report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Langseth*'s cruise in the northwest Atlantic Ocean off the Eastern Seaboard after the end of phase 1 in 2014 and another draft comprehensive report after the end of phase 2 in 2015. 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 power-downs and shut-downs), 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 (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on reported and corrected empirical values for the 36 airgun array and modeling measurements for the single airgun) to the seismic activity at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds 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 Biological Opinion's Incidental Take Statement (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report shall 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, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report shall be considered 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 prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), USGS shall immediately cease the specified activities and 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 e-mail to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov and the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and 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:

(a) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

USGS shall not resume its activities until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with USGS to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. USGS may not resume their activities until notified by NMFS via letter, e-mail, or telephone.

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

In the event that USGS discovers an injured or dead marine mammal, and the lead 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 described in the next paragraph), USGS 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 Howard.Goldstein@noaa.gov, and the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866-755-6622) and/or by e-mail to the NMFS Greater Atlantic Regional Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) and/or by e-mail to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fougeres@noaa.gov). The report must include the same information identified in Condition 8(a) (above). Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with USGS to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

In the event that USGS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), USGS 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 e-mail to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov, and the NMFS Greater Atlantic Marine Mammal Stranding Network (866-755-6622) , and/or by e-mail to the Greater Atlantic Regional Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Regional Stranding Network 9877-433-8299), and/or by e-mail to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fougeres@noaa.gov), within 24 hours of the discovery. USGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

Endangered Species Act Biological Opinion and Incidental Take Statement

9. USGS is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS's ESA Biological Opinion issued to both USGS and NMFS's Office of Protected Resources, Permits and Conservation Division (attached).

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

AUG 21 2014

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

Date

Attachments

Attachment

Table 1. Authorized take numbers, by Level B harassment, for each marine mammal species during USGS's marine seismic survey in the northwest Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015.

Species	Authorized Take in the Northwest Atlantic Ocean Study Area (2014/2015=Total)
Mysticetes	
North Atlantic right whale (*Eubalaena glacialis*)	1or2/1or2=3
Humpback whale (*Megaptera novaeangliae*)	3/38=41
Minke whale (*Balaenoptera acutorostrata*)	2/2=4
Bryde's whale (*Balaenoptera edeni*)	3/3=6
Sei whale (*Balaenoptera borealis*)	3/3=6
Fin whale (*Balaenoptera physalus*)	3/3=6
Blue whale (*Balaenoptera musculus*)	1/1=2
Odontocetes	
Sperm whale (*Physeter macrocephalus*)	83/83=166
Pygmy sperm whale (*Kogia breviceps*)	33/33=66
Dwarf sperm whale (*Kogia sima*)	33/33=66
Northern bottlenose whale (*Hyperoodon ampullatus*)	2/2=4
Cuvier's beaked whale (*Ziphius cavirostris*) and Unidentified *Mesoplodon* beaked whale (*Mesoplodon* spp. includes True's [*M. mirus*], Gervais' [*M. europaeus*], Sowerby's [*M. bidens*], and Blainville's [*M. densirostris*] beaked whale)	84/84=168
Bottlenose dolphin (*Tursiops truncatus*)	244/255=499

Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	33/33=66
Fraser's dolphin (*Lagenodelphis hosei*)	100/100=200
Atlantic spotted dolphin (*Stenella frontalis*)	1,056/1,056-2,112
Pantropical spotted dolphin (*Stenella attenuata*)	724/724=1,448
Striped dolphin (*Stenella coeruleoalba*)	4,916/4,916=9,832
Spinner dolphin (*Stenella longirostris*)	65/65=130
Clymene dolphin (*Stenella clymene*)	52/341=393
Short-beaked common dolphin (*Delphinus delphis*)	203/203=406
Rough-toothed dolphin (*Steno bredanensis*)	16/16=32
Risso's dolphin (*Grampus griseus*)	342/342=684
Melon-headed whale (*Peponocephala electra*)	100/100=200
Pygmy killer whale (*Feresa attenuata*)	25/25=50
False killer whale (*Pseudorca crassidens*)	15/15=30
Killer whale (*Orcinus orca*)	6/6=12
Short-finned pilot whale (*Globicephala macrorhynchus*)	697/697=1,394
Long-finned pilot whale (*Globicephala melas*)	697/697=1,394
Harbor porpoise (*Phocoena phocoena*)	4/4=8
Pinnipeds	
Harbor seal (*Phoca vitulina concolor*)	0
Gray seal (*Halichoerus grypus*)	0
Harp seal (*Phoca groenlandica*)	0
Hooded seal	0

(Cystophora cristata)	

Table 2. Modeled distances to which sound levels greater than or equal to 160, 180 and 190 dB could be received during the marine seismic survey in the northwest Atlantic Ocean off the U.S. Eastern Seaboard during August to September 2014 and April to August 2015. The buffer and exclusion zone radii are used for triggering mitigation.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances (m)		
			Shut-down Exclusion Zone for Pinnipeds 190 dB	Shut-down Exclusion Zone for Cetaceans 180 dB	Level B Harassment Zone 160 dB
Single Bolt Airgun 40 in^3	9	Deep (>1,000)	100	100	388
36 Airguns 6,600 in^3	9	Deep (>1,000)	286	927	5,780

Attachment 3

NMFS Biological Opinion/Incidental Take Statement

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

Mr. Bauke (Bob) Houtman, Integrative Programs Section Head
OCE Environmental Operations
Division of Ocean Sciences
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Dear Mr. Houtman:

Enclosed is the National Marine Fisheries Service's (NMFS) biological opinion on the effects on threatened and endangered species of the United States Geological Survey's use of the National Science Foundation's vessel *Langseth* to conduct a seismic survey along the U.S. East Coast, pursuant to section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 United States Code 1536). This biological opinion also considers the effects of NMFS's proposed authorization for the United States Geological Survey and National Science Foundation to take, in the form of harassment, marine mammals and sea turtles incidental to the proposed seismic activities.

The biological opinion concludes that the proposed seismic survey is not likely to jeopardize the continued existence of threatened or endangered species under NMFS's jurisdiction or destroy or adversely modify critical habitat that has been designated for those species (do not expect critical habitat to be affected by the proposed actions). However, we expect some species of ESA-listed whales and sea turtles to be taken incidental to the proposed survey. Terms and conditions are included. The incidental take statement enclosed in the biological opinion allows for exemption to take under ESA section 9(a) and includes measures that must be undertaken in order for the exemption prescribed in section 7(o)(2) of the ESA to apply.

This concludes formal consultation on the United States Geological Survey's use of the National Science Foundation's vessel *Langseth* for marine seismic survey activities along the U.S. East Coast. Reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained and if: (1) the amount or extent of taking specified in the Incidental Take Statement is exceeded; (2) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) any of the identified actions are subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

I look forward to continued cooperation with the United States Geological Survey and National Science Foundation on future section 7 consultations. If you have questions, comments, or concerns, please contact Brian Bloodworth (Fisheries Biologist, Endangered Species Act Interagency Cooperation Division) at Brian.Bloodworth@noaa.gov or 301-427-8454.

Sincerely,

Perry Gayaldo

for Donna S. Wieting
Director
Office of Protected Resources

Enclosure

NOAA's National Marine Fisheries Service

Endangered Species Act Section 7 Consultation Biological Opinion

Agencies:	National Science Foundation-Division of Ocean Sciences, United States Geological Survey, and NOAA's National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division
Activities Considered:	Seismic survey by the United States Geological Survey and Lamont-Doherty Earth Observatory along the U.S. East Coast 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:	Perry Gayaldo
Date:	AUG 21 2014

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List of Acronyms

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

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

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

USGS-United States Geological Survey

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 United States Geological Survey (USGS), 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 the U.S. East Coast from August to September of 2014 and sometime between April and August 2015, in support of an NSF-funded collaborative research project led by the USGS. The NMFS's Permits and Conservation Division is also a Federal action agency as it is proposing to issue an incidental harassment authorization 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) of 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, an 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 November 4, 2013, the NMFS's ESA Interagency Cooperation Division received a request from the NMFS's Permits and Conservation Division for technical discussions on the proposed seismic survey. On Thursday, November 7, 2013, we met with the USGS, and its contractor responsible for USGS's environmental assessment, to discuss the proposed action. This initiated technical assistance on the action. Phone conversations among the entities continued on a regular basis here after.

On March 21, 2014, the NMFS's ESA Interagency Cooperation Division received a request for formal consultation from the USGS to incidentally harass marine mammal and sea turtle species during seismic surveys; information was not sufficient to initiate consultation with the USGS on this date. On the same date, 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 April 25, 2014, the NSF, USGS, and NMFS's ESA Interagency Cooperation Division discussed issues that were preventing initiation via teleconference.

On May 16, 2014, the USGS provided the NMFS's ESA Interagency Cooperation Division with an updated environmental assessment that, along with information that was previously provided, met ESA section 7 formal consultation initiation requirements. Remaining issues pertinent to assessing the effects of the action were resolved during other dates of the consultation.

On June 12, 2014, the NMFS's ESA Interagency Cooperation Division received a request for formal consultation from the NMFS's Permits and Conservation Division. Information was sufficient to initiate consultation with the Permits and Conservation Division on this date.

On June 23, 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 15, 2014, the NMFS's ESA Interagency Cooperation Division received the final environmental assessment from the USGS.

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 the U.S. East Coast during an approximate 21-day period in mid-August to September, 2014 and again during an unidentified three-week period from April to August 2015 in support of a USGS-funded and USGS-led research project. An array of 36 airguns will be deployed as an energy source. In addition, a multibeam echosounder and sub-bottom profiler (SBP) will continuously operate from the *Langseth*, except during transits to and from the survey site. An eight-kilometer-long hydrophone streamer will also be deployed as well as a towed magnetometer, 24 sonobuoys with suspended filament cable, and expendable bathythermographs (24 deployments). 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 1) establish the outer limits of the U.S. continental shelf, also referred to as the Extended Continental Shelf , as defined by Article 76 of the Convention of the Law of the Sea and 2) study the sudden mass transport of sediments down the continental shelf as submarine landslides that pose potential tsunamigenic hazards to the Atlantic and Caribbean coastal communities. The proposed survey is part of a larger, multi-agency effort chaired by the U.S. Department of State and co-vice-chaired by Department of Interior and NOAA to determine the U.S. entitlement to sovereign rights in the area beyond 200 nautical miles according to established methods of measuring sediment thickness according to guidelines established by the Commission on the Limits of the Continental Shelf.

2.1 Schedule

The NSF proposes to allow the use of the *Langseth* by L-DEO in support of the USGS-led extended continental shelf activities for roughly 36-42 days of seismic operations, divided between roughly equal operating periods in 2014 and 2015. Some minor deviation from the proposed dates is possible in 2014 and dates in 2015 have not yet been identified, although a definite period has been (April to August), depending on logistics and weather conditions. It is anticipated that portions of seismic lines may be reshot in the event of substandard data collection, but no additional line-kilometers of shooting would be added. This is because the reshooting effort would come at the expense of planned trackline being shot. During an approximate 21-day period in mid-August to September 2014 and again in April to August 2015, corresponding to an effective incidental harassment authorization, the *Langseth* would survey the action area. The *Langseth* would depart from Brooklyn, New York and return to Norfolk, Virginia. Therefore, NMFS's Permits and Conservation Division proposes to issue an authorization that is effective from August 15, 2014 to August 14, 2015. However, take would only be authorized during the period of August to September in 2014 and for a contiguous period of roughly 21 days between April and August 2015.

2.2 Source Vessel Specifications

The *Langseth* will tow the airgun array along predetermined lines (see 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.

2.3 Airgun Description

The airgun array will consist of 40 airguns (including four spare airguns), with a total operational volume of up to 6,600 in^3. However, only 36 of these airguns will be operational and total discharge volume will be limited to 6,600 in^3. The airgun configuration includes four identical linear arrays or "strings" (Figure 1). Each string will have ten airguns. Nine airguns in each of four strings would fire at any one time. The four airgun strings will be towed behind the vessel. The tow depth of the array will be 9 m. The airgun array will fire roughly every 22-23 seconds. During firing, a brief (approximately 0.1 s) pulse of sound will be emitted, followed by silence during the intervening listening. 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.

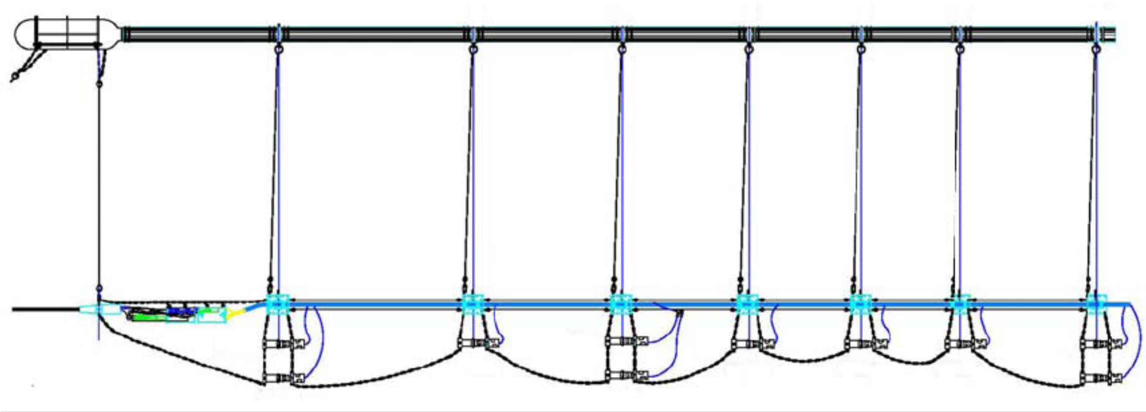


Figure 1. One linear airgun array or string with ten airguns.

36-airgun array specifications

• Energy source	36- 1,950 psi Bolt airguns of 40-360 in^3 each, in four strings of nine operating airguns per string
• Source output (downward)-36 airgun array	0-pk is 259 dB re 1 μPa·m (84 bar·m); pk-pk is 265 dB re 1 μPa·m (177 bar·m)
• Air discharge volume	~6,600 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 Multibeam Echosounder and Sub-bottom Profiler

Along with airgun operations, two 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. 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.

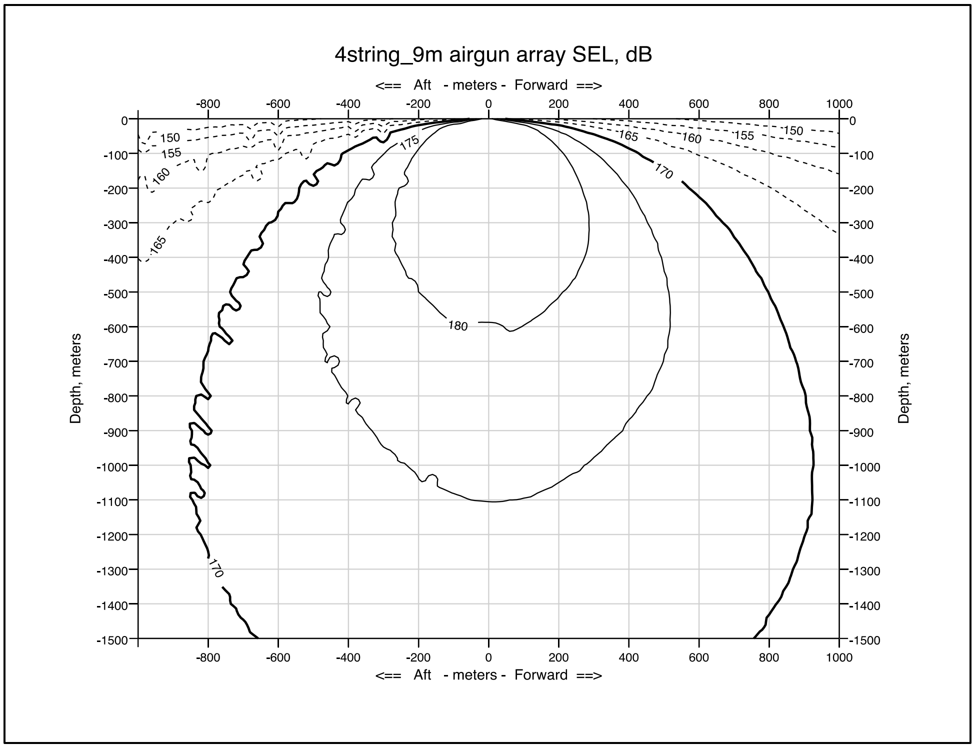
***Langseth* sub-bottom profiler specifications**

• 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

2.5 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.

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). Empirical data concerning 180 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). However, the tow depth was different in the Gulf of Mexico calibration study (6 m tow depth) than in the proposed survey (9 m tow depth). Maximum radii were established at the maximum diving depth for listed species (2,000 m). As several 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.



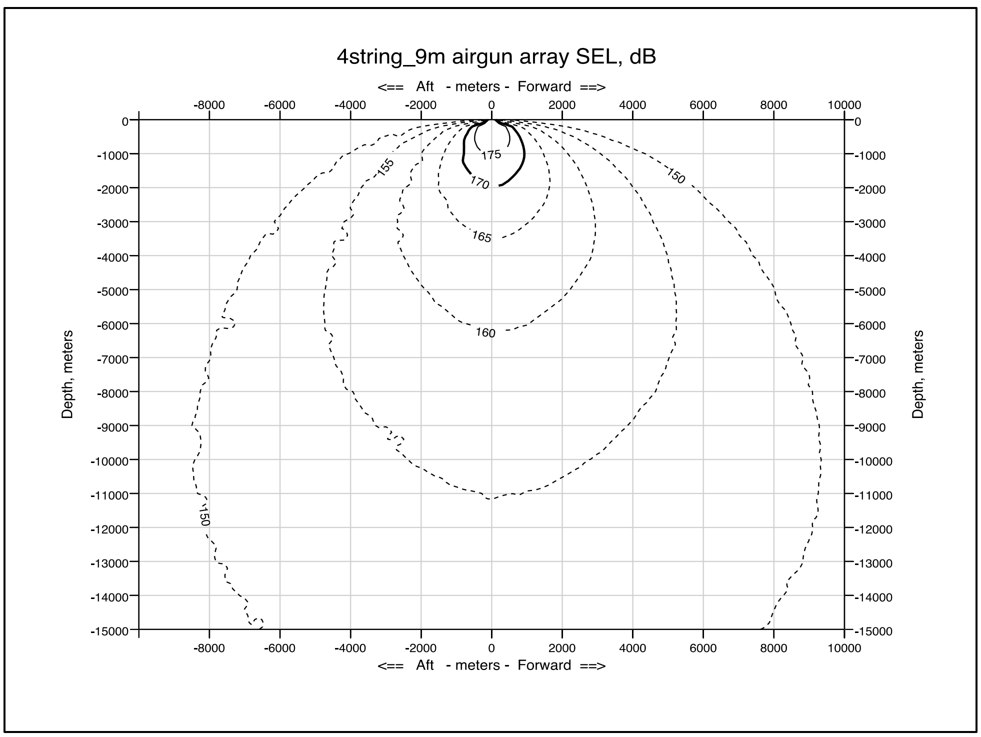


Figure 2. Modeled SEL contour distances for the 36-airgun array at nine meter tow depth in deep water.

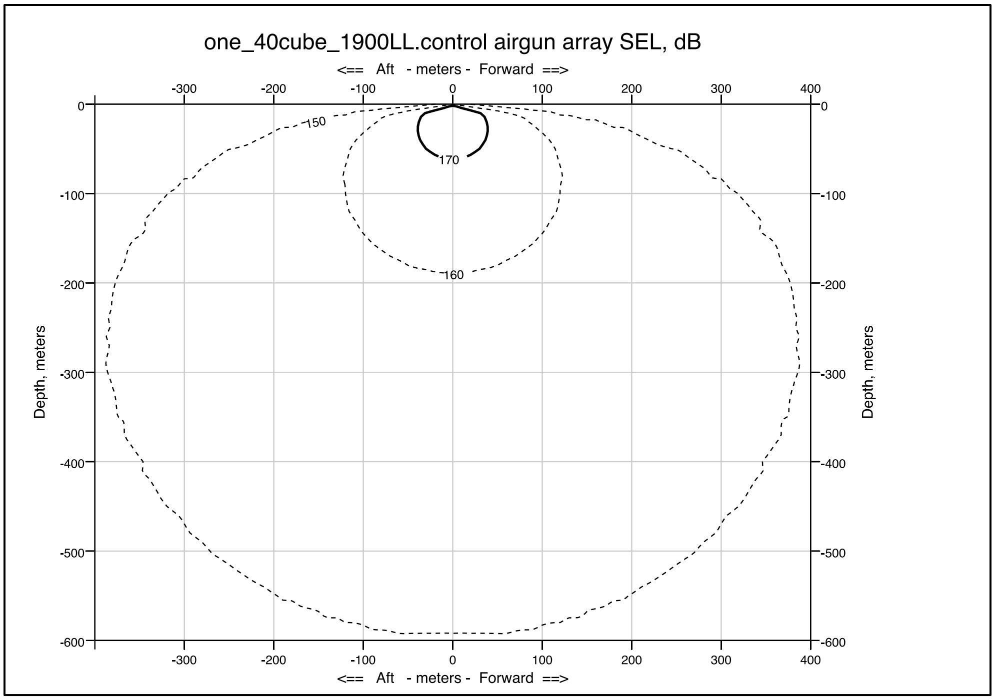


Figure 3. Modeled SEL contour distances for the 40 in^3 mitigation gun at nine meter tow depth in deep water.

Table 1 shows the distances at which three rms (root mean squared) sound levels are expected to be received from the 36-airgun array and a single airgun. The 180 dB re 1 μPa_{rms} distance is the safety criteria as specified by NMFS (1995) as applicable to cetaceans under the MMPA. This 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 180 dB isopleth would also be the exclusion zone boundary for sea turtles. The 166 dB isopleth represents our best understanding of the threshold at which sea turtles exhibit behavioral responses to seismic airguns. 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, 166, and 160 dB re 1 μPa_{rms} could be received from the 36-airgun arrays as well as the 40 in^3 airgun in water depths greater than 100 m.

Source, volume, and tow depth	Predicted RMS radii (m)		
	180 dB	**166 dB**	**160 dB**
36-airgun array 6,600 in^3 @ 9 m	927	3,740	5,780
Single Bolt airgun, 40 in^3 @ 6 m	100	185	388

2.6 Magnetometer, sonobuoys, and expendable bathythermographs

Several additional devices will be used during the proposed activities. A one-meter-long magnetometer will be deployed roughly 100 m behind the Langseth alongside the towed streamer. Twenty-four sonobuoys will be deployed from the side of the Langseth. These one-meter-long by 10 cm wide devices will float from the surface and drop a hydrophone 30 to 60 meters below the surface tethered by a filament cable. Deployments will last roughly eight hours before the sonobuoy sinks. Several dozen expendable bathythermographs will also be deployed from the side of the Langseth, deploying filaments to depths of several hundred to 1,000 m. Filament wire is relatively fragile and easily broken.

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. The incidental harassment authorization will be valid from August 15, 2014 through August 14, 2015, and will authorize the incidental harassment of the following endangered species (among other 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. Take would only be authorized from August to September 2014 and April to August 2015. The proposed incidental harassment authorization identifies the following requirements that L-DEO must comply with as part of its authorization.

A. Establish an exclusion zone[1] corresponding to the anticipated 180 dB re 1 μPa_{rms} isopleth for full (6,600 in^3) and single (40 in^3) airgun operations as well as a 160 dB re 1 μPa_{rms} buffer zone.

B. Use two, NMFS-approved, vessel-based observers to watch for and monitor marine mammal species near the seismic source vessel during daytime airgun operations, 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, 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 4 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 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

---

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.

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 within the exclusion zone, USGS 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 30 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 three 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 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.

F. 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 more than 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 180 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.

H. 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.

I. 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 30 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.

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.

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), USGS will cease operating seismic airguns and report the incident to NMFS's Office of Protected Resources at 301-427-8401, and the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866-755-6622) and/or by email to the NMFS Greater Atlantic Regional Stranding Coordinator (Mendy. Garron@noaa. gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) and/or by e-mail to the Southeast Regional Stranding Coordinator (Blair. Mase@noaa. gov) and Southeast Regional Stranding Program Administrator (Erin. Fourgeres@noaa. gov) immediately. Airgun operation will then be postponed until NMFS is able to review the circumstances and work with USGS to determine whether modifications in the activities are appropriate and necessary. If the lead observer judged that the injury or mortality is not a result of the authorized activities, operations may continue.

M. In the event that USGS 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), USGS 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 Howard.Goldstein@noaa.gov, and the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866-755-6622) and/or by email to the NMFS Greater Atlantic Regional

Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) and/or by e-mail to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fourgeres@noaa.gov). Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with USGS to determine whether modifications in the activities are appropriate.

N. In the event that USGS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e. g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), USGS 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 Howard.Goldstein@noaa.gov, and the NMFS Greater Atlantic Marine Mammal Stranding Network (866-755-622), and/or by e-mail to the Greater Atlantic Regional Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Regional Stranding Network (877-433-8299), and/or by e-mail to the Southeast Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fourgeres@noaa.gov), within 24 hours of the discovery. USGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

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 2014 activities and again after the completion of 2015 activities. The report would describe the proposed operations that were conducted and sightings of marine mammals within the vicinity of the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, and all marine mammal sightings (i.e., dates, times, locations, activities, associated seismic survey activities, and associated PAM detections). This report must also contain and summarize the following information:

1. Summaries of monitoring effort – total hours, total distances, and distribution of marine mammals through the study period accounting for Beaufort sea state and wind force, and other factors affecting visibility and detectability of marine mammals;

2. Analyses of the effects of various factors influencing detectability of marine mammals including Beaufort sea state and wind force, number of observers, and fog/glare;

3. Species composition, occurrence, and distribution of marine mammals sightings including date, water depth, numbers, age/size/gender, and group sizes; and

analyses of the effects of seismic operations;

4. Sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability);
5. Initial sighting distances versus airgun activity state;
6. Closest point of approach versus airgun activity state;
7. Observed behaviors and types of movements versus airgun activity state;
8. Numbers of sightings/individuals seen versus airgun activity state; and
9. Distribution around the source vessel versus airgun activity state.
10. The report would also include estimates of the number and nature of exposures that could be used to further analyze and consider whether these were "takes" of marine mammals by harassment or in other ways.

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).

In this particular assessment, we identified the stressors associated with the action and determined which had a significant possibility of occurring 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, which can have a variety of effects that can have fitness consequences (Francis and Barber 2013; Nowacek and Tyack 2013) (Figure 4).

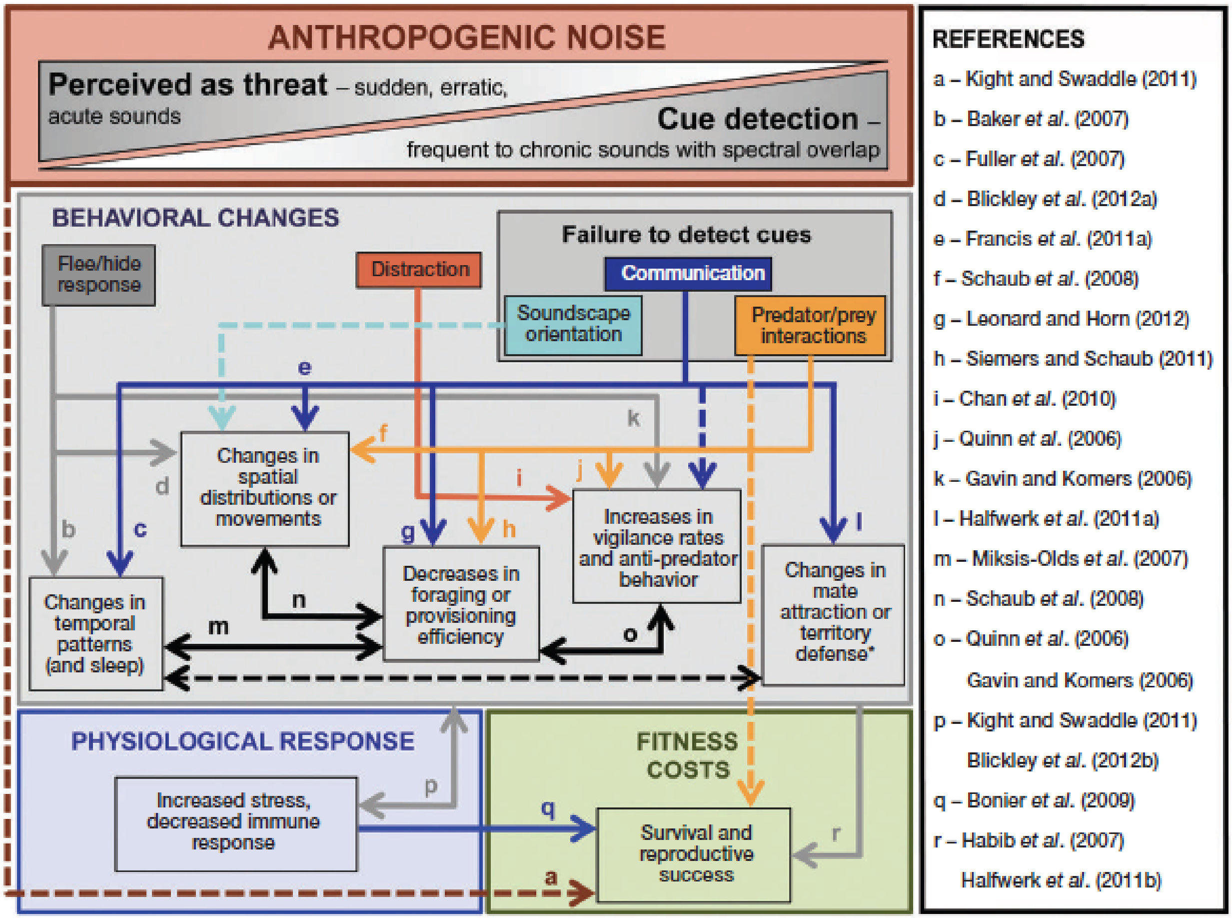


Figure 4. Conceptual framework of how anthropogenic noise impacts individuals and how those impacts can lead to fitness consequences. Figure taken from Francis et al. (2013). Original supporting literature (A. et al. 2007; Baker et al. 2007; Blickley et al. 2012; Blickley and Patricelli 2012; Bonier et al. 2009; Chan et al. 2010; D. et al. 2011; Gavin and Komers 2006; Habib et al. 2007; Halfwerk et al. 2011a; Halfwerk et al. 2011b; Kight and Swaddle 2011a; Leonard and Horn 2012; Miksis-Olds et al. 2007; Quinn et al. 2006; Schaub et al. 2008; Siemers and Schaub 2011).

In the process of this assessment, we were required to make several assumptions where data were insufficient to support conclusions regarding the specific species and actions at hand. 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 (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 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 a broad stretch of the U.S. East Coast (Figure 5), outside of state waters, and both within the U.S. Exclusive Economic Zone (EEZ) (10-20% of trackline) as well as outside of it (80-90%). The region in which the seismic survey will occur is between 29.2° and 39.2° N and 61.7° and 75.9° W. The region encompasses water depths from 1,450-5,400 m along roughly 1,707 km of trackline in 2014 and 1,682 km of trackline in 2015, respectively, including turns and other seismic operations. The applicant did not request an increase in trackline due to equipment failures, a need to reshoot some areas, or other logistical impacts. Responses to seismic sound sources by ESA-listed marine mammals occur within the 160 dB isopleths (modeled to be up to 5.780 km from the *Langseth*), increasing the area ensonified along the trackline to roughly 35,587 km^2 in 2014 and 2015, respectively. Responses to seismic sound sources by ESA-listed sea turtles occur within the 166 dB isopleths (modeled to be up to 3.740 km from the *Langseth*), increasing the area ensonified along the trackline to 12,768 km^2 in 2014 and 12,581 km^2 in 2015 (25,349 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.

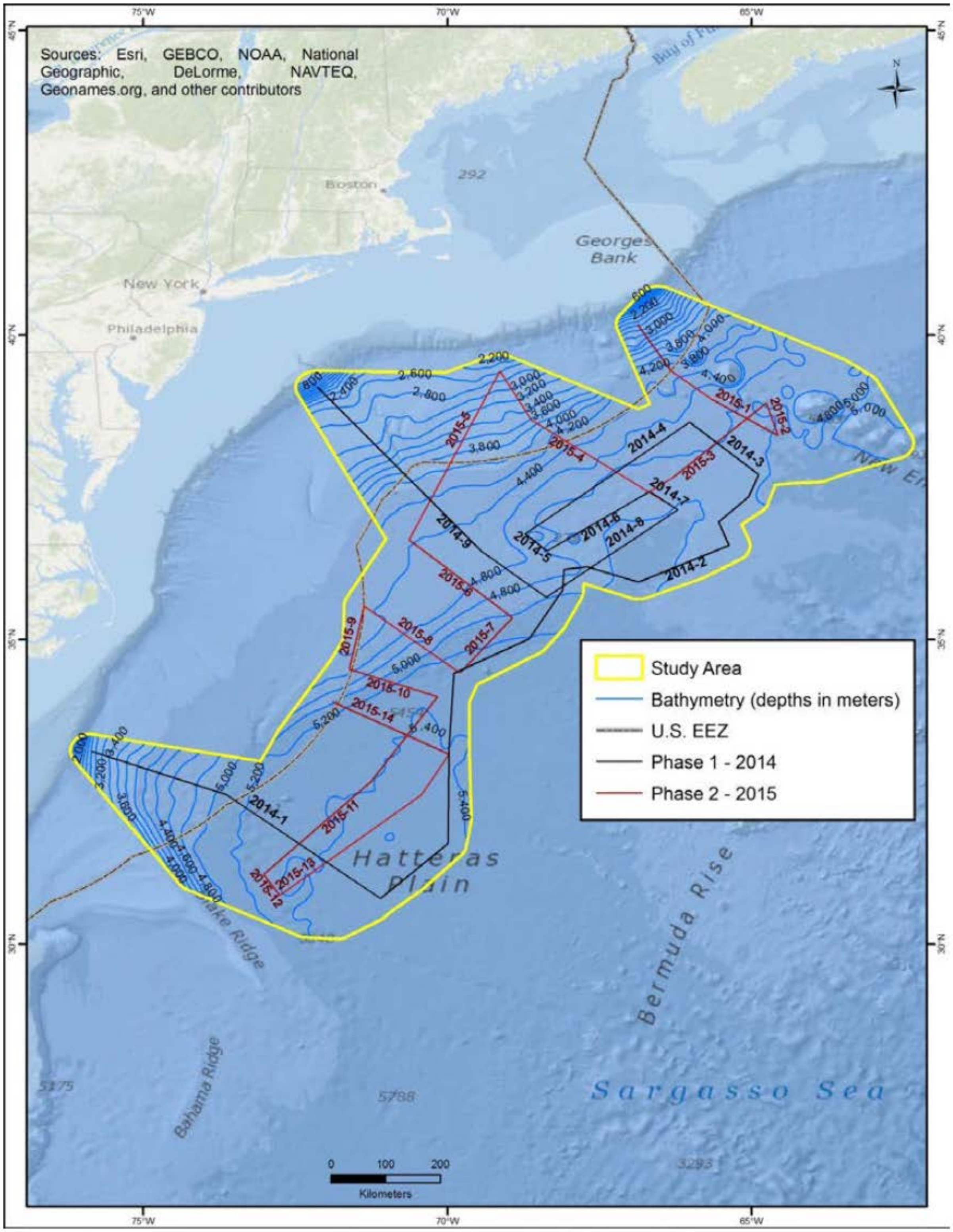


Figure 5. Proposed area for the marine seismic survey off the U.S. East Coast. Trackline for the seismic survey is identified in black and red lines for 2014 and 2015 activities, respectively. The

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 species listed in Table 2, which are provided protection under the ESA.

Table 2. ESA-listed species in the action area that may experience adverse effects as a result of 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		
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*	Endangered

Although the area in which the seismic survey is proposed to occur is relatively close to shore, we do not believe that ESA-listed sturgeons are likely to be present in the action area. Both Atlantic and shortnose sturgeon occur in nearshore marine waters along the mid-Atlantic, but tagging studies have not found them to occur as far offshore as the proposed action area. We also do not expect Atlantic salmon to occur in the action area during the seismic survey. Thus, NMFS does not anticipate that the proposed seismic survey would incidentally take any ESA-listed sturgeons or Atlantic salmon. The action area also co-occurs with designated critical habitat of Northwestern Atlantic Distinct Population Segment (DPS) loggerhead sea turtles, specifically *Sargassum* habitat. The primary constituent elements of the critical 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. 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 animals of loggerheads. Therefore, we do not expect any of the stressors of the proposed actions to impact the primary constituent elements of loggerhead critical habitat and, therefore, do not consider the critical habitat any further.

The biology and ecology of species with anticipated exposure below informs the effects analysis for this Opinion. 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[2] 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).

“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.

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. 1988; 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). A single sighting was made in the study area 55 years ago, but several have been made in the region nearby to the northwest, particularly over the continental shelf break (Belford et al. 2014).

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

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.

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).

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.

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).

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).

Figure 6. 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).

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 1982c). 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).

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 1989a; Cherfas 1989b).

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.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
						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. 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).

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 International Whaling Commission (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).

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).

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. 1985b). 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)
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). No sightings have been made in the study area where seismic surveys would be undertaken, although sightings just west over the continental shelf and continental shelf break regularly occur (Belford et al. 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. 1985a). 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 1982b). 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 1982c). 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). Several sightings have been within the study area, particularly in the northwestern sector (Belford et al. 2014). However, sightings are generally frequent near the continental shelf break (Belford et al. 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 1982c). 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). Hundreds of sightings have been made in the study area, ranging from the continental shelf break to abyssal waters (Belford et al. 2014). However, most sightings are in the northern and western portions of the area where seismic surveys will be conducted (Belford et al. 2014). The Mid-Atlantic Bight is considered a summer habitat for sperm whales (Palka 2006).

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 1989a). 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 1989a). 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 1989a). The diet of large males in some areas, especially in high northern latitudes, is dominated by fish (Rice 1989a). 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 1989b; 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 2004a).

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. Several sightings have been made in the area of the proposed seismic survey tracklines (generally in the northwestern component of the area), but few during the same season as the survey (Belford et al. 2014). Summer sightings are generally over the continental shelf break (Belford et al. 2014).

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 1985b; 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. 1986a; Vargo et al. 1986b; Vargo et al. 1986c). 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 two hawksbill sea turtle sighting have been reported in the study area of the seismic surveys, with a few more west over the continental shelf (Belford et al. 2014).

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)(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. 1986a; Vargo et al. 1986b; Vargo et al. 1986c). 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).

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

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. 1994a). 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. 1994a; Márquez 1990a; 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. 1994b; 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. 1994b). 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. 2005b). 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 1995b). 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 1995a). 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 1998c). 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 (Headstart). 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 2001a). 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. 1986a; Vargo et al. 1986b; Vargo et al. 1986c). 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 2007a).

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 1990b; 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 1990b; 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 1982c). 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 2007c). 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).

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. 2005a).

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 2004b). 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 (2007b)
British Virgin Islands	Nests	1986 - 2006	0-65	▲	McGowan et al. (2008) ;Turtle Expert Working Group (2007b)
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)
Costa Rica (Gandoca)	Nests	1990 - 2004	~583	▼	Chacón and Eckert (2007); Turtle Expert Working Group (2007b)
Panama (Chiriqui Beach)	Nests	2004	1,000-	?	Meylan et al. (2013)

Location	Data: Nests, Females	Years	Annual number	Trend	Reference
		- 2011	4,999		
Colombia	Nests	2006 - 2007	1,653-2,871	?	Patino-Martinez et al. (2008)
Trinidad	Females	1994 - 2005	2,096	▲	Turtle Expert Working Group (2007b)
Guyana	Nests	2007 - 2010	377-1,722	▲	De Freitas and Pritchard (2008; 2009; 2010); Turtle Expert Working Group (2007b); Kalamandeen et al. (2007)
French Guiana	Nests		5,029-63,294	▬	Fossette et al. (2008)
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 (2007b)
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 1990b; 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 2007a). 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 2007c). 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 (2007b) 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 2007c). 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 (2007c) 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 2007c). 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 2007c). 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 2007c). 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 (2007c) 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 2007c).

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. 1986a; Vargo et al. 1986b; Vargo et al. 1986c). 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). Sightings are concentrated over the continental shelf, but are routine east over the shelf break and into deeper waters, particularly in summer (Belford et al. 2014). Hundreds of occurrences have been documented in the study area (Belford et al. 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 1990b; 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 1985a; 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 1998a). 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 1998b). 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 2004a). 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 distinct population segments (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 2004b).

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 1990b).

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 1998c). 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[3]. 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 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).

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3 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.

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. 1986a; Vargo et al. 1986b; Vargo et al. 1986c). 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 2001b). 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 a *Sargassum* habitat area that co-occurs with the proposed seismic surveys in offshore areas.

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 1990c; 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. 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.

A few weeks prior to the proposed seismic survey, 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, 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*).

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). 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 10).

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

Whale or sea turtle species	Operating area							
	Northeast		Virginia Capes		Cherry Point		Jacksonville	
	Harass	Harm	Harass	Harm	Harass	Harm	Harass	Harm
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 11 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. 2007b; 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 7. 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 12). 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). The most advanced in development of these is the Cape Wind Energy project (Cape Cod, Massachusetts), which calls for 130 wind turbine generators. The Bureau of Ocean Energy Management approved a construction and operations plan for the project in 2011 (USDOI 2011). Another six-turbine system is proposed off New Jersey, for which state permits were issued in 2011 (Fisherman's Energy of New Jersey LLC 2011). 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 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.

7.11 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. 2007b). 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 2004b). 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. 2007a). 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. 2010). 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. 2010). 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). [4] 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.

7.12 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

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4 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..

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.

7.13 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 13-22 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.

7.14 Physical and oceanographic features

The presence of key habitat features, such as shelter or foraging opportunities, are the primary reasons why ESA-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 ESA-listed species occur in the action area at the levels we observe or expect. This does not represent a stressor, but is instead an underlining principle for establishing why effects are what we expect them to be.

The continental shelf in the northern half of the region is a nearly uniform, smooth seafloor with an evenly-carved continental shelf edge (Backus 1987). The continental shelf slopes gently and is relatively shallow, marked by an abrupt increase in the seafloor gradient and ranges in water depth from 100 to 150 m. The average width of the continental slope from Georges Bank to Cape Hatteras is approximately 30 km but varies in size from 10 to 50 km (Tucholke 1987). The largest submarine canyon in the area is the Hudson Canyon, which is the most developed canyon on the U.S. Atlantic continental margin. Several other smaller canyon features occur just west of the region where the seismic surveys would take place. Submarine canyons are considered to be complex regions of the continental slope containing a much richer biodiversity compared to uniform, smooth seafloor areas. The abundance of nutrients introduced by the strong down flowing currents are factors leading to the biological richness found in canyons (Cooper et al. 1987).

The Blake Plateau is the largest physical feature of the southern half 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 Gulf Stream Current is a powerful surface current, carrying warm water into the cooler North Atlantic just south of the action area (Pickard and Emery 1990; Verity et al. 1993). Surface velocities range from 2-5 nautical miles per hour and the temperature is generally 25° to 28° C (Mann and Lazier 1991). 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). 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 North Atlantic Oscillation likely cause variation in its position (Pershing et al. 2001; Schmeits and Dijkstra 2000). Wave-like meandering begins to occur at Cape Hatteras and increase 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 ESA-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 North 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).

A persistent front exists from the Mid-Atlantic Bight into New England waters due to the intersection of the continental shelf and slope. This surface manifestation of a thermohaline front extends year round from the surface downward, where it intersects the seafloor just shoreward of the shelf break (Halliwell Jr. and Mooers 1979). Phytoplankton production is enhanced at this frontal boundary, often with twice the concentration of phytoplankton found in adjacent waters (Ryan et al. 1999b).

An annual phenomenon in the Mid-Atlantic Bight is the formation of the “cold pool.” This mass of cooler water occurs over the continental shelf in summer and stretches from the Gulf of Maine to Cape Hatteras and is detectible from spring through fall (Linder et al. 2004). The cold pool usually exists near the seafloor between the 40 m and 100 m isobaths and extends up into the water column for about 35 m. Minimum temperatures for the cold pool occur in early spring and summer and range from 1.1º to 4.7º C.

The North Atlantic Oscillation affects sea surface temperatures, wind conditions, and ocean circulation throughout the North Atlantic Ocean (Stenseth et al. 2002b). The North Atlantic Oscillation 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 North Atlantic Oscillation was generally positive from 1900 to 1950, mainly negative in the 1960s and 1970s, and mainly positive since 1970 (Hurrell et al. 2001).

The North Atlantic Oscillation also influences the latitude of the Gulf Stream Current and is largely responsible for its variable location. During positive North Atlantic Oscillation years, the Gulf Stream is farther east (Taylor and Stephens 1998). The flow rate of the Gulf Stream is also affected; during negative North Atlantic Oscillation 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 North Atlantic Oscillation (Pershing et al. 2001). During low North Atlantic Oscillation 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 North Atlantic Oscillation influences the northern North Atlantic most, its effects remain significant south through the Outer Banks (Hurrell et al. 2001).

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

Primary productivity fluctuates little south of the Chesapeake Bay. 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).

Phytoplankton are single-celled organisms that form the base of marine food chains and whose occurrence and abundance are strongly driven by light, temperature, and nutrient conditions. As nutrients from river outflows near shore generally provide more nutrients than are present offshore, phytoplankton are generally more abundant nearshore. Although the North Atlantic is generally well mixed (nutrients are generally available), light levels tend to be low for phytoplankton, limiting their growth (Ryan et al. 1999a). However, spring time is a period with reduced mixing and increasing light levels, meaning that phytoplankton tend to stay at the surface and are better able to photosynthesize, grow, and reproduce at exponential rates (Mann and Lazier 1991; Parsons et al. 1984; Ryan et al. 1999a). However, nutrients are eventually exhausted in surface waters by May and seasonal progression into winter returns the region to a light-limiting condition. During spring and summer, nectophytoplankton are dominant in northern areas but are replaced by nanophytoplankton during limiting conditions (Ryan et al. 1999b). Diatoms, cyanobacteria, cryptophytes, and prasinophytes make up most of the phytoplankton community in the southern portion of the region, 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. These organisms serve as prey for those animals that ESA-listed individuals prey upon, such as jellyfish, zooplankton, and schooling fishes.

Not only the water conditions, but intersections between water bodies (frontal boundaries) are important factors in biological productivity. This is the case year-round between the shelf and slope waters of the mid-Atlantic, but particularly during winter and spring (Ryan et al. 1999a; Ryan et al. 1999b).

Zooplankton, the next higher level in the marine food chain from phytoplankton and the prey of several ESA-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). However, zooplankton biomass abundance can increase when shelf water intrudes over slope water, creating a stratified water column. High nutrients and a shallow mixed layer set conditions for enhanced phytoplankton production, which subsequently aids zooplankton biomass increases. Copepods are the primary zooplankters dominate in New England shelf waters, and whose abundance is highest in spring on the outer shelf but highest in summer on the inner shelf (Flagg et al. 1984). *Calanus finmarchicus* and *Pseudocalanus* sp. are the predominant copepods over the outer shelf while the inner shelf has *Centropages typicus* and *Temora longicornis* predominating. The relatively large size of *Calanus* species and its annual cycle in New England waters makes it a major driver of New England marine ecosystem during spring (Flagg et al. 1984). Zooplankton concentrate in areas of increased primary productivity, such as along Gulf Stream frontal boundaries and eddy peripheries (Oschlies and Garcon 1998). Here, 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.

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, or 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 consider 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 does not define 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"[5] 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

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5 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)

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, magnetometer, expendable bathythermographs, or sonobuoy filament cable;
5. sound fields produced by airguns; and
6. sub-bottom profiler or multibeam echosounder.

Stressors Determined to be Discountable or Insignificant

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 impact ESA-listed species directly or pose hazards to their food sources.

The propulsion system of the *Langseth* is designed to be very quiet compared to other vessels to reduce interference with seismic activities. Although noise originating from vessel propulsion will propagate into the marine environment, this amount would be highly improbable. The *Langseth*'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). The same can be said for the chase vessel.

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 and the probability of a ship-strike (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* has traveled without a ship strike, general expected movement of marine mammals away or parallel to the *Langseth*, as well as the generally slow movement of the *Langseth* during most of its travels (Hauser and Holst 2009; Holst 2009; Holst 2010; Holst and Smultea 2008a). We have concluded the potential for ship strike or acoustic interference from propulsion and machinery noise is highly improbable and is discountable. Therefore, these potential stressors 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 and magnetometer 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. Expendable bathythermographs and sonobuoy filament cable do not trail behind the *Langseth*, but drop roughly vertically into the water column. Although information exists to support the potential for marine animals to become entangled in vertical lines, the probability of any individual interacting with a line to a degree that a negative consequence results is very low given the duration lines associated with the proposed action will be in the water and the number of lines involved. Based on this, we find the risk of entanglement in towed hydrophone, magnetometer, expendable bathythermographs, or sonobuoy filament cable so low as to be discountable. Therefore, it is not likely to adversely affected ESA-listed species and will not be considered further in this Opinion.

Stressors Considered Further

This consultation focused on the following stressors from the proposed seismic activities not considered insignificant or discountable and may 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 and multibeam echosounder sonars.

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 received levels greater than 166 dB re 1 μPa_{rms} would be significant enough to result in "take" pursuant to the ESA.

For all ESA-listed species, the USGS 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 a very limited potential of re-ensonifying the same location within the action area. We find that 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 and sea turtles move (ex. feeding 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 immediate area. This is particularly significant given that marine mammals and sea turtles tend to return to specific areas for foraging and breeding, or use particular migratory corridors. We expect that at least some individuals would return to the area once the seismic activity has ceased. Observations from previous seismic surveys support the likelihood that individuals will be re-exposed is very low, if at all. 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. However, this is unlikely to happen in other than random, rare cases and we expect the vast majority of animals would only be exposed once.

The USGS 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 a product of animal density and ensonified area. The ESA Interagency Cooperation 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 exposure estimates. Maximum radii associated with seismic airgun isopleth modeling were established at the maximum diving depth for listed species (2,000 m). As several 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.

The USGS and NMFS's Permits and Conservation Division used data from the Navy Operating Area density estimates detailed in DON (2007) for sperm, humpback (summer), and fin whales, 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. USGS imported a shapefile of the study area (outlined in yellow in Figure 5) 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. This database only produces density estimates within the U.S. EEZ and 80% of the 2014 seismic survey trackline and 90% of the 2015 seismic survey trackline occurs outside the U.S. EEZ. The USGS 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 for spring and summer seasons, respectively. These densities were used to represent the expected density throughout the entirety of the action area, including that which extends outside the U.S. EEZ. Only fin, humpback (summer), and sperm whale densities were generated in this way. For blue, humpback (spring), North Atlantic right, and sei whales, the action agencies assumed that a single group would be exposed during each 2014 and 2015 phases of the seismic survey, respectively and used mean group size observed during surveys reported in the Cetacean and Turtle Assessment Program (1982a) and Atlantic Marine Assessment Program for Protected Species surveys from 2009-2013 as the expected number of exposures.

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.
- NMFS's Permit and Conservation Division was able to reproduce the density estimates provided by the USGS in their environmental assessment with the information USGS provided, although with a small degree of difference likely stemming from map and shape file geospatial projections.
- The modeling process produces sharp changes in density in some locations that are not expected to be 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:

- Estimates are based within U.S. EEZ waters and are applied outside the U.S. EEZ, where a large majority of the seismic survey track line occurs, frequently hundreds of miles from the U.S. EEZ.
- Little survey effort is incorporated into OBIS-SEAMAP through much of where the southern portion of the study area enters the U.S. EEZ, which makes up a major component of data used to determine overall density (Ropert-Coudert et al. 2010).
- The USGS 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.
- Finally, the "study area" boundaries themselves were defined by the USGS as a general area surrounding the planned seismic survey tracklines that would allow for a degree of flexibility in altering these tracklines as the project developed. Although the area included within the study area was highly influential in determining the density data that were included in USGS's analysis, defining the area to be included did not consider biological, oceanographic, or anticipated effects within it, likely resulting in a considerable degree of subjectivity in the resulting density estimates.

For blue, humpback (spring), North Atlantic right, and sei whales, OBIS-SEAMAP data were not available to estimate a density, or produced estimates of zero individuals exposed (Prieto et al. 2012). In these cases, the action agencies assumed that a single group would be exposed during each 2014 and 2015 phases of the seismic survey, respectively and used mean group size observed during surveys reported in the Cetacean and Turtle Assessment Program (1982a) and Atlantic Marine Assessment Program for Protected Species surveys from 2009-2013 as the expected number of exposures. The Permits and Conservation Division provided the ESA Interagency Cooperation Division with a rationale for group size as an appropriate estimate of exposure in the action area. This included expectations of blue, sei, North Atlantic right, and humpback (spring) rarity in the action area, extrapolations of relative blue to fin whale density observed in other areas (roughly 1:10), and potential timing differences of the seismic survey legs in 2014 and 2015 resulting in the different likelihoods of these species being present in the action area in one year versus another.

The ESA Interagency Cooperation 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). This database utilizes the same data incorporated into OBIS-SEAMAP, and additional habitat-based modeling datasets that provide density estimates that encompass the entire study and action area of the proposed seismic survey. We worked with the NMFS's Permits and Conservation Division during consultation 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 action area, including those that were not available or conducted through OBIS-SEAMAP.

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). We expect that the seismic survey trackline in 2014 would be followed during the NMSDD summer season therefore we used this season for estimating density. The 2015 trackline may be done anytime between the months of April and August. As the earlier portion of this timeframe corresponds to the spring season on NMSDD maps and the later corresponds to summer, we used the season that would yield the highest density estimate for each species, respectively, for density estimates in 2015. 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 2014 and 2015 trackline could be undertaken, respectively. Maps were downloaded and georeferenced in ArcGIS 10.2. We then imported shape files, provided by USGS, for the 160 dB re 1 μPa_{rms} isopleth around the planned seismic survey trackline for 2014 and 2015, respectively. This was overlaid onto the georeferenced NMSDD map for each species. For each year's area ensonified to at least 160 dB re 1 μPa_{rms} (and for each species), that area was divided into 20 equal segments along the length of the trackline (Figure 8). For each of the 20 segments, the highest density estimated to occur within that particular segment was determined and that density assigned to the entire segment. Once values were assigned to each of the 20 segments, a mean of these densities was calculated and assigned for that species in that year. The process was replicated for 2014 and 2015 for each ESA-listed marine mammal species.

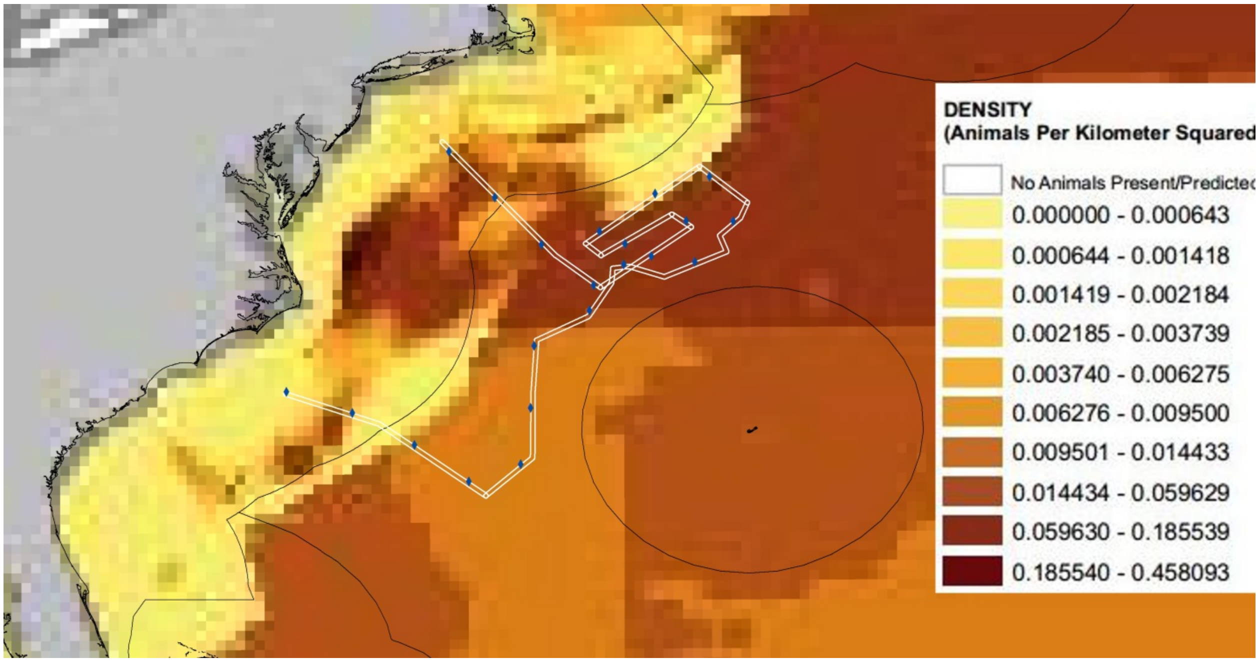

Figure 8. NMSDD summer sperm whale density estimate map georeferenced in ArcGIS 10.2 with area ensonified to at least 160 dB re 1 µPa_{rms} during 2014 seismic survey trackline. Blue diamonds demarcate start and end points between 20 equally-long segments of the 2014 survey trackline. Color shades (lightest to darkest) represent ranges of increasing density modeled within 10-40 km^2 squares from NMSDD. For the darkest shade identified in each of the 20 segments, the highest value of a particular density range was used as the value assigned to each of the 20 segments, respectively. Although the resolution of the map data are relatively course, we believe it provides sufficient detail to support the analytical process adopted in determining density in trackline segments.

Strengths in the NMSDD approach include:

- Greater density coverage of the action area.
- Density estimates are closer to the action area.
- 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 action area.
- This dataset includes estimates derived from habitat usage information including continental slope waters and some abyssal areas driven more by continental shelf, slope, and nearshore physical and oceanographic processes.
- 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:

- Underlying data are not available to us because data from outside the U.S. EEZ was licensed from a third party and not available from the U.S. Navy itself.
- The U.S. Navy itself expressed opinion that use of the NMSDD maps alone was not appropriate.
- The spatial resolution of the maps is gross (10-40 km^2 and likely somewhat more due to due to 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 USGS estimated the exposure radii around the proposed *Langseth* operations using empirical data gathered in the Gulf of Mexico in 2007-2008 aboard the *Langseth*. The distances to which sound levels (rms) might propagate for single airgun and the 36-airgun array used during the proposed study are provided in Table 1. The maximum distance from airguns where received levels might reach 160 dB re 1 μPa_{rms} (36-airgun array) at 2,000 m depth (maximum depth at which ESA-listed species are expected to occur) is 5.78 km with a 9 m tow depth. A thorough review of available literature (see *Response Analysis*) supports this level as a general point at which baleen whales tend to show some avoidance response to received seismic sound.

The USGS'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 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 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). A received level of 166 dB re 1 μPa_{rms} (3.74 km for the 36-airgun array at nine meter tow depth) is considered here to be the threshold for harassment for sea turtle response based upon the little information available (McCauley et al. 2000a; McCauley et al. 2000b) (see sea turtle section below).

A major mitigation factor proposed by the USGS (and L-DEO) is visual monitoring, especially for marine mammals, which should reduce exposure of ESA-listed whales and sea turtles. However, visual monitoring has several limitations. Although regions ensonified by 160, 166, and 180 dB re 1 μPa_{rms} propagation distances are 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 the exposure 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 to 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 significantly by the use of ramp-ups and shut-downs. Vessel platforms are subject to some limitations such as that even under good sighting conditions observers have limited ability to identify protected species during their brief time at the surface. Vocalizations by protected species will also help in identifying abundance 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.

Marine Mammals

Exposure of Listed Mammals to Airguns. Exposure estimates from OBIS-SEAMAP and NMSDD whale density estimates and a planned ensonified area of approximately 36,587 km^2 in 2014 and 2015, respectively, along survey track lines, including areas of repeated exposure from adjacent track lines and turning legs.

The OBIS-SEAMAP exposure estimates (Tables 23 and 24) and NMSDD map exposure estimates (Tables 25 and 26) were calculated by using the density per 1,000 km^2 multiplied by the total survey track area (1,707 km track line ensonifying 36,587 km^2 to the 160 dB re 1 μPa_{rms} level in 2014 and 1,682 km track line ensonifying about the same area to the same level in 2015) to obtain the total number of exposures (rounded to the next whole number). For OBIS-SEAMAP exposure estimates, where density estimates were not available from the database or USGS qualitatively considered them to be low, group size for the species stemming from the Cetacean and Turtle Assessment Program (1982a) is substituted. As we cannot know whether 2015 activities will occur in spring or summer, the higher value of spring or summer is presented.

Table 23. 2014 estimated exposure of ESA-listed whales to sound levels ≥160 dB re 1 μPa_{rms} during the proposed seismic activities developed from OBIS-SEAMAP data and group size estimates.

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	Up to 1	440	Up to 0.22%	Northwest Atlantic[1]
Fin-0.06	3	Up to 3	3,985	Up to 0.08%	Northwest 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
Sei-n/a	3	Up to 3	386	Up to 0.78%	Nova Scotia stock[1]
Humpback-n/a	3	Up to 3	11,600	Up to 0.03%	Northwestern Atlantic[2]
North Atlantic right-n/a	3	Up to 3	444	Up to 0.68%	North Atlantic[1]
Sperm-2.251	83	Up to 83	13,190	Up to 0.63%	Northeast Atlantic, Faroe Islands, Iceland, and northeastern U.S. coast[3]
Total	131	--	--	--	--

[1] *Waring et al. (2013)*
[2] *IWC (2014)*
[3] *Whitehead (2002)*

Table 24. 2015 estimated exposure of ESA-listed whales to sound levels ≥160 dB re 1 μPa$_{rms}$ during the proposed seismic activities developed from OBIS-SEAMAP data and group size estimates.

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	Up to 1	440	Up to 0.22%	Northwest Atlantic[1]
Fin-0.06	3	Up to 3	3,985	Up to 0.08%	Northwest Atlantic[1]
Sei-n/a	3	Up to 3	386	Up to 0.78%	Nova Scotia stock[1]
Humpback-1.017	38	Up to 38	11,600	Up to 0.33%	Northwestern Atlantic[2]
North Atlantic	3	Up to 3	444	Up to 0.68%	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
right-n/a					
Sperm-2.251	83	Up to 83	13,190	Up to 0.63%	Northeast Atlantic, Faroe Islands, Iceland, and northeastern U.S. coast[3]
Total	131	--	--	--	--

[1] *Waring et al. (2013)*
[2] *IWC (2014)*
[3] *Whitehead (2002)*

Table 25. 2014 estimated exposure of ESA-listed whales to sound levels ≥160 dB re 1 μPa$_{rms}$ during the proposed seismic activities developed from NMSDD maps.

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-0.035	2	Up to 2	440	Up to 0.45%	Northwest Atlantic[1]
Fin-0.603	23	Up to 23	3,985	Up to 0.58%	Northwest Atlantic[1]
Sei-5.851	215	Up to 215	386	Up to 55.70%	Nova Scotia stock[1]
Humpback-2.104	77	Up to 77	11,600	Up to 0.66%	Northwestern Atlantic[2]
North Atlantic right-0.023	1	Up to 1	444	Up to 0.22%	North Atlantic[1]
Sperm-57.428	2,102	Up to 2,102	13,190	Up to 15.94%	Northeast Atlantic, Faroe Islands, Iceland, and northeastern U.S. coast[3]

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
Total	2,420	--	--	--	--

[1] Waring et al. (2013)
[2] IWC (2014)
[3] Whitehead (2002)

Table 26. 2015 estimated exposure of ESA-listed whales to sound levels ≥160 dB re 1 μPa$_{rms}$ during the proposed seismic activities developed from NMSDD maps.

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-0.033	2	Up to 2	440	Up to 0.45%	Northwest Atlantic[1]
Fin-5.762	211	Up to 211	3,985	Up to 5.29%	Northwest Atlantic[1]
Sei-1.756	229	Up to 229	386	Up to 59.32%	Nova Scotia stock[1]
Humpback-7.23	265	Up to 265	11,600	Up to 2.92%	Northwestern Atlantic[2]
North Atlantic right-0.029	2	Up to 2	444	Up to 0.45%	North Atlantic[1]
Sperm-57.692	2,111	Up to 2,111	13,190	Up to 16.00%	Northeast Atlantic, Faroe Islands, Iceland, and northeastern U.S. coast[3]
Total	2,820	--	--	--	--

[1] Waring et al. (2013)
[2] IWC (2014)
[3] Whitehead (2002)

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 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 vacating the immediate area of the sound field. Other individuals may move, but move to locations where re-exposure could occur, either due to the direction or short distance they travel. Thus, it is reasonable that some individuals may be exposed more than once (this is unlikely unless the stressor does not represent a significant one motivating the individual to vacate the area, the motivation to stay in a specific area is high, and/or an individually randomly moves to a location that is later during the seismic survey). 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 expect the vast majority of exposed individuals will experience only a single exposure to the 160 dB re 1 μPa_{rms} level or higher.

Whales of all age classes are likely to be exposed. Based upon our understanding of listed whale life history presented in the *Status of Listed Resources,* 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 and sub-bottom profiler.

Two additional acoustic systems will operate during the proposed *Langseth* cruise: the multibeam echosounder and the sub-bottom profiler. These systems have the potential to expose ESA-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 and 3.5 kHz for the sub-bottom profiler) and this mitigates effects since 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 or sub-bottom profiler noise of equal amplitude would reach them. Thus, as explained below, operational airguns mitigate multibeam echosounder and sub-bottom profiler noise exposure.

The *Langseth* is expected to avoid close whale approaches, which reduces the chance of exposure to sonars as well. While airguns are not operational, marine mammal observers will remain on duty to collect sighting data. If ESA-listed whales were to approach the vessel, the *Langseth* would take evasive actions to avoid a ship-strike and simultaneously mitigate exposure to very high source levels. Ship strike has already been ruled out as an insignificant effect, and we also rule out high-level ensonification of listed whales (multibeam echosounder source level = 242 dB re 1 μPa_{rms}; 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 and/or sub-bottom profiler sound. We are unable to quantify the level of exposure, but do not expect any exposure to occur at high levels.

Sea Turtles

Exposure of ESA-listed turtles to airguns. The USGS did not estimate the number or extent of exposure that would be expected for sea turtle species. We estimated 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. 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, hawksbill, and olive ridley (not expected to occur in the action area) 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 $6/7^{ths}$ proportion of exposures to green sea turtles and $1/7^{th}$ proportion to hawksbill sea turtles based upon the number of species-specific sightings (provided from OBIS-SEAMAP via the USGS environmental assessment) documented to occur in the action area during the same seasons 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.

Our exposure estimates (Tables 26 and 27) were calculated by using the density per 1,000 km^2 multiplied by the total survey track area (1,707 km track line ensonifying 12,768 km^2 to the 166 dB re 1 μPa_{rms} level in 2014 and 1,682 km track line ensonifying about 12,581 km^2 to the same level in 2015) to obtain the total number of exposures (rounded to the next whole number). We also expect that the potential amount of re-exposure described for marine mammals applies to sea turtles.

We do not expect sound generated by the proposed action to expose eggs or hatchlings 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.

Table 27. 2014 estimated exposure of ESA-listed sea turtles to sound levels $\geq$166 dB re 1 μPa_{rms} during the proposed seismic activities.

Sea turtle density per 1,000 km^2	# of exposures to listed turtles	# of turtles exposed to proposed activities	Population size	% of population exposed	Population/ location
Green-18.994	243	Up to 243	Unknown	Unknown	North Atlantic
Hawksbill-3.166	41	Up to 41	Unknown	Unknown	North Atlantic
Kemp's ridley-8.543	110	Up to 110	>189,000	Up to 0.06%	North Atlantic[1]
Leatherback–76.243	974	Up to 974	34,000	Up to 2.86%	North Atlantic[2]
Loggerhead - 35.394	452	Up to 452	>32,000	Up to 1.41%	Northwestern Atlantic[3]
Total	1,820	**--**	**--**	**--**	**--**

[1]*Gallaway et al. (2013)*
[2]*TEWG (2007b)*
[3]*(NMFS 2001b; TEWG 1998c)*

Table 28. 2015 estimated exposure of ESA-listed sea turtles to sound levels $\geq$166 dB re 1 μPa_{rms} during the proposed seismic activities.

Sea turtle density per 1,000 km^2	# of exposures to listed turtles	# of turtles exposed to proposed activities	Population size	% of population exposed	Population/ location
Green-66.205	833	Up to 833	Unknown	Unknown	North Atlantic
Hawksbill-11.034	139	Up to 139	Unknown	Unknown	North Atlantic
Kemp's ridley-12.407	102	Up to 102	>189,000	Up to 0.05%	North Atlantic[1]
Leatherback–41.958	528	Up to 528	34,000	Up to 1.55%	North Atlantic[2]

Sea turtle density per 1,000 km^2	# of exposures to listed turtles	# of turtles exposed to proposed activities	Population size	% of population exposed	Population/ location
Loggerhead - 101.357	1,276	Up to 1,276	>32,000	Up to 3.99%	Northwestern Atlantic[3]
Total	2,878	--	--	--	--

[1]*Gallaway et al. (2013)*
[2]*TEWG (2007b)*
[3]*(NMFS 2001b; TEWG 1998c)*

Exposure of ESA-listed turtles to multibeam echosounder and sub-bottom profiler. As with baleen whales, sea turtles hear in the low frequency range. The multibeam echosounder operates at 10.5-13 kHz and the sub-bottom profiler operates at 3.5 kHz, both of which are outside the hearing frequency of sea turtles. Thus, there is a low probability that sea turtles could experience exposure to sounds emitted by multibeam echosounder or sub-bottom profiler.

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 μPa^2s.

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 s 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). 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. 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 (Guerra et al. 2011), potentially interfering with the ability of animals to hear otherwise detectible sounds in their environment.

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 $\mu Pa_{p\text{-}p}$ (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). 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).

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. 1996a; McCauley et al. 2000a; McCauley et al. 2000b; McCauley et al. 2003; Popper et al. 2005; Santulli et al. 1999). Nedelec et al. (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 $\mu Pa_{p\text{-}p}$. 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 $\mu Pa_{0\text{-}p}$ and alarm responses at >177 dB re 1 $\mu Pa_{0\text{-}p}$ (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 $\mu Pa_{0\text{-}p}$. 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 $\mu Pa_{0\text{-}p}$ 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. 1996a). 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 $\mu Pa_{0\text{-}p}$, 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. (1996b) 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.

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. 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).

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 and sub-bottom profiler. We expect ESA-listed whales to experience ensonification from not only airguns, but also seafloor and ocean current mapping systems. 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 above and below the enter frequency 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). 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 or sub-bottom profiler 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, military activities, entrapment and entanglement, invasive species impacts, wind energy projects, entrainment in power plants, ship-strikes, pollution, scientific research, and harvests 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 by USGS 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 two 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 OBIS-SEAMAP and group size approach, we expect up to 2 blue, 6 fin, 6 sei, 41 humpback, 6 North Atlantic right, and 166 sperm whales could be exposed to airgun sounds during the course of the proposed seismic survey (2014 and 2015) which will elicit a behavioral response of temporarily moving out of the area. Under the approach using NMSDD maps, we expect up to 4 blue, 234 fin, 444 sei, 342 humpback, 3 North Atlantic right, and 4,213 sperm whales could be exposed to airgun sounds that would result in a similar response over the entirety of the seismic survey. We expect a low-level, transitory stress response to accompany this behavior. The number of individuals exposed based on the OBIS-SEAMAP and group size approach is expected to generally represent a small fraction of the populations. A larger proportion of sei and sperm whale populations would be expected to be exposed in the NMSDD map approach. 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.

The other actions we considered in the Opinion, the operation of multibeam echosounder and sub-bottom profiler 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 1,076 green, 180 hawksbill, 212 Kemp's ridley, 1,502 leatherback, and 1,728 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 and sub-bottom profiler systems, we do not expect direct effects from these systems on sea turtle fitness. We do not anticipate any indirect effects from the proposed actions to influence 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 Opinion that USGS's proposed seismic survey using the NSF's vessel off the U.S. East Coast 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 action 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 USGS and NMFS's Permits and Conservation Division so that they become binding conditions for USGS and 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. The final authorization will be issued and its mitigation and monitoring measures incorporated in this Incidental Take Statement as terms and conditions. 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 along the U.S. East Coast is likely to result in the incidental take of ESA-listed species by harassment. In this case, we evaluated exposure and take through two approaches for marine mammals, both of which had advantages and disadvantages, and a single approach for sea turtles. These approaches produced markedly different take estimates. Under the OBIS-SEAMAP and group size approach, we expect up to 2 blue, 6 fin, 6 sei, 41 humpback, 6 North Atlantic right, and 166 sperm whales could be exposed to airgun sounds during the course of the proposed seismic survey (2014 and 2015) which will elicit a behavioral response that would constitute harassment. Under an alternative analytical approach using NMSDD maps, we expect up to 4 blue, 234 fin, 444 sei, 342 humpback, 3 North Atlantic right, and 4,213 sperm whales could be exposed to airgun sounds that would result in a similar response over the entirety of the seismic survey. As detailed in the *Exposure Analysis*, all approaches have a large number of deficiencies that bring each into question as to being a best available approach. It was concluded that enough uncertainly exists that a single approach cannot be established as best. We also consider that our incidental take statement cannot exempt take where or to the extent that take is not authorized pursuant to the MMPA, as amended (16 U.S.C. 1371(a)(5)). As such, we cannot authorize more take for ESA-listed species than was included in the MMPA incidental harassment authorization.

We recognize that if we cannot identify a best approach, then we need to base our findings on what is the most conservative outcome for the ESA-listed resources in question. By authorizing the lowest estimated take numbers for each ESA-listed species as calculated from the various methods in front of us, it is reasonable to conclude that reinitiation will be triggered sooner than if larger estimates are adopted, thereby minimizing effects to ESA-listed species as a result of the proposed action. We acknowledge that this also means that future baseline conditions will not include the larger numbers associated with other approaches assessed here, which may impact the outcomes of future biological opinions. Based upon these considerations, the proposed action is expected to take by harassment 2 blue, 6 fin, 6 sei, 41 humpback, 3 North Atlantic right, and 166 sperm whales as well as 1,076 green, 180 hawksbill, 212 Kemp’s ridley, 1,502 leatherback, and 1,728 loggerhead sea turtles by exposing individuals to received seismic sound levels greater than 160 dB re 1 μPa by harassment (166 dB re 1 μPa for sea turtles) utilizing the group size approach (blue and sei), OBIS-SEAMAP approach (fin, humpback and sperm whales), and NMSDD map approach (North Atlantic right whales and sea turtles) over the course of the project (2014 and 2015 combined). 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 USGS, L-DEO, 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 or type, the USGS, 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 the USGS, L-DEO, and NMFS's authorization for the exemption in Section 7(o)(2) to apply. If the USGS, L-DEO, 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 USGS and L-DEO must implement and monitor 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 USGS, NSF, and L-DEO must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above. These terms and conditions are non-discretionary.

To be exempt from the prohibitions of Section 9 of the ESA, the NSF, USGS, L-DEO, and Permits and Conservation Division must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above and outlines the mitigation, monitoring and reporting measures required by the Section 7 regulations (50 CFR 402.14(i)). These terms and conditions are non-discretionary. If NSF, USGS, 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 Measures, the USGS, L-DEO, and the NMFS's Permits and Conservation Division shall ensure that:

<u>Mitigation and Monitoring Requirements</u>

A. Establish an exclusion zone corresponding to the anticipated 180 dB re 1 μPa_{rms} isopleth for full (6,600 in^3) and single (40 in^3) airgun operations as well as a 160 dB re 1 μPa_{rms} buffer zone in which to document take and conduct mitigation.

B. Use two, NMFS-approved, vessel-based observers to watch for and monitor marine mammals and sea turtles near the seismic source vessel during daytime airgun operations, 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 and 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. Observer shifts will last no longer than 4 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 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, USGS 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 30 minutes. If the observer sees no marine mammals or sea turtles 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 turtles 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 or sea turtles 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 three 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 available when technical issues occur during the survey.

F. 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 more than 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 180 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 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 30 min (mysticetes, large odontocetes, and sea turtles). The *Langseth* may operate a small-volume airgun (*i.e.*, mitigation airgun) during turns and maintenance 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 are 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.

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), USGS will cease operating seismic airguns and report the incident to NMFS's Office of Protected Resources at 301-427-8401 immediately. Airgun operation will then be postponed until NMFS is able to review the circumstances and work with USGS to determine whether modifications in the activities are appropriate and necessary. If the lead observer judged that the injury or mortality is not a result of the authorized activities, operations may continue.

M. In the event that USGS 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), USGS 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 Howard.Goldstein@noaa.gov, and (for marine mammals only) the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866-755-6622) and/or by email to the NMFS Greater Atlantic Regional Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) and/or by e-mail to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fourgeres@noaa.gov). Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with USGS to determine whether modifications in the activities are appropriate.

N. In the event that USGS discovers an injured or dead marine mammal or sea turtle, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e. g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), USGS 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 Howard.Goldstein@noaa.gov, and (for marine mammals only) the NMFS Greater Atlantic Marine Mammal Stranding Network (866-755-622), and/or by e-mail to the Greater Atlantic Regional Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Regional Stranding Network (877-433-8299), and/or by e-mail to the Southeast Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fourgeres@noaa.gov), within 24 hours of the discovery. USGS shall provide photographs or video footage (if available) or other documentation of the stranded mammal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

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:

B. 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 2014 activities and again after the completion of 2015 activities. The report would describe the proposed operations that were conducted and sightings of marine mammals and sea turtles within the vicinity of the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, and all marine mammal and sea turtle sightings (i.e., dates, times, locations, activities, associated seismic survey activities, and associated PAM detections). This report must also contain and summarize the following information:

1. Summaries of monitoring effort – total hours, total distances, and distribution of marine mammals and sea turtles through the study period accounting for Beaufort sea state and wind force, and other factors affecting visibility and detectability of marine mammals and sea turtles;

2. Analyses of the effects of various factors influencing detectability of marine mammals and sea turtles including Beaufort sea state and wind force, number of observers, and

fog/glare;

3. Species composition, occurrence, and distribution of marine mammal and sea turtle sightings including date, water depth, numbers, age/size/gender, and group sizes; and analyses of the effects of seismic operations;
4. Sighting rates of marine mammal and sea turtles during periods with and without airgun activities (and other variables that could affect detectability);
5. Initial sighting distances versus airgun activity state;
6. Closest point of approach versus airgun activity state;
7. Observed behaviors and types of movements versus airgun activity state;
8. Numbers of sightings/individuals seen versus airgun activity state; and
9. Distribution around the source vessel versus airgun activity state.
10. The report would also include estimates of the number and nature of exposures that could result in "takes" of marine mammals and sea turtles by harassment or in other ways.

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 and fishes:

1. *Effects of seismic noise on sea turtles.* The NSF and USGS 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 USGS and L-DEO on board the *R/V Langseth* in the Atlantic Ocean off the U.S. East Coast, 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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