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
in association with YOLO Environmental Inc., GeoSpatial Strategy Group, and Ecology and Environment Inc.

Contributing Authors:

Sue Belford (YOLO)
Kent Simpson (GeoSpatial)
Sara Bowman (E&E)
David Trimm (E&E)
Tony LaPierre (RPS)
Teresa Trenck (RPS)
Jonathan R. Childs (USGS)

August 2014

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS vi

EXECUTIVE SUMMARY viii

1 INTRODUCTION 1

1.1 PURPOSE AND NEED FOR THE PROJECT 3

1.2 REGULATORY CONTEXT 5

1.3 COORDINATION WITH OTHER AGENCIES 5

1.4 ENVIRONMENTAL ASSESSMENT SCOPE AND METHODOLOGY 7

1.5 APPROACH 8

1.6 SCOPE OF THE ASSESSMENT 8

1.6.1 Scoping Requirements 11

1.7 ASSESSMENT METHODOLOGY 12

1.7.1 Identification of Valued Environmental Components 12
1.7.2 Description of Existing Conditions 13
1.7.3 Study Area 13
1.7.4 Temporal, Spatial and Ecological Boundaries and Study Area 14
1.7.5 Analysis, Mitigation and Environmental Effects 15

1.8 FOLLOW-UP AND MONITORING 15

1.9 CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT 15

2 PROPOSED ACTION AND ALTERNATIVES 17

2.1 PROJECT OVERVIEW 17

2.2 PROJECT LOCATION 18

2.3 PROJECT COMPONENTS 18

2.3.1 Seismic Vessel 20
2.3.2 2D Seismic Towed Array and Hydrophone Streamer 22
2.3.3 Multibeam Echosounder and Sub-bottom Profiler 23

2.4 ALTERNATIVES TO THE PROJECT 27

2.4.1 No Action 27
2.4.2 Alternative Time 28
2.4.3 Alternative Technologies 28

3 AFFECTED ENVIRONMENTS 30

3.1 METOCEAN DATA 30

3.2 GEOLOGY AND SEDIMENTOLOGY AND SEDIMENTARY BASINS 32

3.3 UNDERWATER SOUND ENVIRONMENT 32

3.4 PROTECTED AREAS 32

3.5 MARINE MAMMALS 33

3.5.1 ESA-listed Cetacean Species 50

3.6 MARINE AND MIGRATORY BIRDS 51

3.6.1 ESA-listed Bird Species 53

3.7 MARINE FISH 55

3.7.1 Demersal Fish 55
3.7.2 Pelagic Fish 55
3.7.3 Fish Species Listed as Threatened or Endangered 56
3.7.4 Fish Eggs and Larvae 56

3.8 BENTHIC INVERTEBRATES 57

3.8.1 Deep-Sea Corals and Sponges 57
3.8.2 Essential Fish Habitat 59

3.9 SEA TURTLES 61

3.10 OCEAN RESOURCE USERS 68

3.10.1 Navy Operation Areas 68
3.10.2 Marine Traffic 71
3.10.3 Petroleum 73
3.10.4 Submarine Cables 76
3.10.5 Commercial and Recreational Fisheries 78

4 ENVIRONMENTAL CONSEQUENCES 89

4.1 PROPOSED ACTION 89

4.2 NOISE EMISSIONS 89

4.2.1 Sound Effect Criteria 90
4.2.2 Exclusion Zone 91
4.2.3 Direct Effects on Mysticetes, Odontocetes, and Pinnipeds 92
4.2.4 Direct Effects on Marine Birds 100
4.2.5 Direct Effects on Marine Fish, Marine Shellfish, and Essential Fish Habitat 100
4.2.6 Direct Effects on Sea Turtles 101
4.2.7 Direct Effects on Fisheries 102
4.2.8 Indirect Effects on Marine Mammals and Sea Turtles 103
4.2.9 Conclusions for Marine Mammals and Sea Turtles 103
4.2.10 Conclusions for Invertebrates, Fish and Fisheries 104
4.2.11 Conclusions for Seabirds 104
4.2.12 Conclusions for Essential Fish Habitat 104

4.3 NON-ACOUSTIC DIRECT EFFECTS 104

4.3.1 Disturbance by Vessel Presence 104
4.3.2 Collisions 104
4.3.3 Entanglement with Towed/Deployed Gear 105
4.3.4 Waste Discharges 105
4.3.5 Potential Malfunctions and Accidental Events 107
4.3.6 Additional Safety concerns for *R/V Langseth* 108

4.4 ANALYSIS OF ALTERNATIVES – ALTERNATIVE ACTION: ANOTHER TIME 108

4.5 ANALYSIS OF ALTERNATIVES – NO ACTION ALTERNATIVE 109

5 CUMULATIVE EFFECTS 110

5.1 CUMULATIVE EFFECTS OF PROPOSED TWO-CRUISE (2014, 2015) SEISMIC PROGRAM 110

5.2 METHODOLOGY FOR THE CUMULATIVE EFFECTS ANALYSIS 111

6 SUMMArY of MITIGATION 118

7 LITERATURE CITED 120

8 LIST OF PREPARERS 130

9 Appendix A: Acoustic Modeling of Seismic Source 131

10 Appendix B: Request for an Incidental Harassment Authorization 136

11 Appendix C: Description of NSF New Jersey and GeoPRISMS/ENAM Surveys. 137

12 Appendix D: NMFS Consultation (Essential Fish Habitat) 138

13 Appendix E: USFWS Consultation (Endangered Species Act) 139

14 Appendix F: Federal Register Notice (NMFS, IHA Application) 140

15 Appendix G: Comments Received in Response to NMFS FR Notice 141

TABLE OF FIGURES

Figure 1: Study Area with Bathymetry 1

Figure 2: Study Area with NSF/USGS PEIS NW Atlantic detailed analysis area and BOEM Atlantic OCS G&G PEIS Area of Interest 10

Figure 3: 2D Seismic Lines (2014 and 2015) 17

Figure 4: Seismic vessel and towed system (Source NSF/USGS PEIS) 19

Figure 5: Survey Vessel *R/V Marcus G. Langseth* 21

Figure 6: Study Area with Bathymetry 30

Figure 7: Gulf Stream 31

Figure 8: Marine Protected Areas and the Proposed Study Area 33

Figure 9: Baleen Whales (regular occurrence, multiyear observations) 35

Figure 10: Baleen Whales (rare occurrence, multiyear observations) 36

Figure 11: North Atlantic Right Whale Seasonal Distribution and Habitat Use 37

Figure 12: Toothed Whales (regular occurrence, multiyear observations) 38

Figure 13: Toothed Whales (rare occurrence, multiyear observations) 39

Figure 14: Dolphins and Porpoises (regular occurrence, multiyear observations) 40

Figure 15: Dolphins and Porpoises (rare occurrence, multiyear observations) 41

Figure 16: Deep-sea Corals 58

Figure 17: Seafloor Sediment 60

Figure 18: Seasonal Distribution of Loggerhead Turtles (multiyear observations) 62

Figure 19: Seasonal Distribution of Green Turtles (multiyear observations) 63

Figure 20: Seasonal Distribution of Hawksbill Turtles (multiyear observations) 64

Figure 21: Seasonal Distribution of Kemp's Ridley Turtles (multiyear observations) 65

Figure 22: Seasonal Distribution of Leatherback Turtles (multiyear observations) 66

Figure 23: Navy Operation Areas 69

Figure 24: Unexploded Ordnance 70

Figure 25: Marine Traffic 71

Figure 26: Ports and Terminals 73

Figure 27: LNG Deepwater Ports 75

Figure 28: Submarine Cables 77

Figure 29: Primary Red Crab Fishing Grounds and Closed PLL Areas 79

Figure 30: Tuna Catch Levels (mt) within the Project Area 81

Figure 31: Swordfish Catch Levels (mt) within the Project Area 82

Figure 32: Marlin Catch Levels (mt) within the Project Area 83

TABLE OF TABLES

Table 1: Responsible Regulatory Agencies and Legislation 5
Table 2: Resource Components Determined to Require No Further Analysis 11
Table 3: Selection of Environmental and Socio-economic Components 12
Table 4: Potential Project - Environment Interaction Matrix 15
Table 5: Geographic Location of Survey 18
Table 6: Seismic Equipment and Survey Parameters 22
Table 7: Summary of Key Monitoring and Mitigation Measures 23
Table 8: Marine Mammals Occurring in the Study and Regional Areas 42
Table 9: ESA-listed Marine Mammal Species that May Occur in the Study Area 50
Table 10: Conservation Status and Sightings of Seabirds That May Occur In or Near the Proposed Study Area 51
Table 11: ESA-listed Bird Species That May Occur in the Study Area 54
Table 12: ESA-listed Sea Turtles That May Occur the Proposed Study Area 67
Table 13: Reported Landings (mt) in the U.S. Atlantic Pelagic Longline Fishery (2002-2011) 84
Table 14: U.S. vs. International Catch of HMS Reported to ICCAT in 2011 86
Table 15: Estimated International Atlantic Tuna Landings (mt ww) 87
Table 16: Injury and Behavior Exposure Criteria for Cetaceans 91
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 91
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 98
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 99
Table 20: Summary of Seismic Vessel Related Emissions and Discharges 105
Table 21: Scoping of Offshore Activities and Interactions with the Survey Project 111
Table 22: Assessment of Cumulative Effects 115
Table 23: Environmental Factor-Specific Mitigation Measures and Follow-Up 118

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.

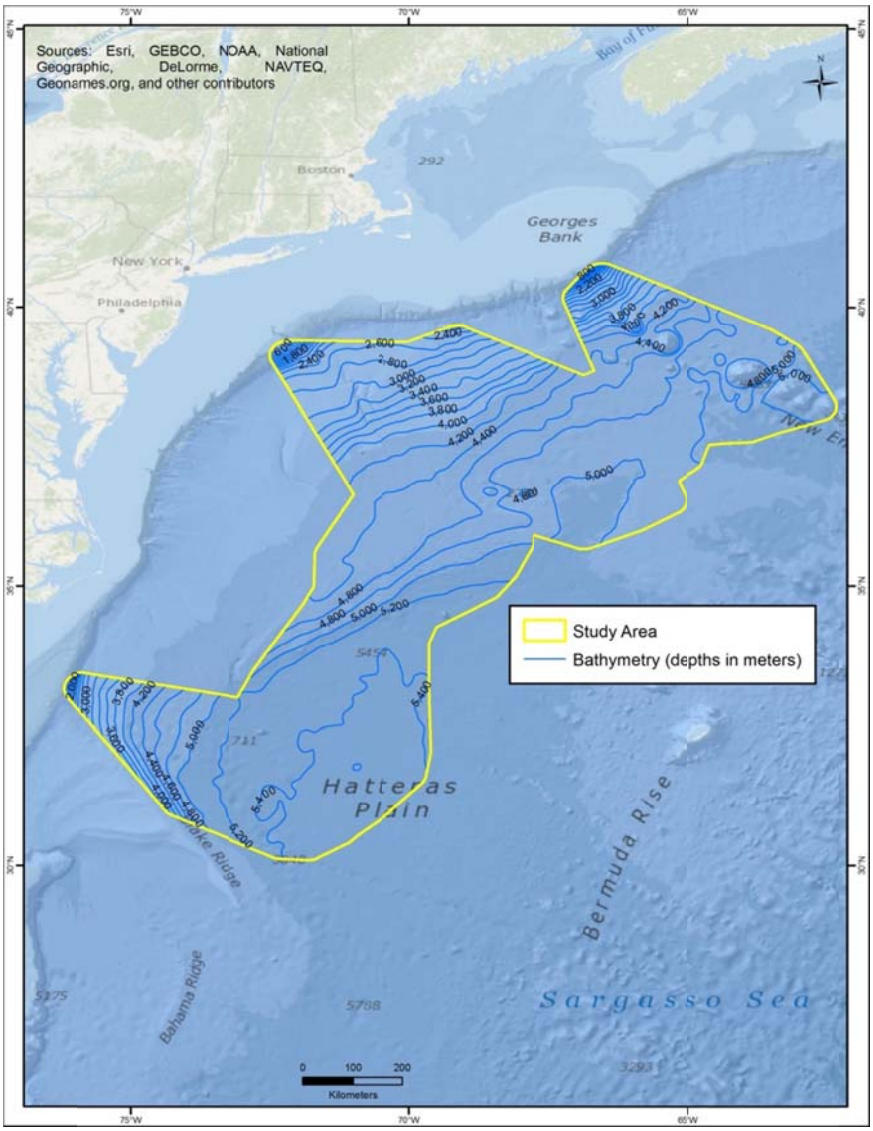


Figure 1: Study Area with Bathymetry

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.

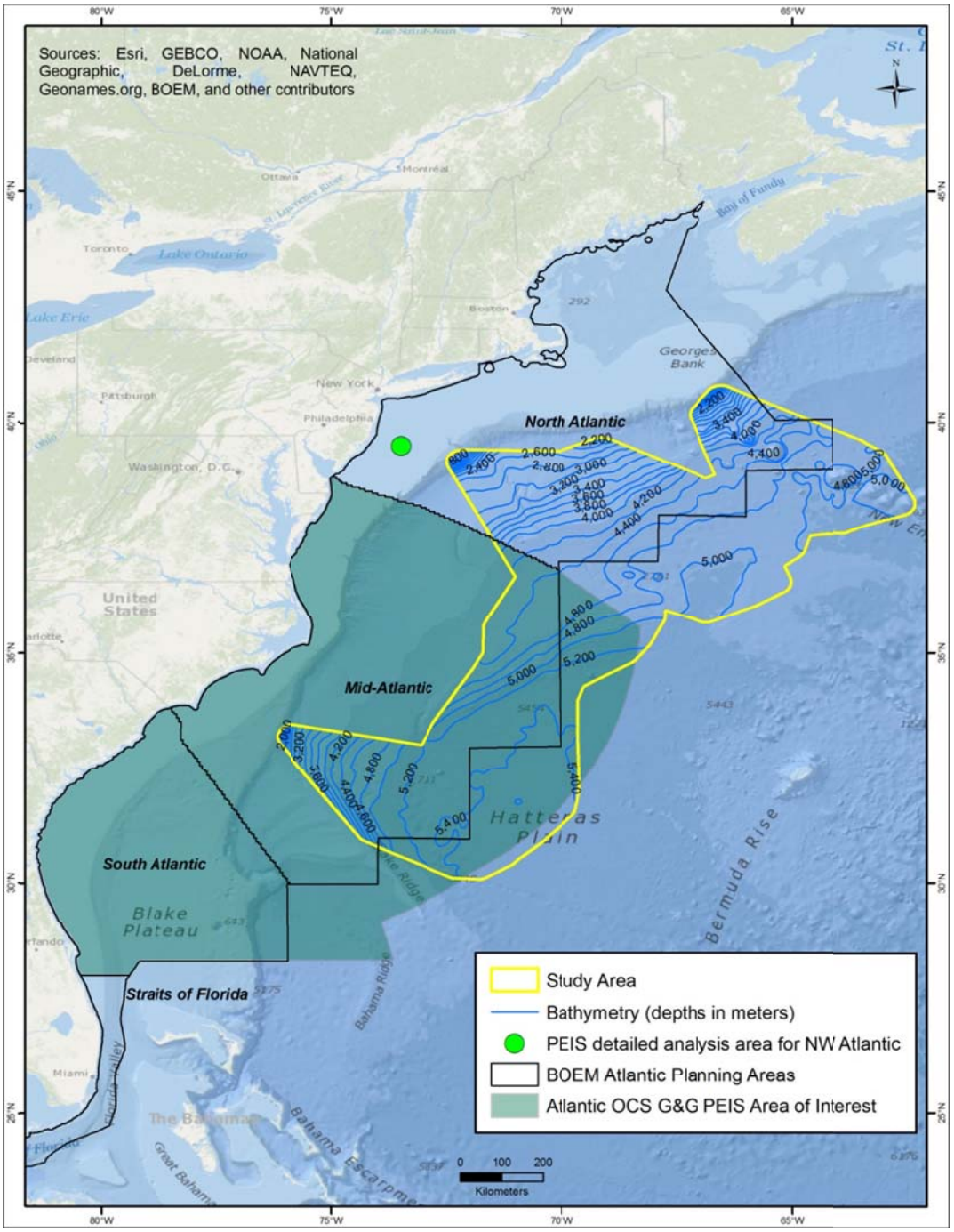


Figure 2: Study Area with NSF/USGS PEIS NW Atlantic detailed analysis area and BOEM Atlantic OCS G&G PEIS Area of Interest

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.

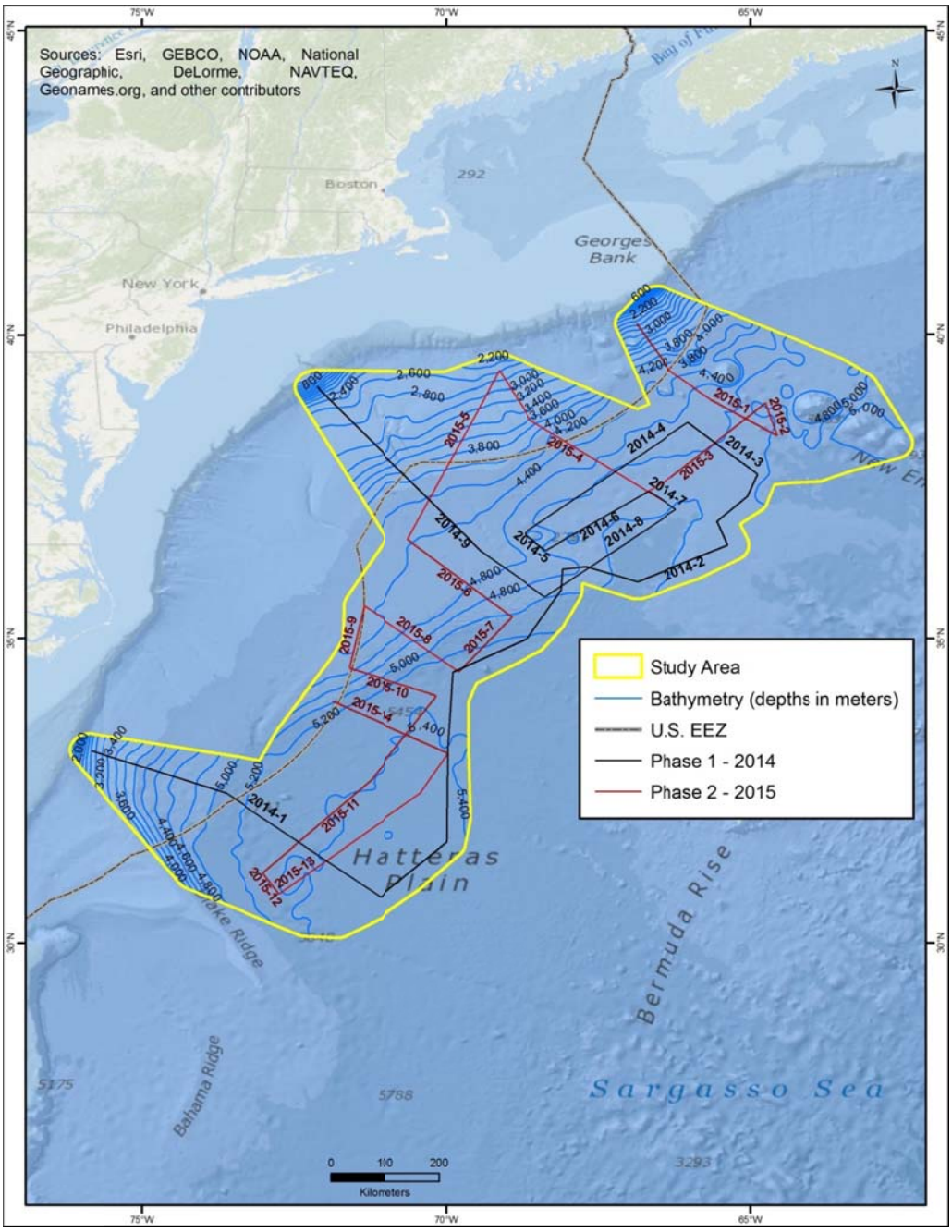


Figure 3: 2D Seismic Lines (2014 and 2015)

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.

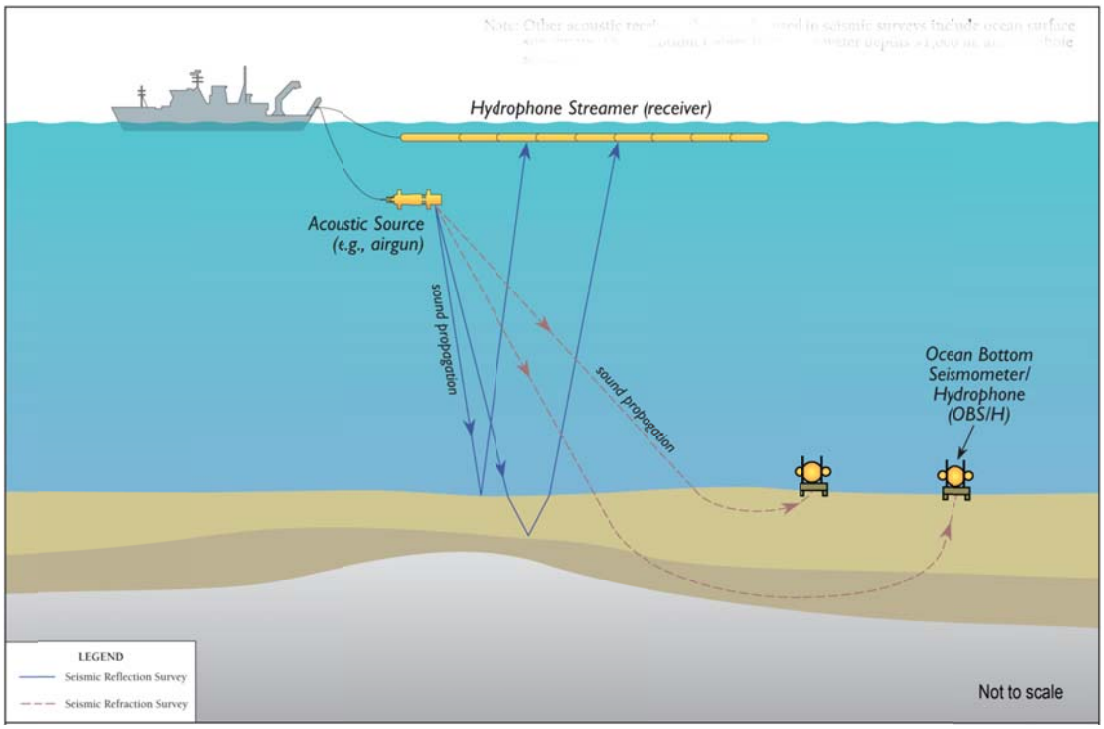


Figure 4: Seismic vessel and towed system (Source NSF/USGS PEIS)

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).

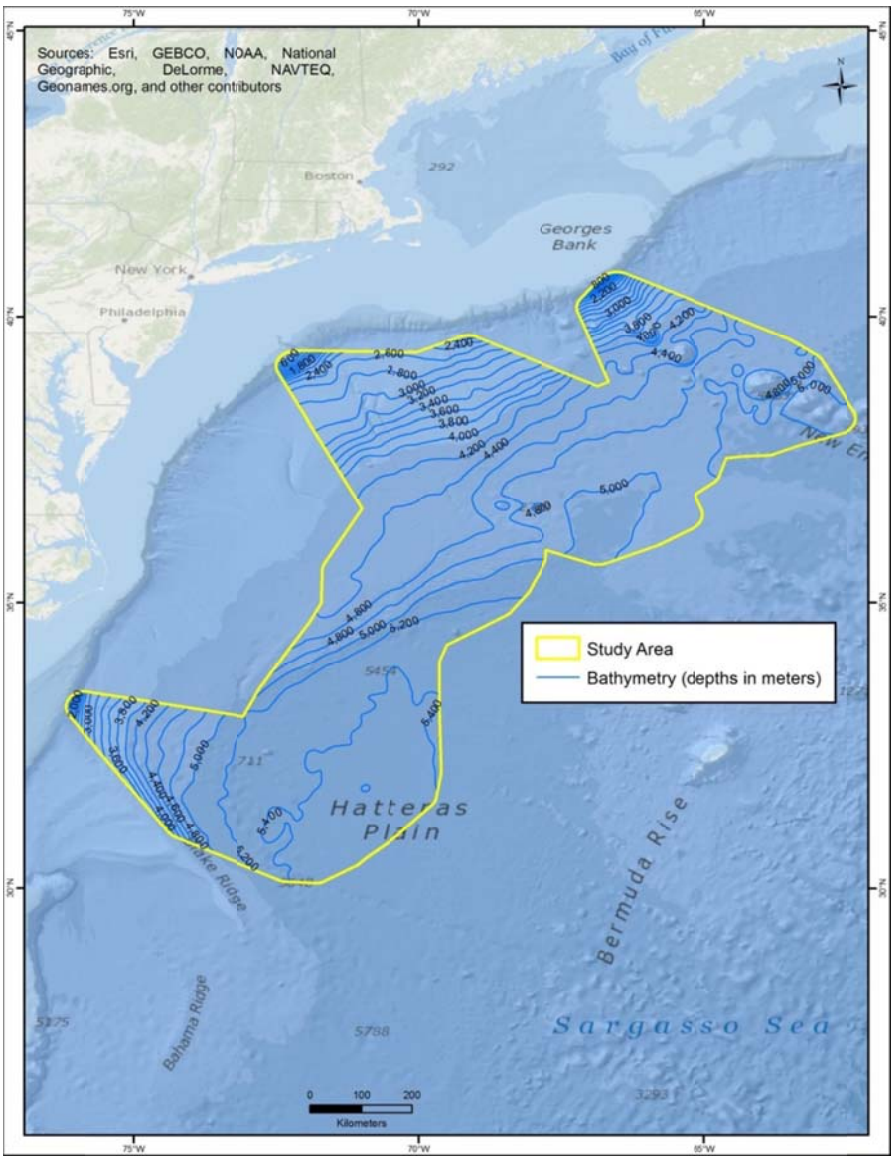


Figure 6: Study Area with Bathymetry

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).

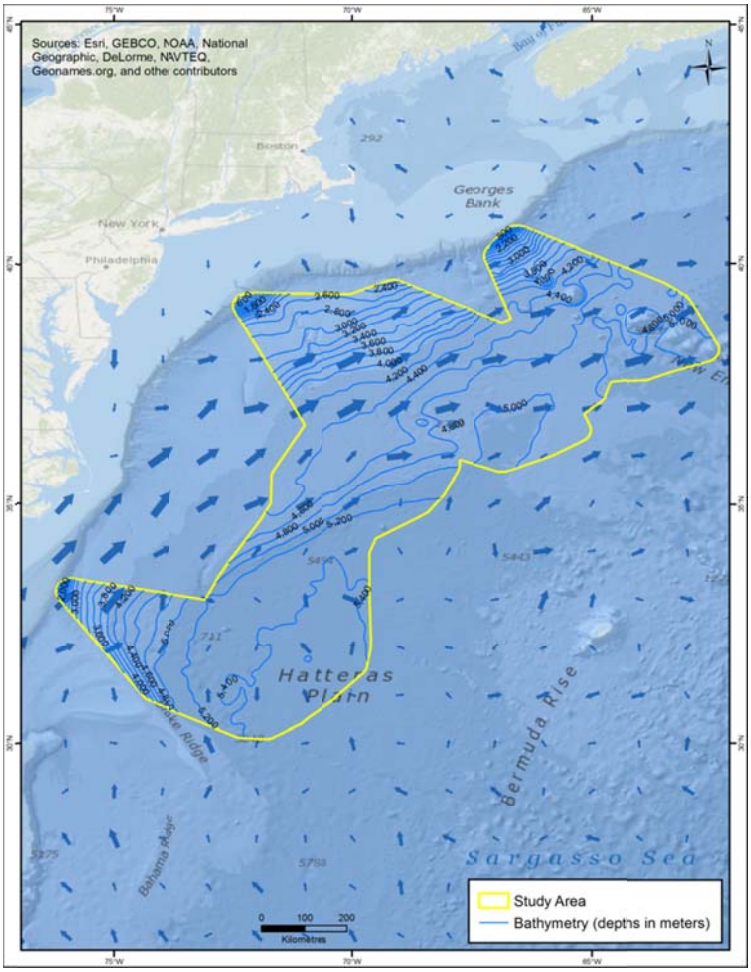


Figure 7: Gulf Stream

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.

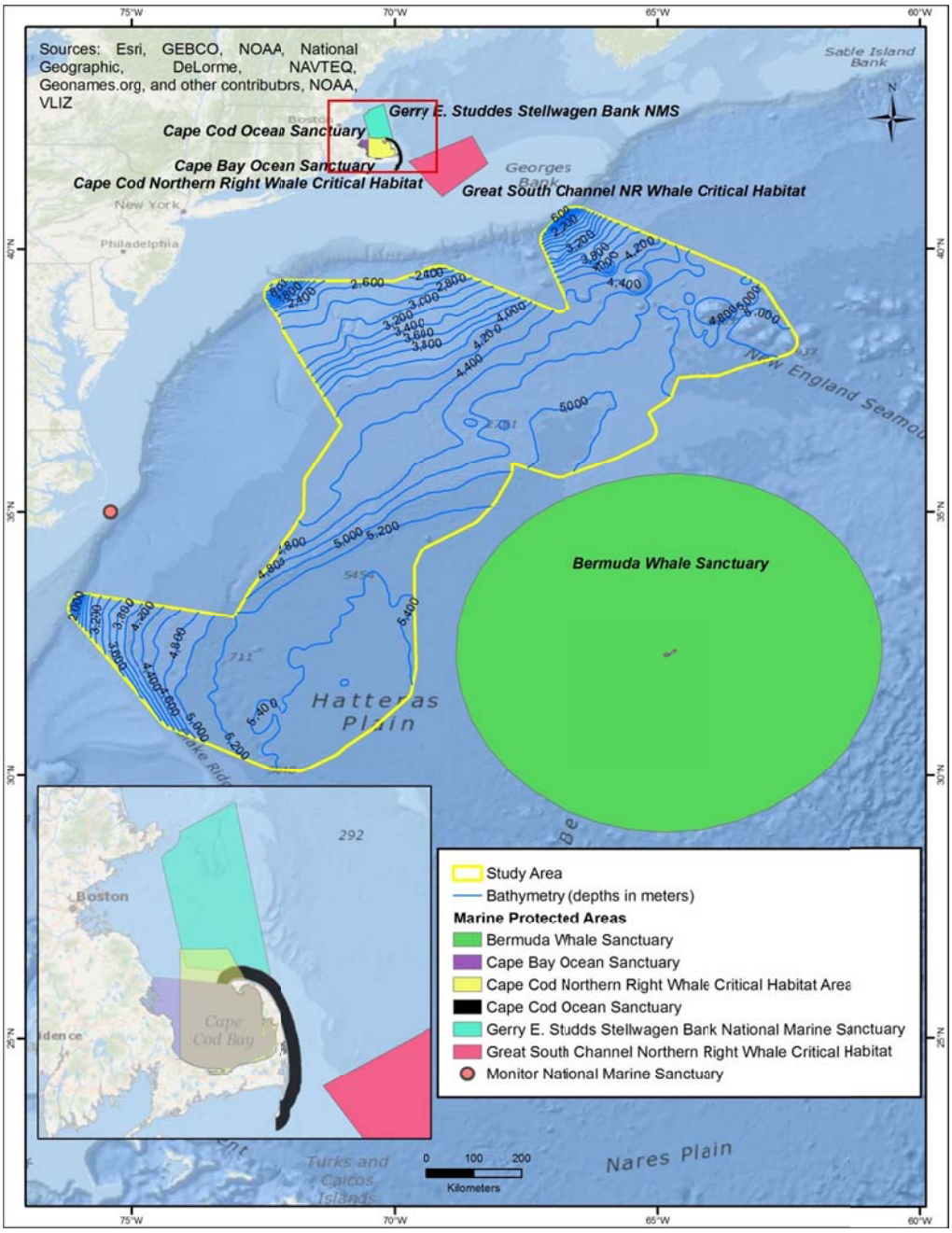


Figure 8: Marine Protected Areas and the Proposed Study Area

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).

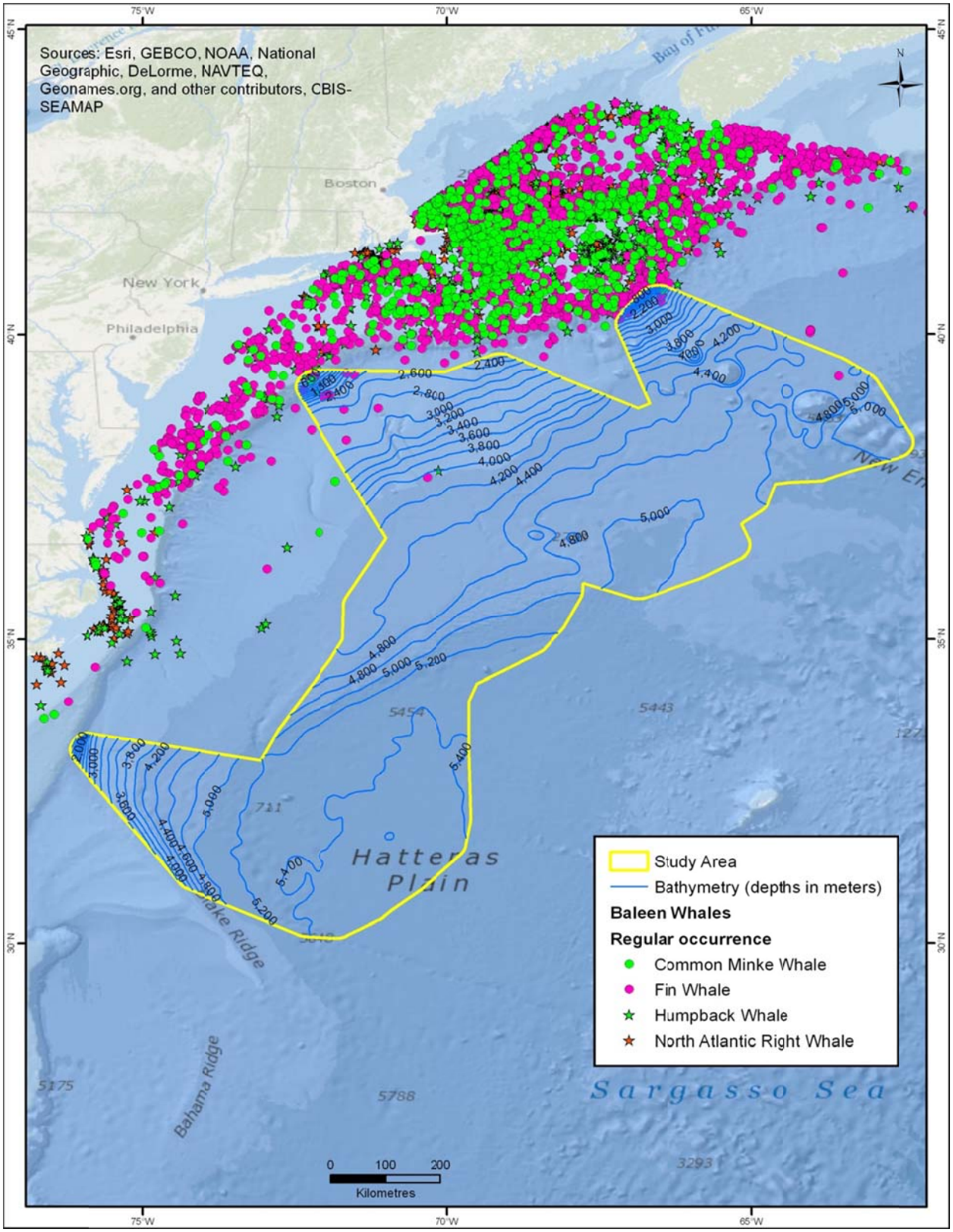


Figure 9: Baleen Whales (regular occurrence, multiyear observations)

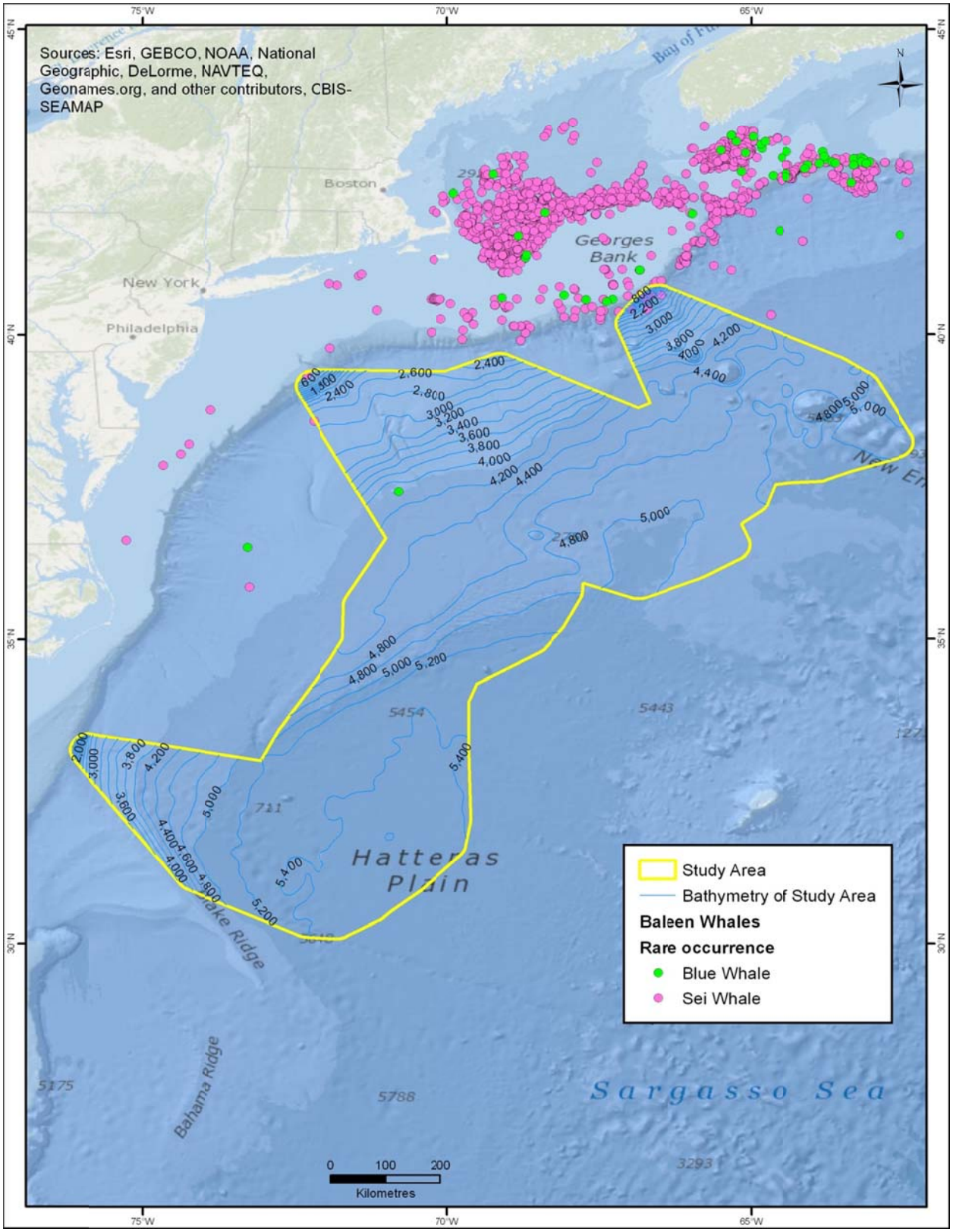


Figure 10: Baleen Whales (rare occurrence, multiyear observations)

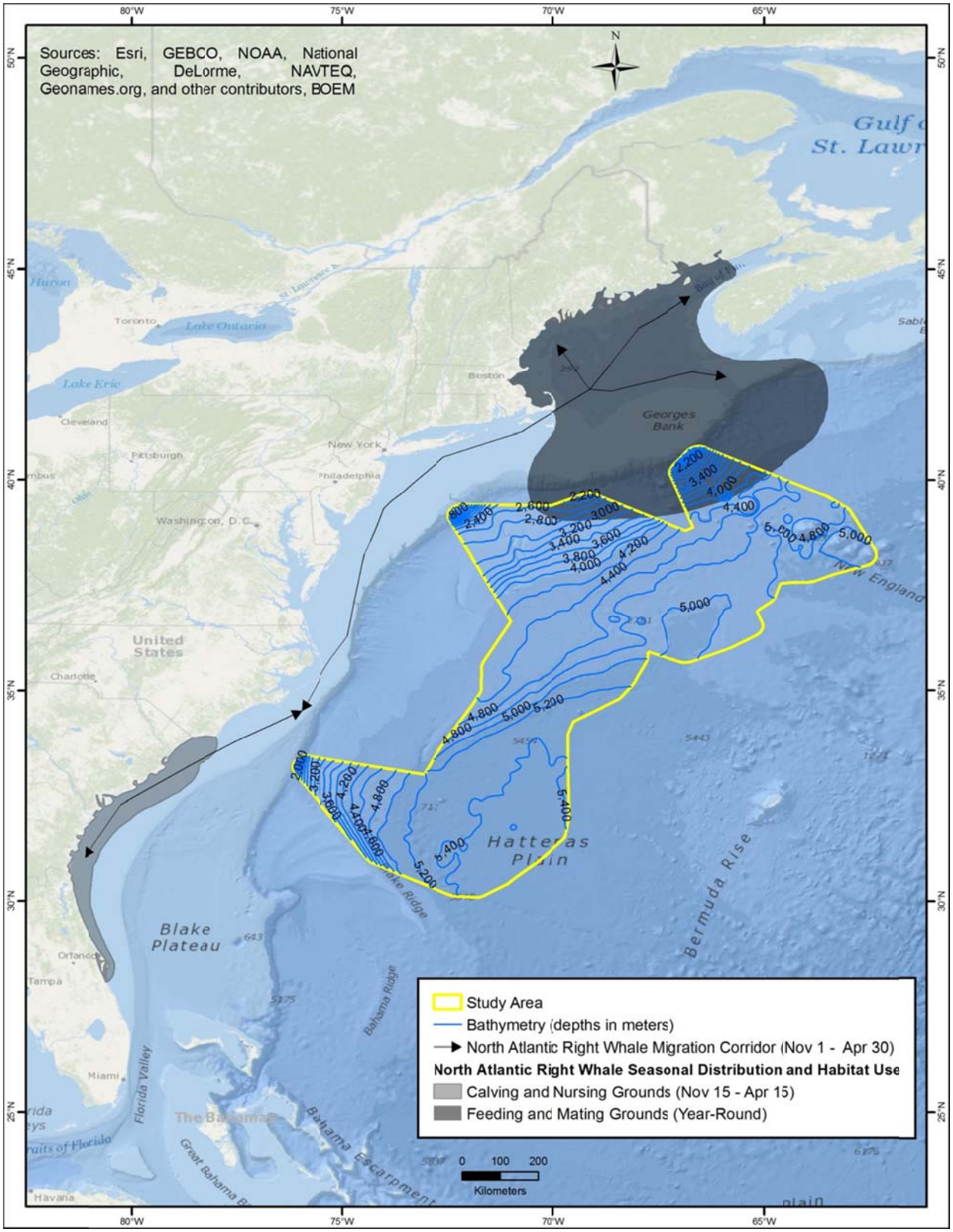


Figure 11: North Atlantic Right Whale Seasonal Distribution and Habitat Use

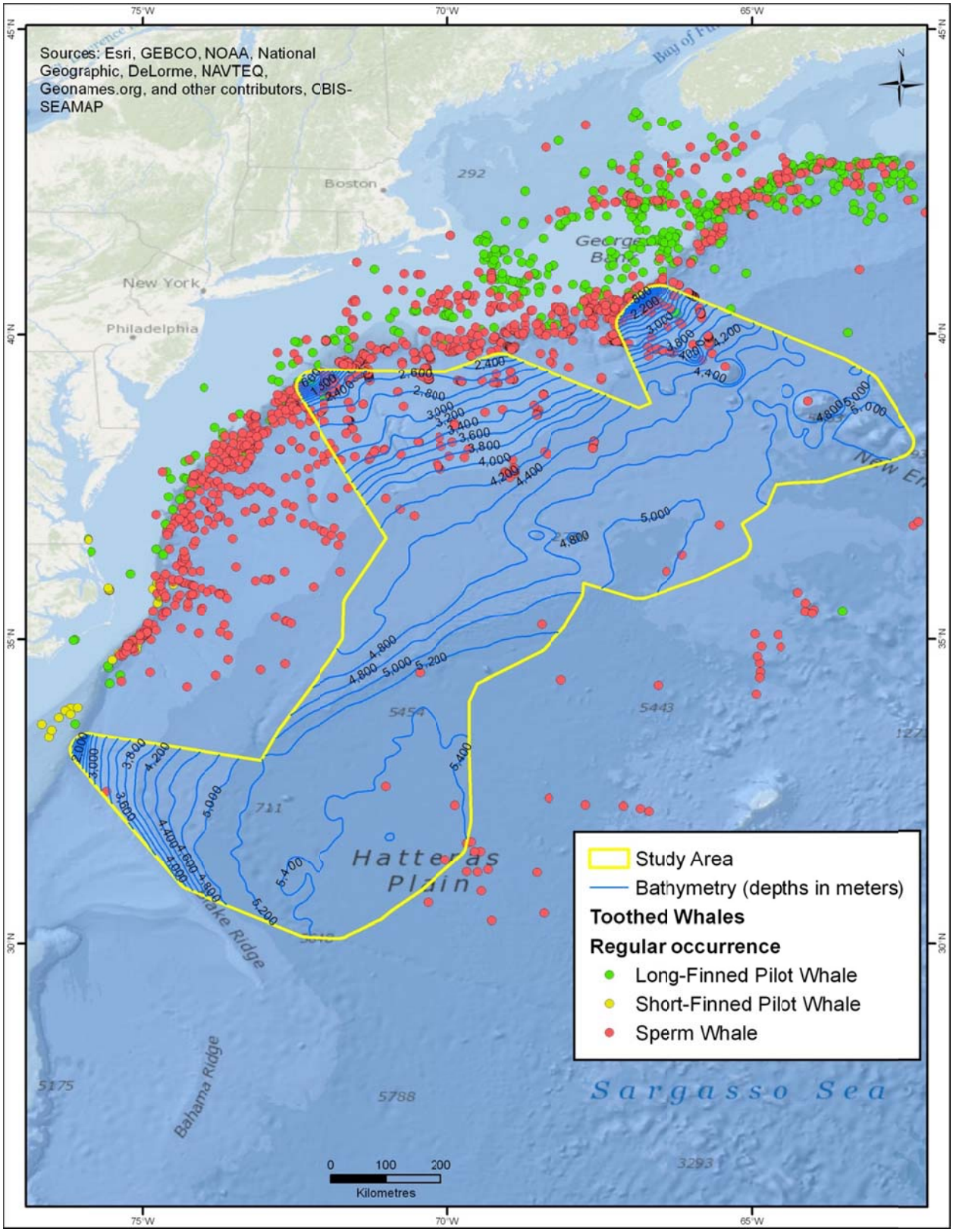


Figure 12: Toothed Whales (regular occurrence, multiyear observations)

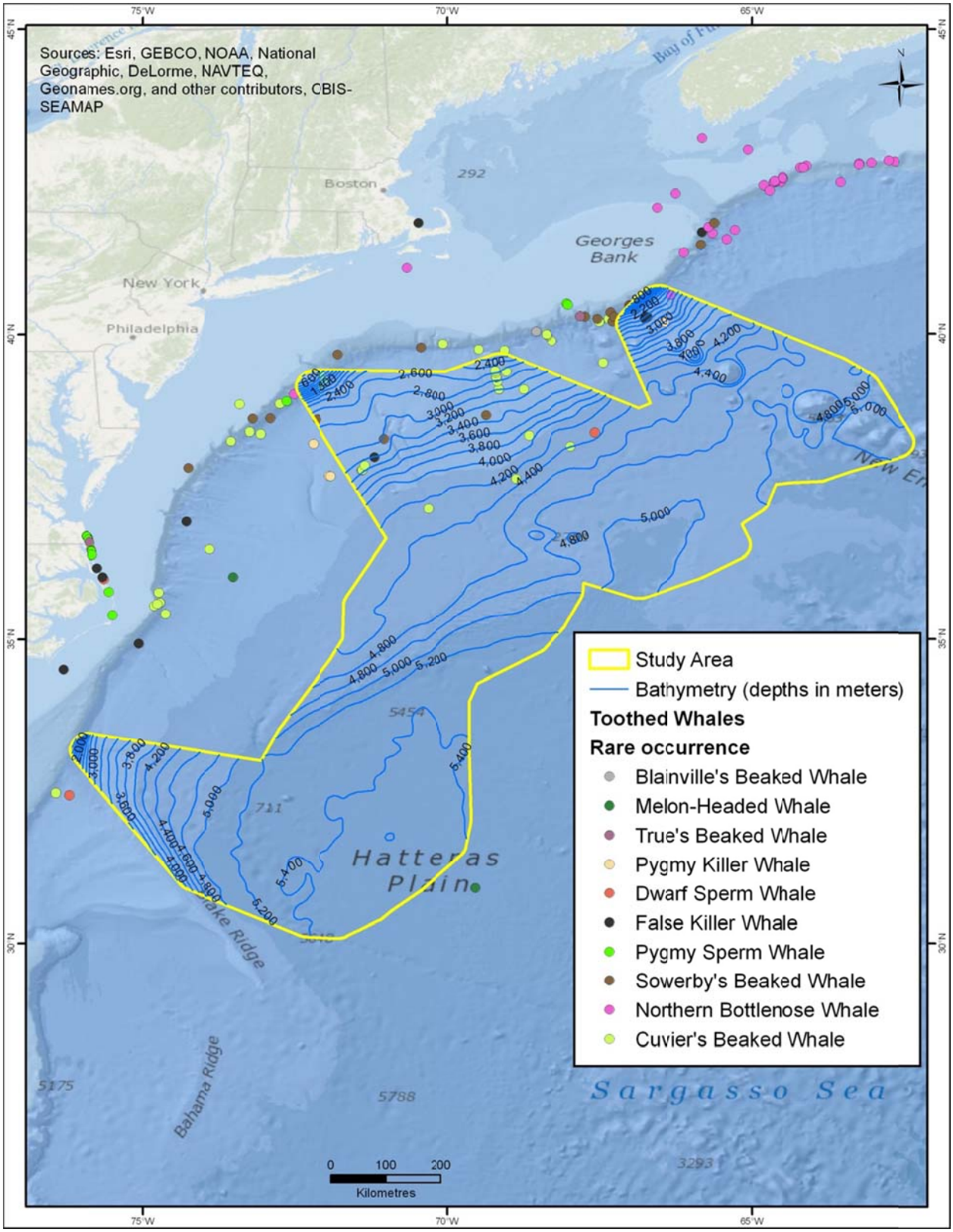


Figure 13: Toothed Whales (rare occurrence, multiyear observations)

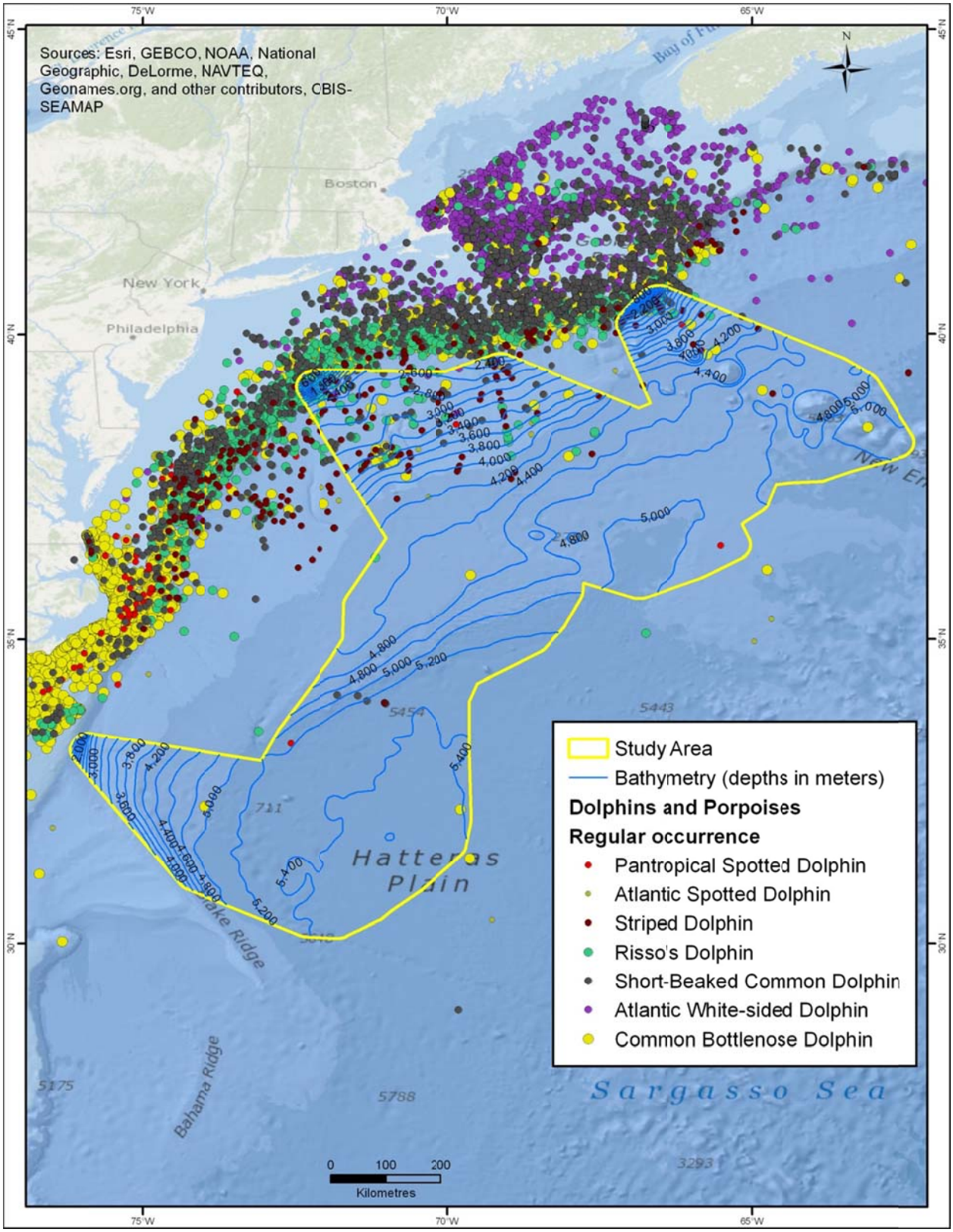


Figure 14: Dolphins and Porpoises (regular occurrence, multiyear observations)

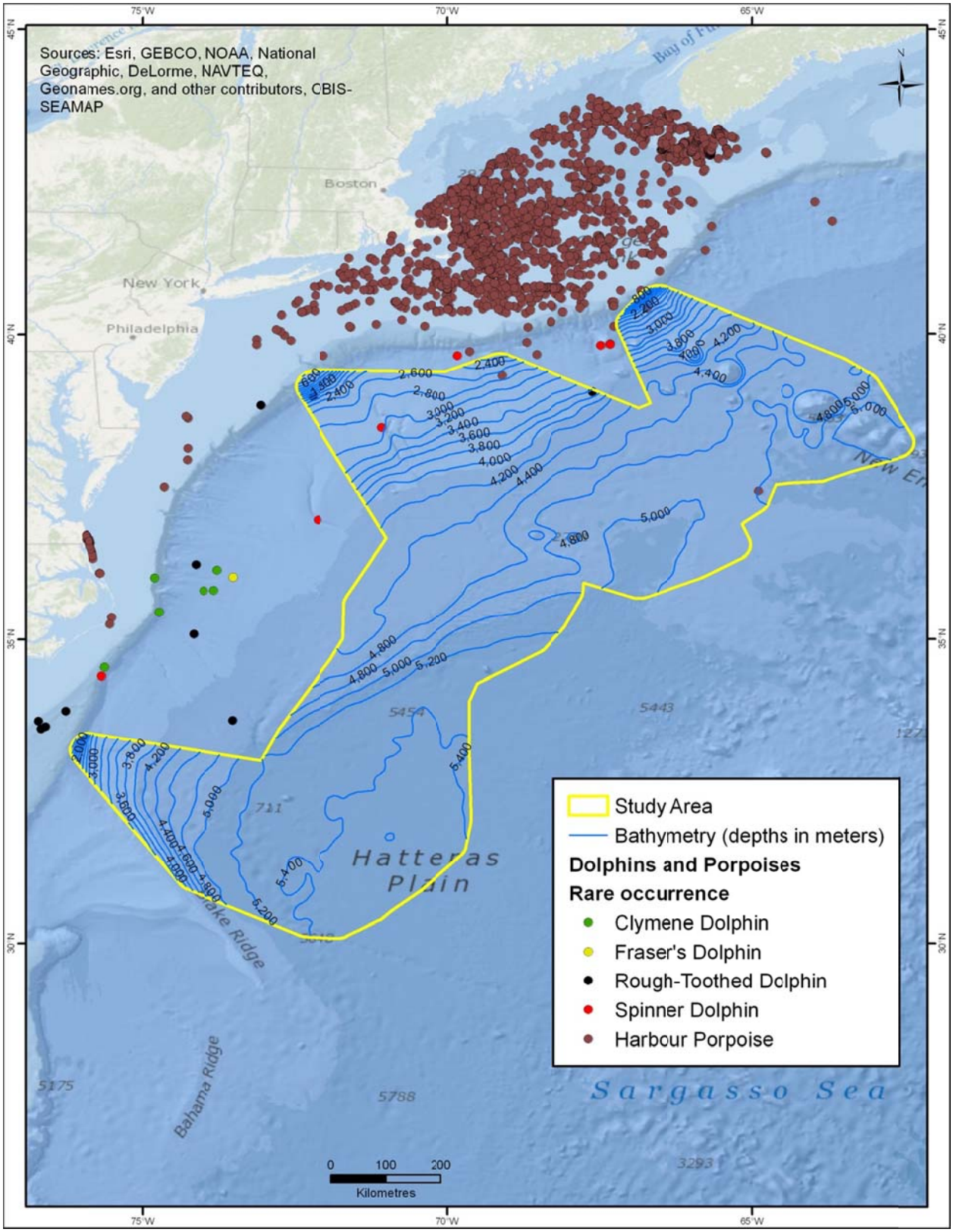


Figure 15: Dolphins and Porpoises (rare occurrence, multiyear observations)

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).

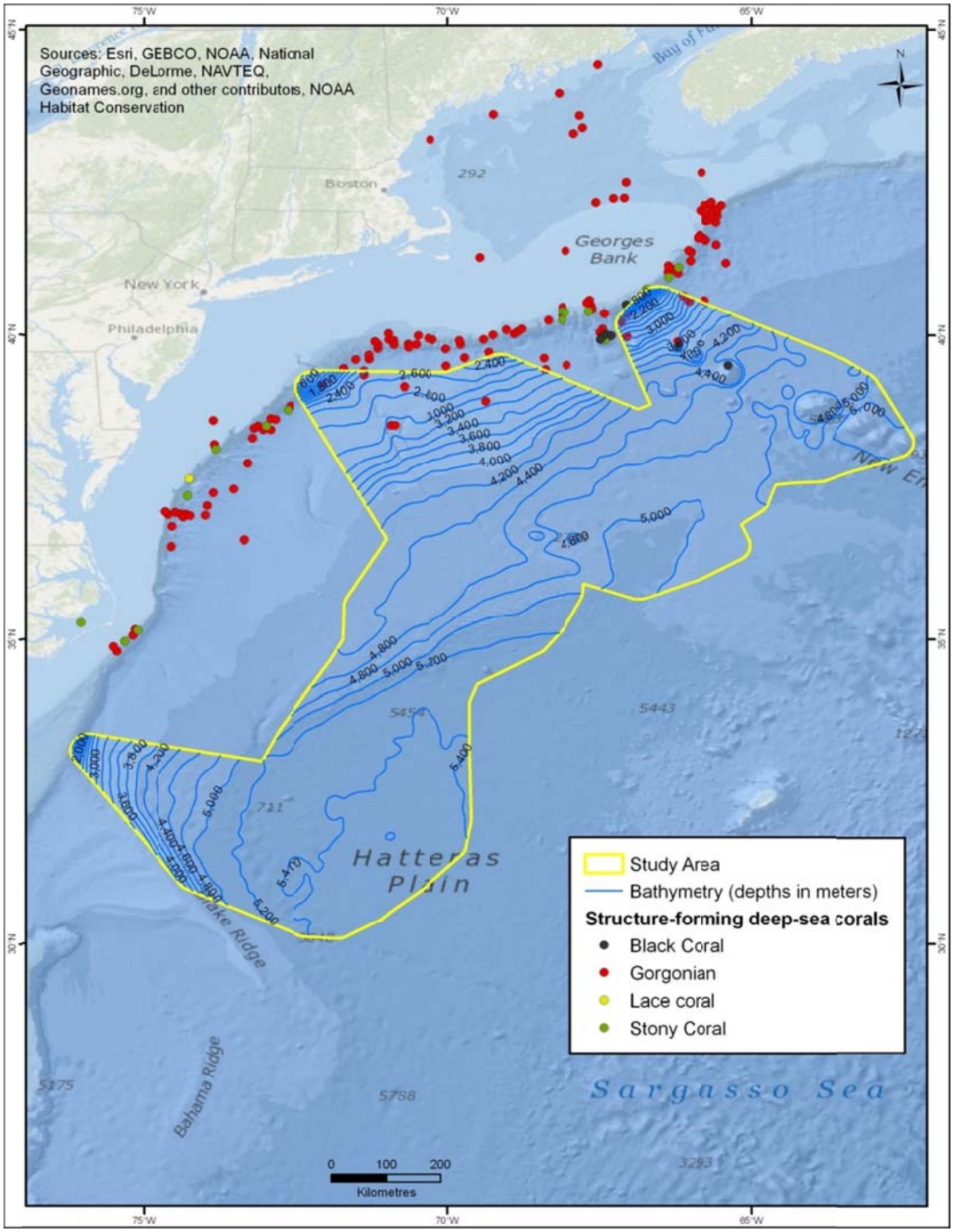


Figure 16: Deep-sea Corals

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.

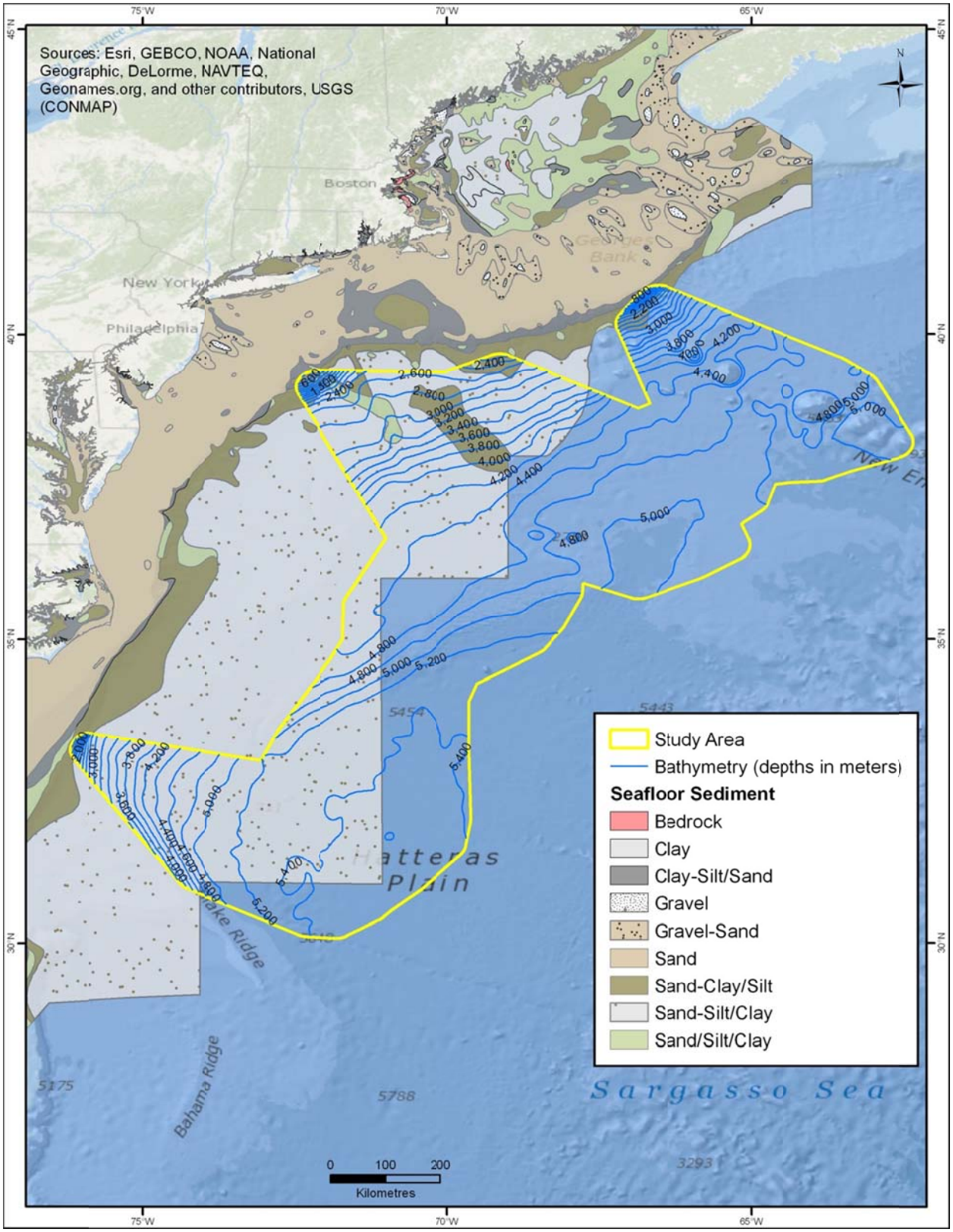


Figure 17: Seafloor Sediment

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.

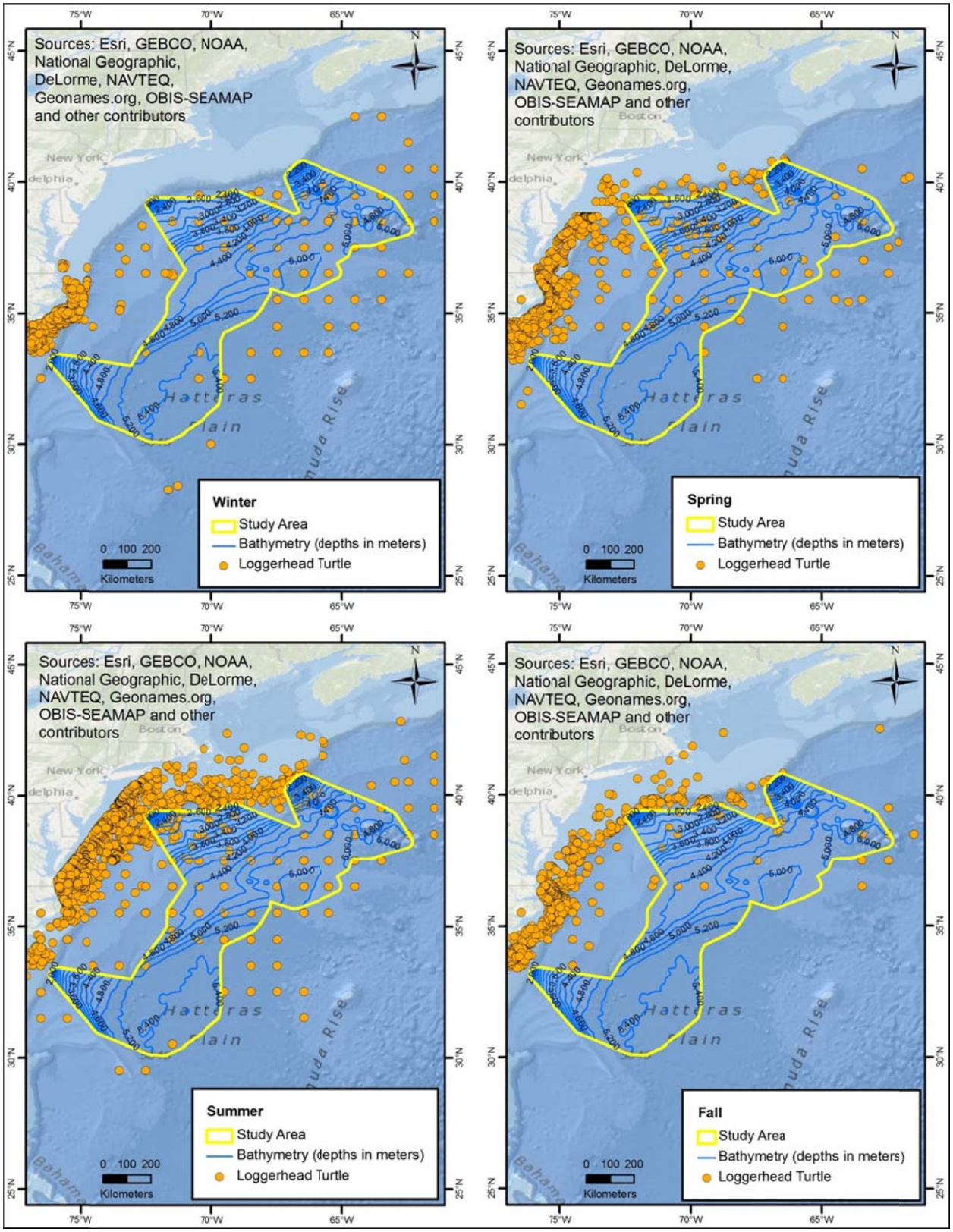


Figure 18: Seasonal Distribution of Loggerhead Turtles (multiyear observations)

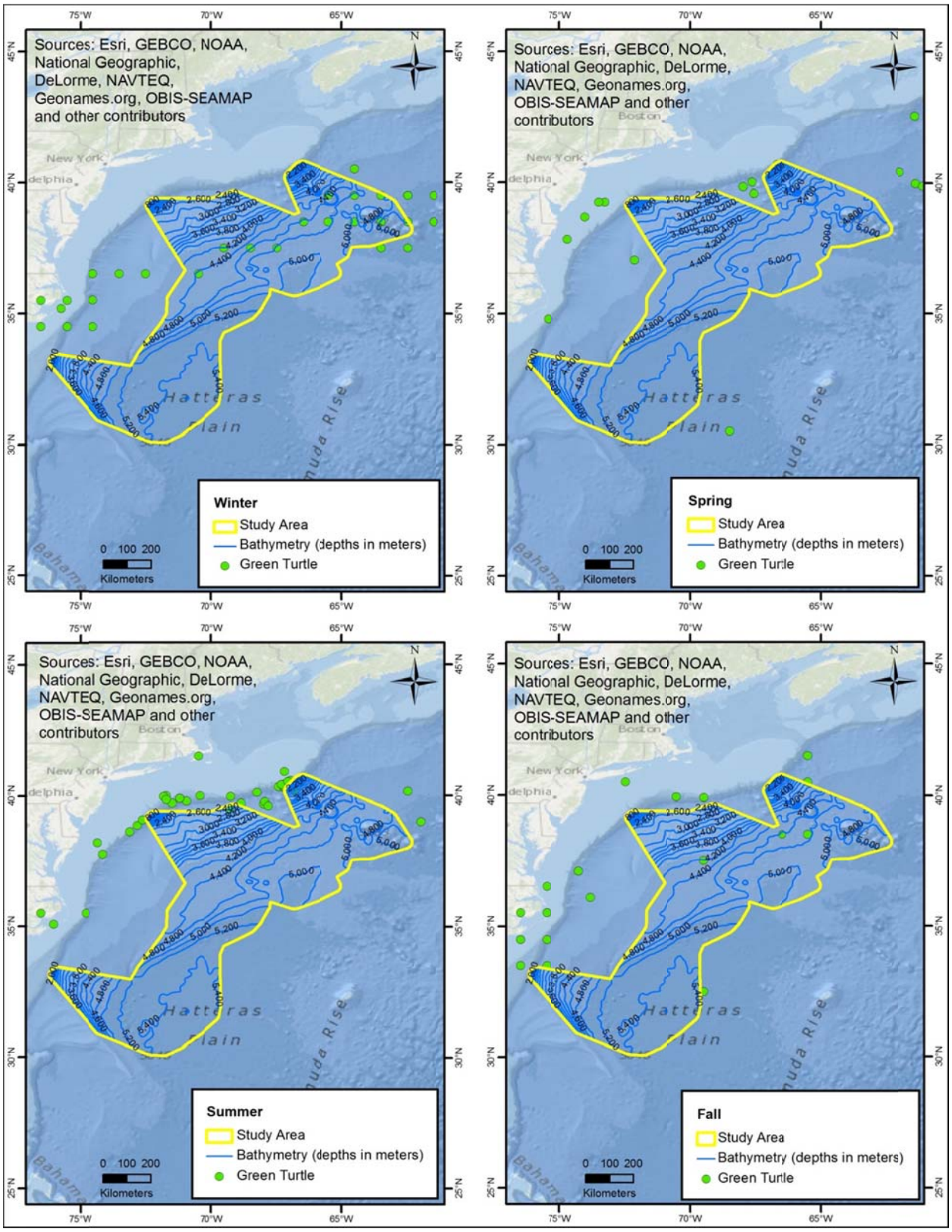


Figure 19: Seasonal Distribution of Green Turtles (multiyear observations)

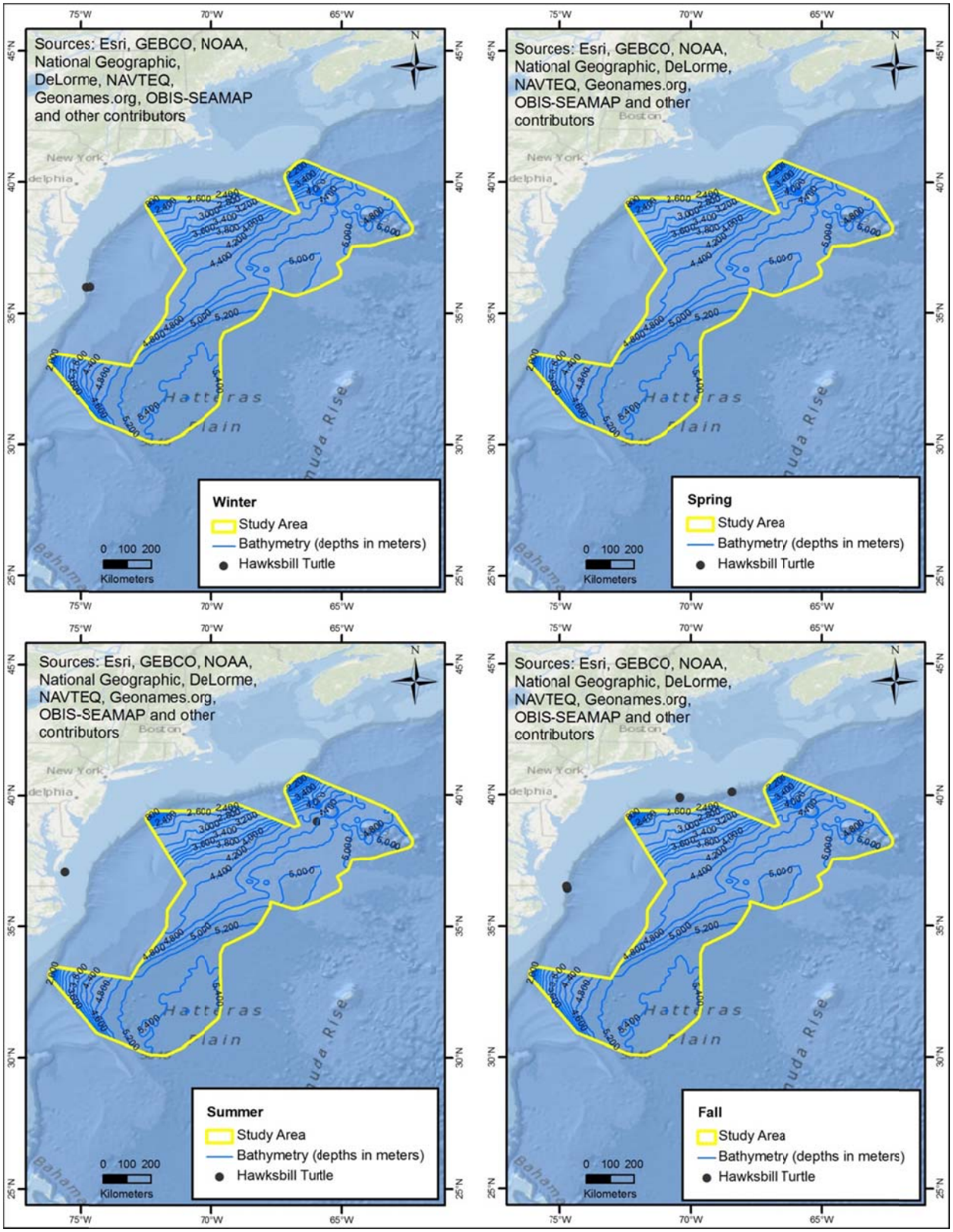


Figure 20: Seasonal Distribution of Hawksbill Turtles (multiyear observations)

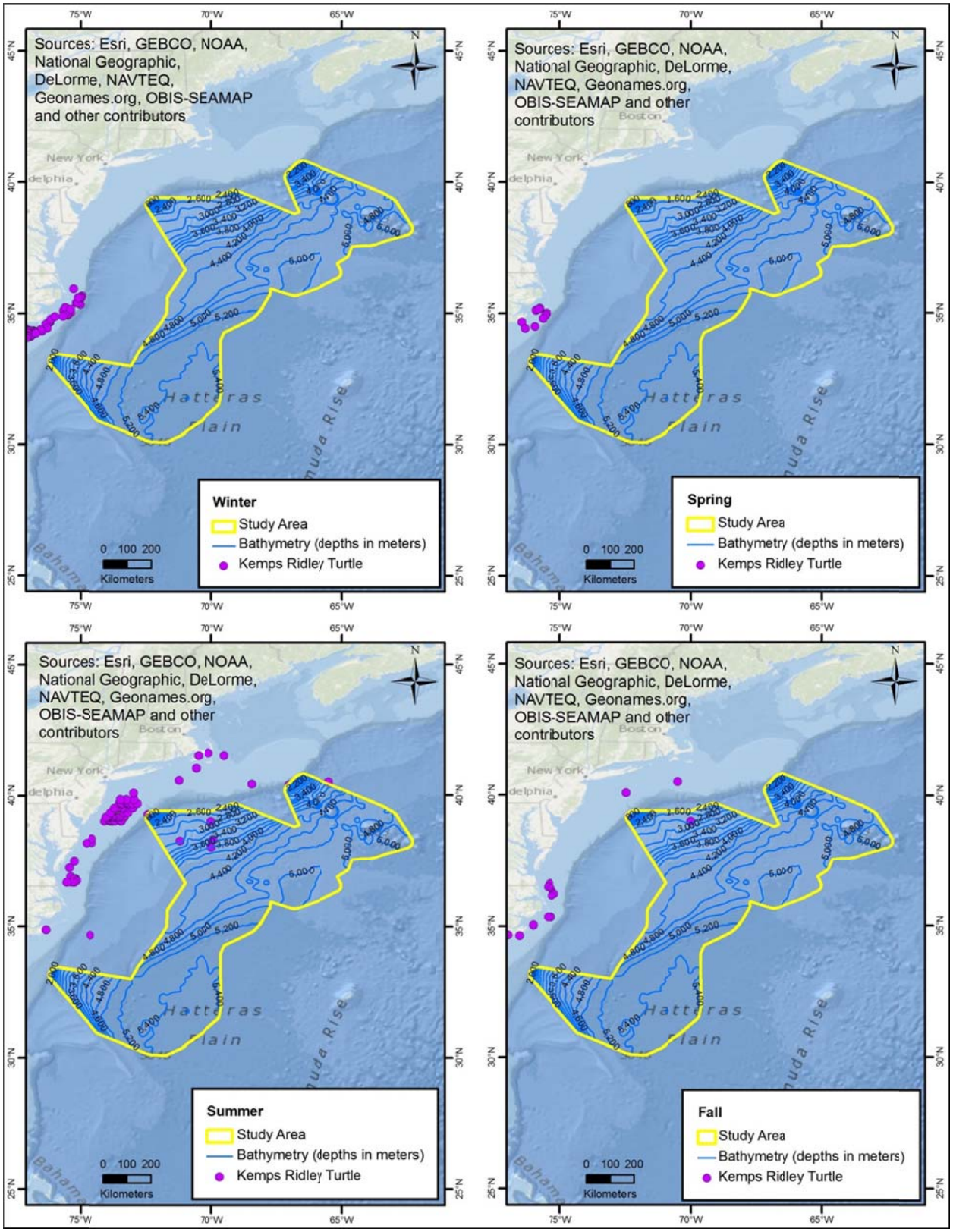


Figure 21: Seasonal Distribution of Kemp's Ridley Turtles (multiyear observations)

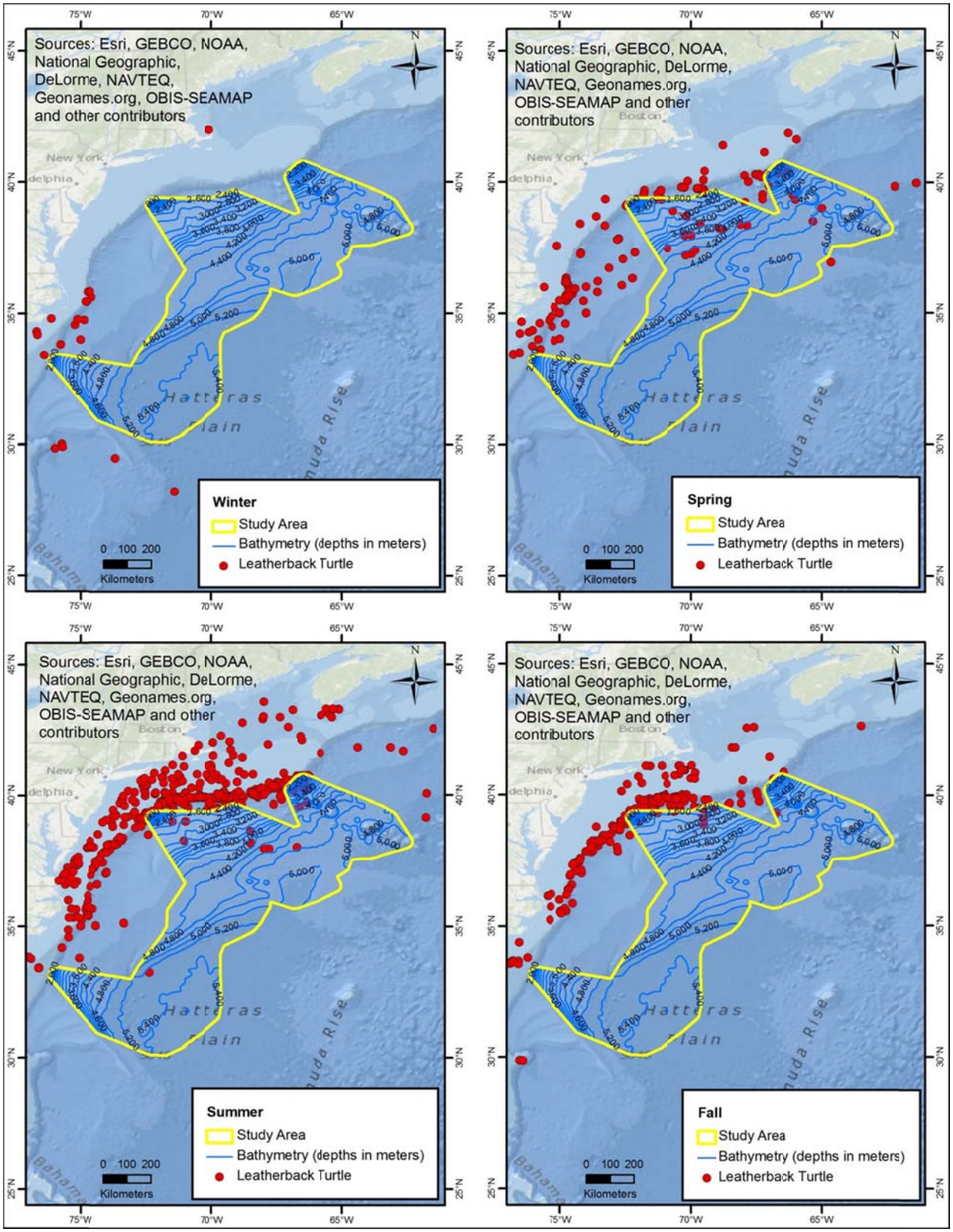


Figure 22: Seasonal Distribution of Leatherback Turtles (multiyear observations)

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.

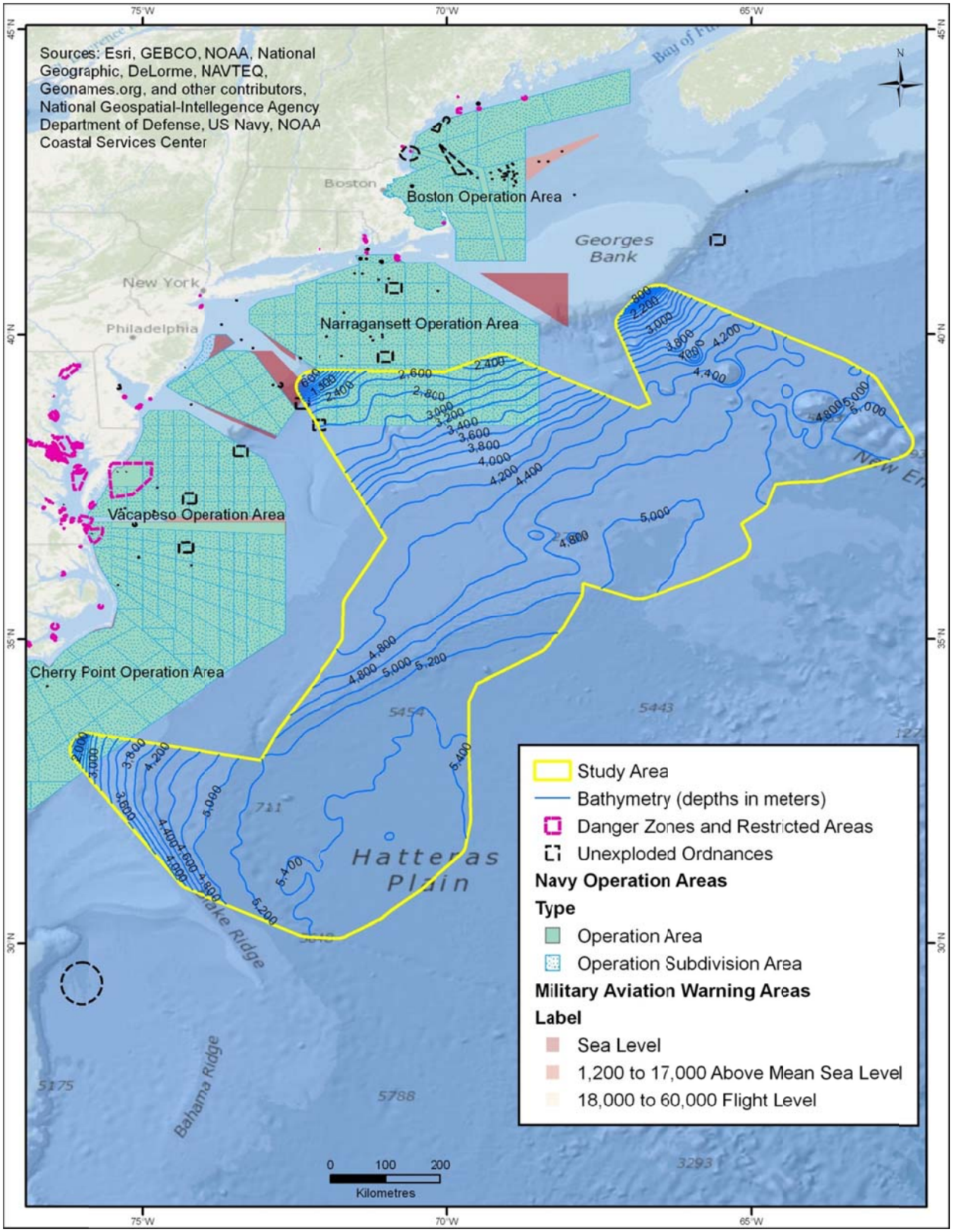


Figure 23: Navy Operation Areas

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.

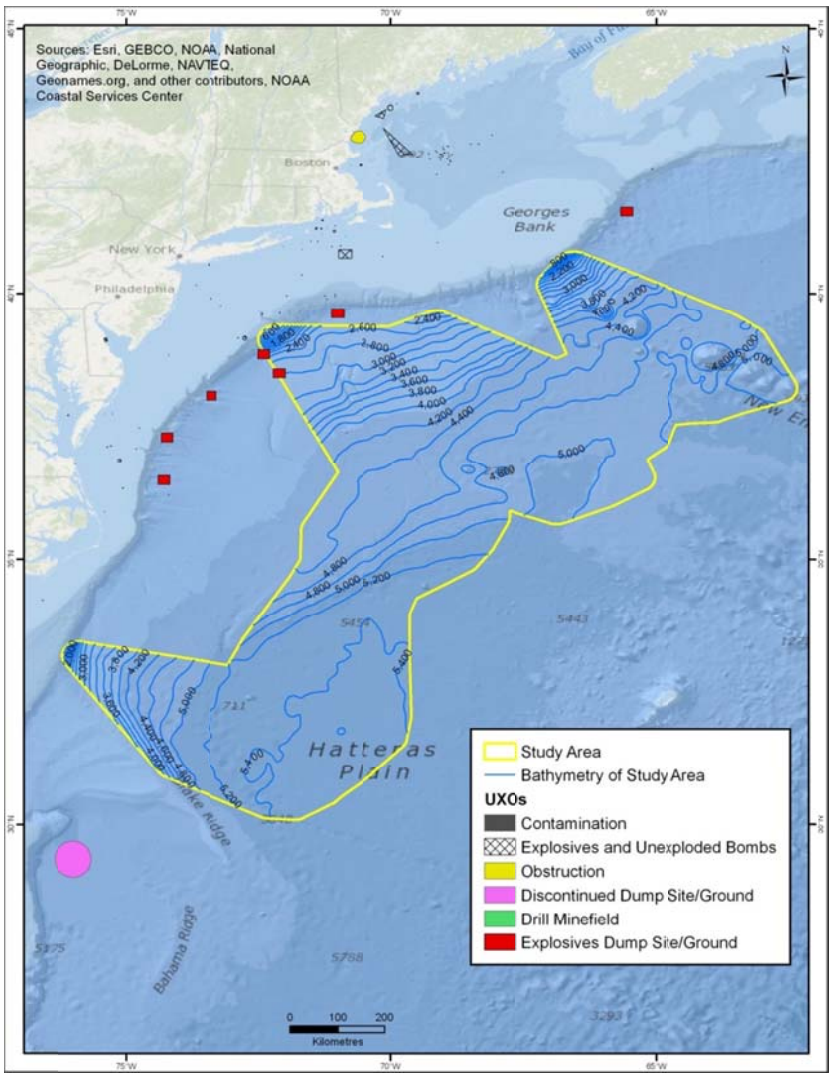


Figure 24: Unexploded Ordnance

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).

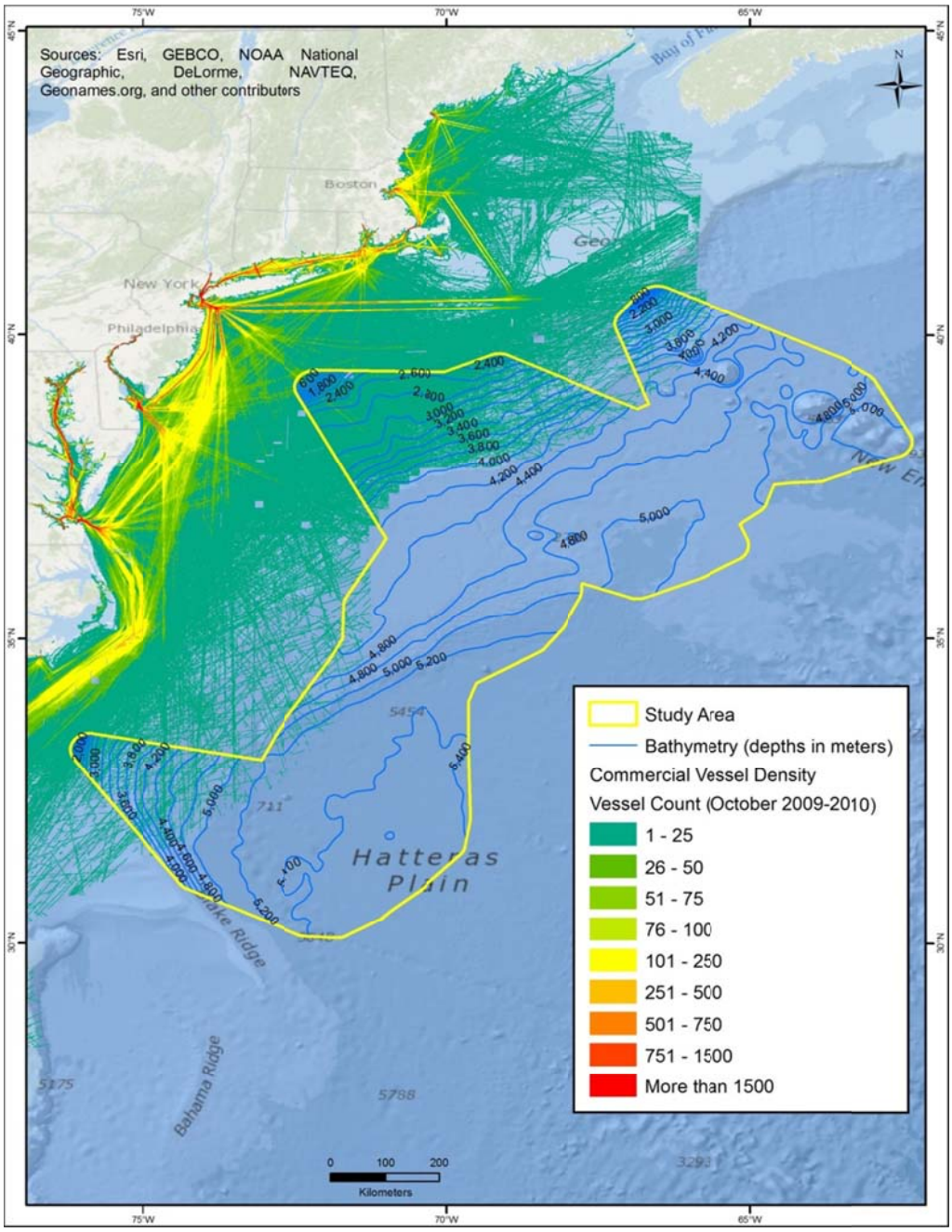


Figure 25: Marine Traffic

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.

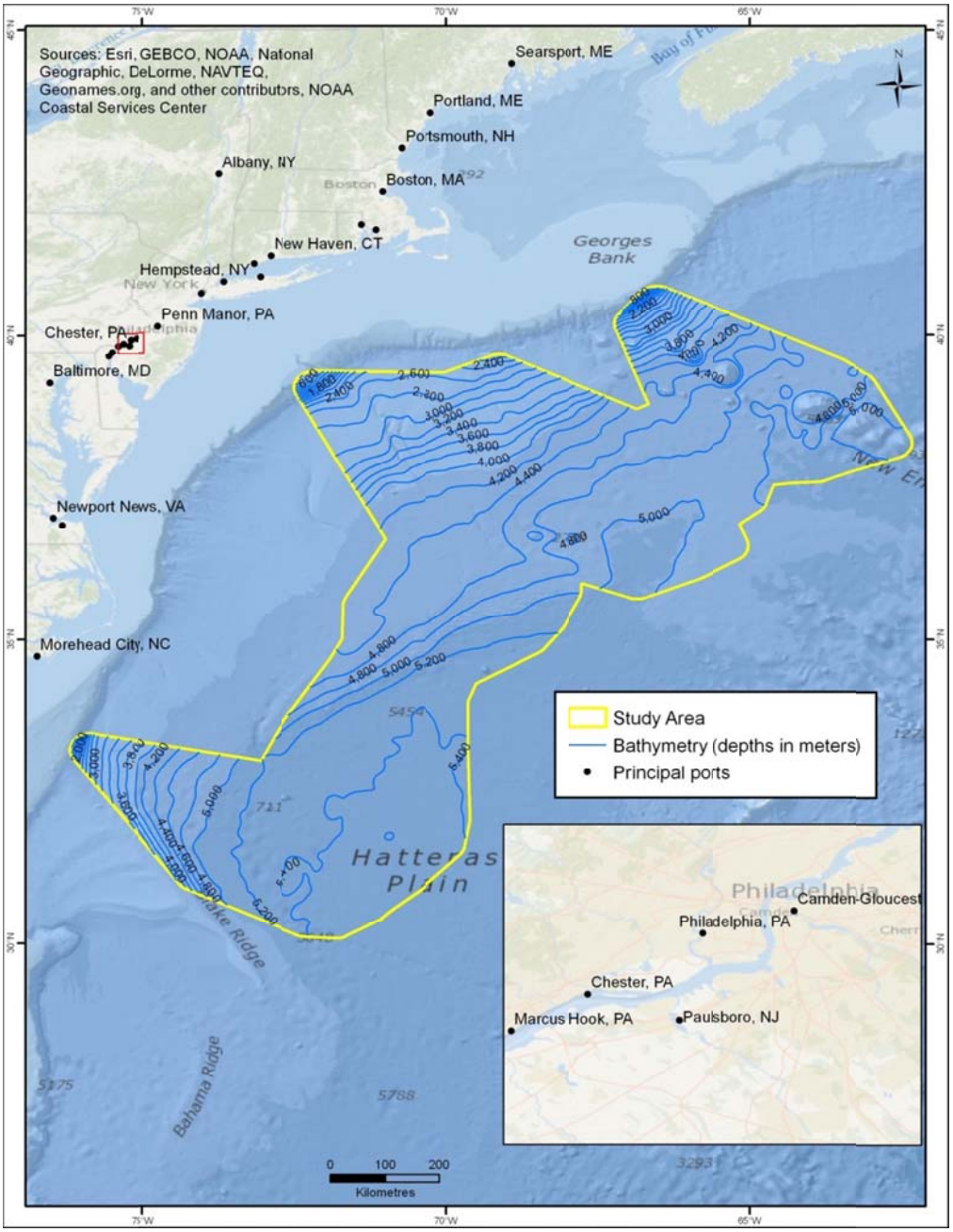


Figure 26: Ports and Terminals

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.

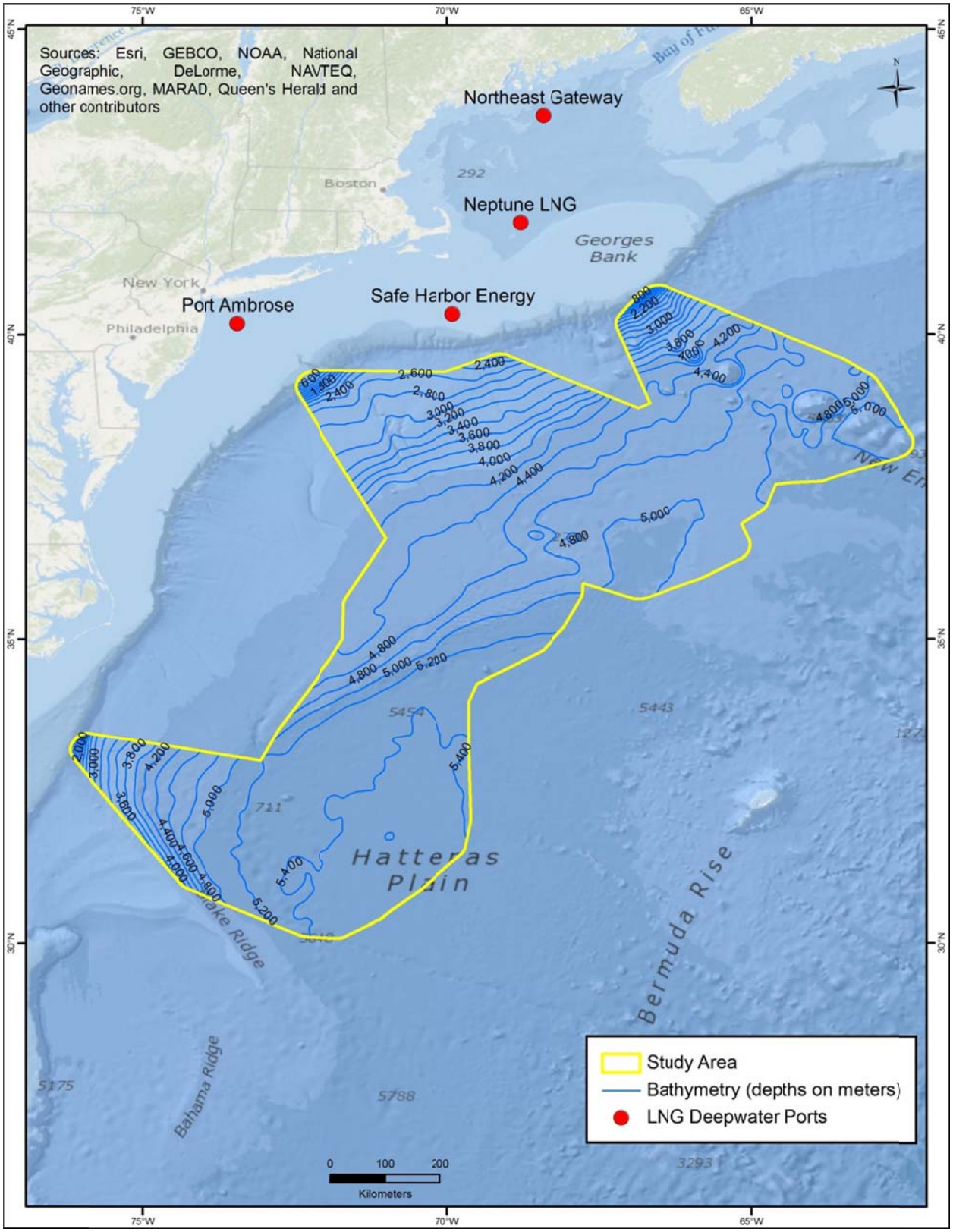


Figure 27: LNG Deepwater Ports

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.

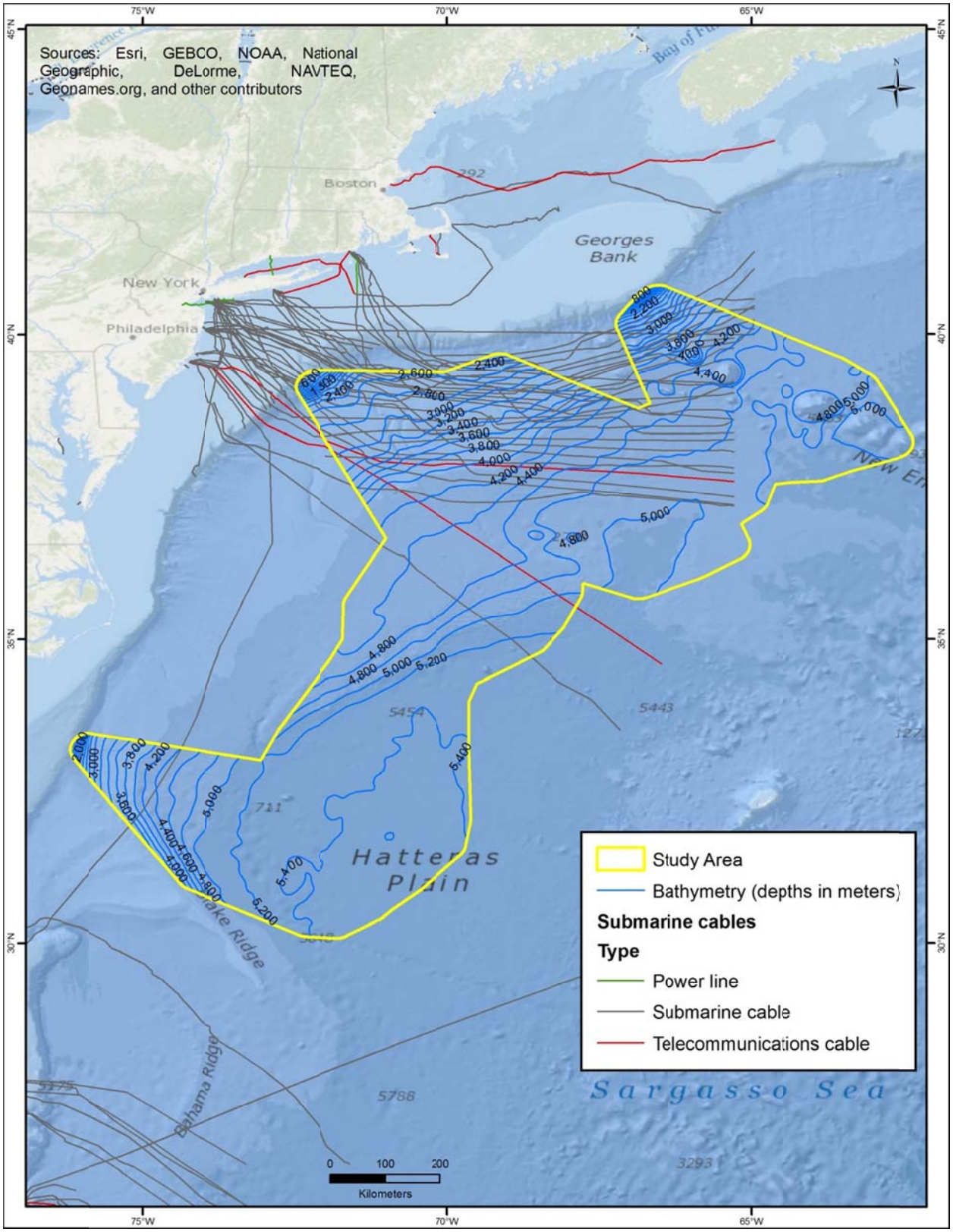


Figure 28: Submarine Cables

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.

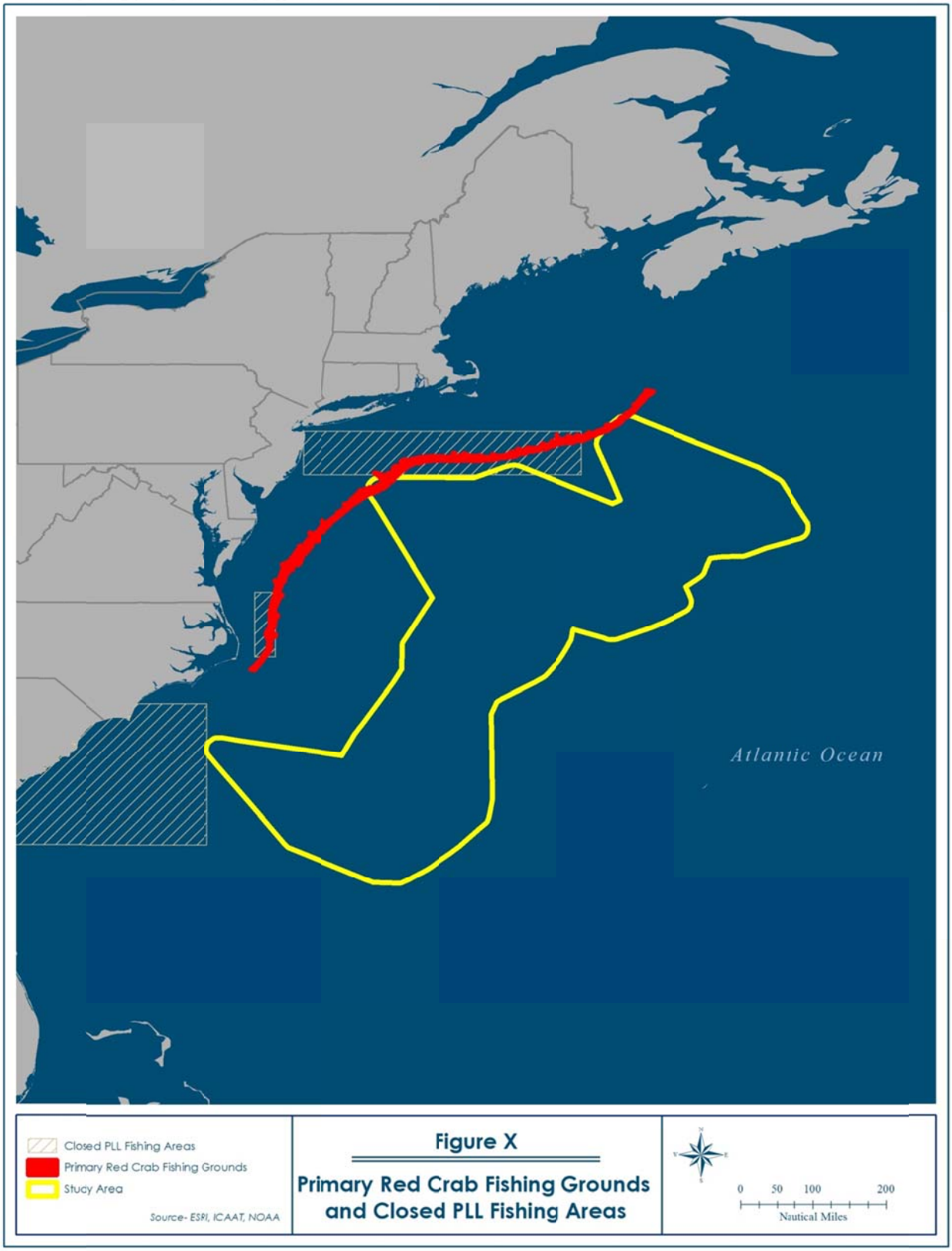


Figure 29: Primary Red Crab Fishing Grounds and Closed PLL Areas

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.

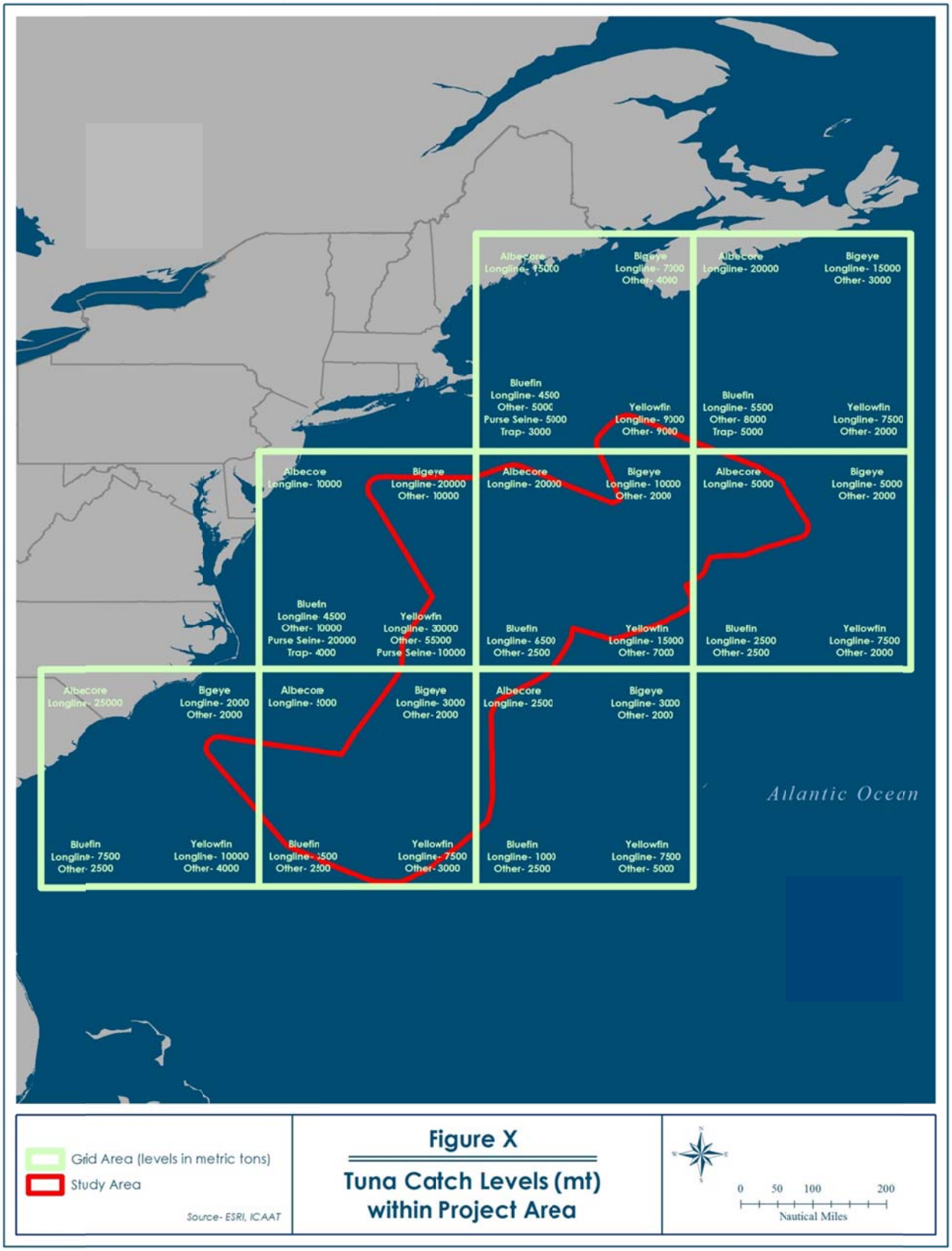


Figure 30: Tuna Catch Levels (mt) within the Project Area

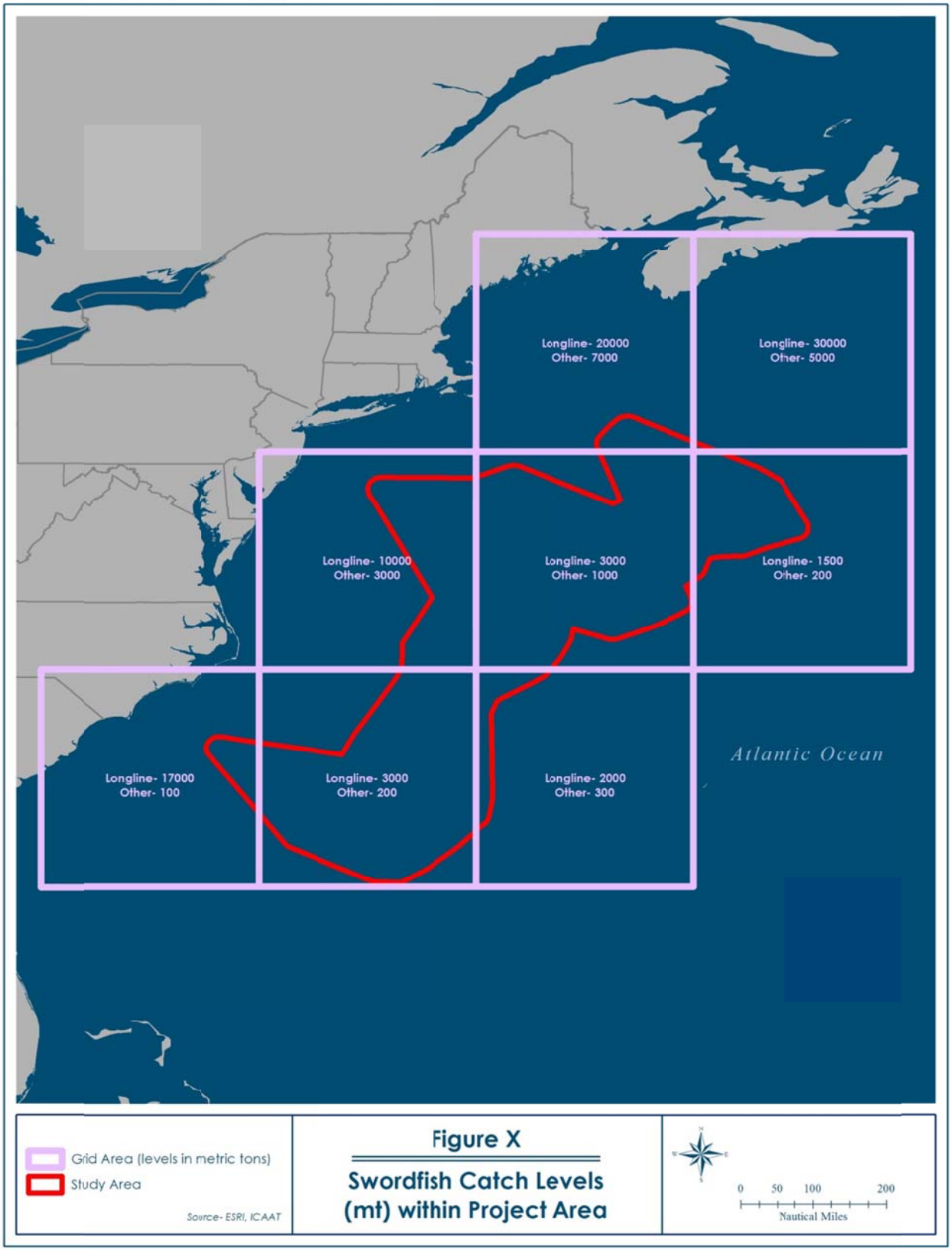


Figure 31: Swordfish Catch Levels (mt) within the Project Area

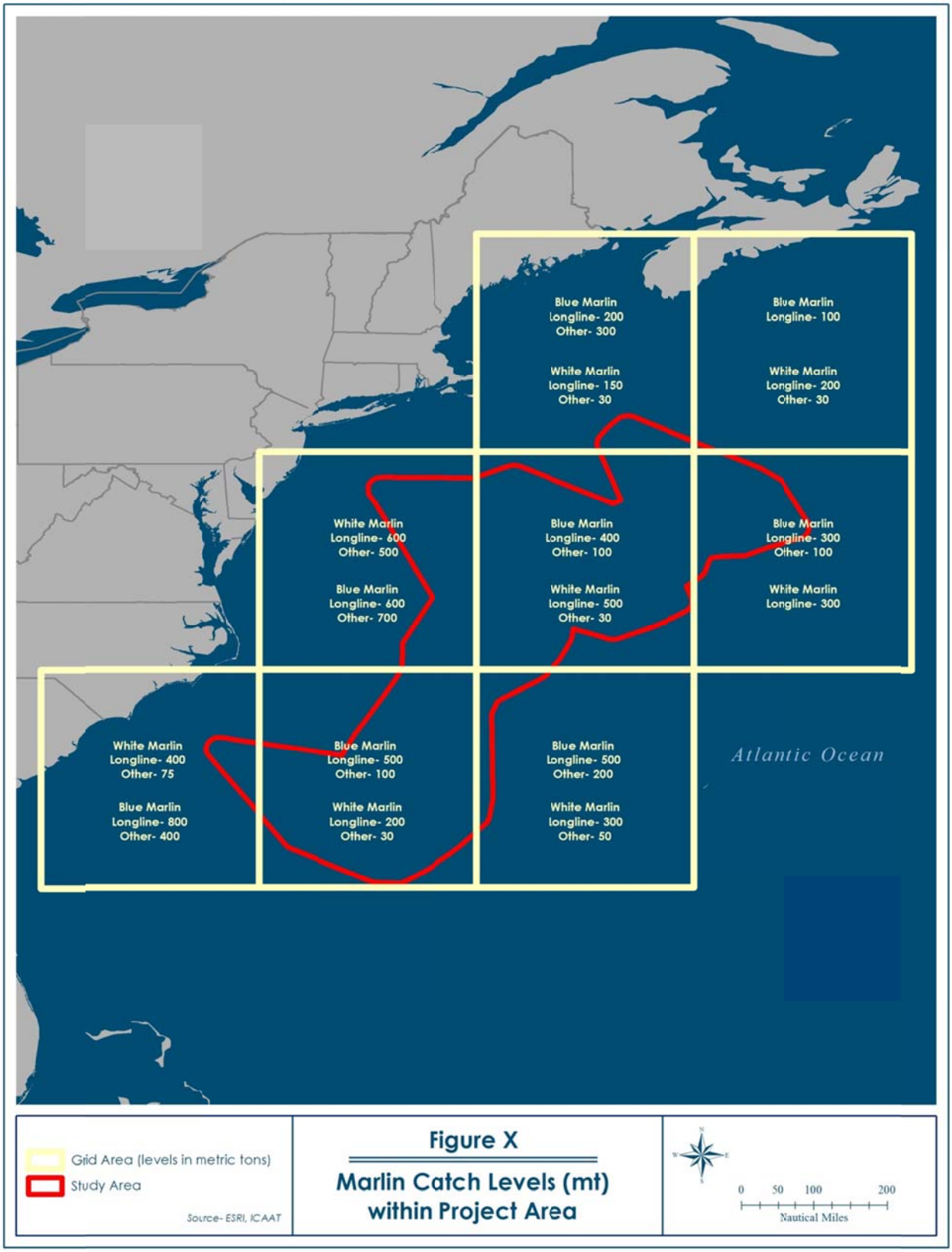


Figure 32: Marlin Catch Levels (mt) within the Project Area

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 (#/km^2)[a]	Ensonified Area (km^2)	Calcu-lated Take[b]	% of Regional Population[c]	Mean Group Size[d]	Level B Proposed Take[e] USGS	Level B Proposed Take[e] 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	0.0021370	36,600	79	1.1139	79
Blainville's Beaked Whale		36,600			
Gervais' Beaked Whale		36,600			
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

7 LITERATURE CITED

Adams, C.E., T.J. Berger, W.C. Boicourt, J.C. Churchill, M.D. Earle, P. Hamilton, F.M. Vukovich, R.J. Wayland, and R.D. Watts. 1993. A Review of the Physical Oceanography of the Cape Hatteras, North Carolina Region: Volume I Literature Synthesis. MMS Contract 14-35-0001-30594. Science Applications International Corporation. 152 p.

AMAPPS, 2010, Annual Report to the Inter-Agency Agreement M10PG00075/0001: A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean, 70 pp, http://www.nefsc.noaa.gov/psb/AMAPPS/docs/Final_2010AnnualReportAMAPPS_19Apr2011.pdf

AMAPPS, 2011, Annual Report to the Inter-Agency Agreement M10PG00075/0001: A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean, 166 pp, http://www.nefsc.noaa.gov/psb/AMAPPS/docs/NMFS_AMAPPS_2011_annual_report_final_BOEM.pdf

AMAPPS, 2012, Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean, 121 pp, http://www.nefsc.noaa.gov/psb/AMAPPS/docs/NMFS_AMAPPS_2012_annual_report_FINAL.pdf

AMAPPS, 2013, Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean, 204 pp, http://www.nefsc.noaa.gov/read/protspp/mainpage/AMAPPS/docs/NMFS_AMAPPS_2013_annual_report_FINAL3.pdf

Amato, R.V. 1994. Sand and Gravel Maps of the Atlantic Continental Shelf with Explanatory Text. U.S. Department of the Interior, Minerals Management Service. OCS Monograph MMS-93.0037.

Andersen, J. M., Y. F. Wiersma, G. Stenson, M. O. Hammill, and A. Rosing-Asvid. 2009. Movement Patterns of Hooded Seals *(Cystophora cristata)* in the Northwest Atlantic Ocean During the Post-Moult and Pre-Breed Seasons. J. Northw. Atl. Fish Sci., 42: 1–11. doi:10.2960/J.v42.m649.

Barco, S.G., W.A. McLellan, J.M. Allen, R.A. Asmutis-Silvia, R. Mallon-Day, E.M. Meagher, D.A.Pabst, J.Robbins, R.E. Seton, W.M. Swingle, M.T. Weinrich, and P.J. Clapham. 2002. Population Identity of Humpback Whales (Megaptera novaeangliae) in the Waters of the U.S. Mid-Atlantic States. Journal of Cetacean Research and Management4 (2):135-141.

Baumgartner, M.F. and B.R. Mate. 2005. Summer and Fall Habitat of North Atlantic Right Whales (Eubalaema glacialis) Inferred from Satellite Telemetry. Canadian Journal of Fisheries and Aquatic Sciences 62:527-543.

Best, P.B. and C.H. Lockyer. 2002. Reproduction, Growth and Migration of Sei Whales Balaenoptera borealis Off the West Coast of South Africa in the 1960s. South African Journal of Marine Science 24:111-133.

Blanton, J.O., F.B. Schwing, A.H. Weber, L.J. Pietrafesa, and D.W. Hayes. 2013. Wind Stress Climatology in the South Atlantic Bight, in Oceanography of the Southeastern U.S. Continental Shelf (eds. Atkinson, L.P., D.W. Menzel, and K.A. Bush), American Geophysical Union, Washington, D. C.. doi: 10.1029/CO002p0010

BOEM, 2014, Final Programmatic Environmental Impact Statement Atlantic Outer Continental Shelf Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas, US Department of Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region. New Orleans, published in the Federal Register (79 FR 13074) on March 7, 2014, and available online at http://www.boem.gov/Atlantic-G-G-PEIS/

BOEM (Bureau of Ocean Energy Management Gulf of Mexico OCS Region). 2012. OCS EIS/EA BOEM 2012-005 - Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas Final Programmatic Environmental Impact Statement Volume I: Chapters 1-8; Volume II: Figures, Tables, Appendices, and Keyword Index. US Department of Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region. New Orleans.

BOEM (Bureau of Ocean Energy Management, U.S. Dept. of the Interior). 2011. Proposed Outer Continental Shelf Leasing Program, 2012-2017. November 2011. Internet website: http://www.boem.gov/uploadedFiles/Proposed_OCS_Oil_Gas_Lease_Program_2012-2017.pdf.

Budelmann, B.U. and R. Wouldiamson. 1994. Directional Sensitivity of Hair Cell Afferents in the Octopus statocyst. Journal of Experimental Biology 187:245-259.

Carwardine, M. 1995. Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 p.

Chaytor, J.D., Twichell, D.C., ten Brink, U.S., Buczkowski, B.J., Andrews, B.D., 2007. Revisiting submarine mass movements along the U.S. Atlantic margin: Implications for tsunami hazards, in: Lykousis, V., Sakellariou, D., Locat, J. (Eds.), Submarine Mass Movements and Their Consequences. V. Springer, pp. 395-403.

COSEWIC 2005. COSEWIC assessment and update status report on the fin whale Balaenoptera physalus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.ix + 37 pp.

Castellote, M., C. W. Clark, and M. O. Lammers. 2012. Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. Biological Conservation 147:115-122.

Cato, D. H. 2013. Ambient noise and its significance to aquatic life. Bioacoustics 17:21-23.

Department of Navy. 2012. Commander Task Force 20, 4th, and 6th Fleet Navy Marine Species Density Database. (Technical Report). Naval Facilities Engineering Command Atlantic, Norfolk, VA. March 30, 2012, 63 pp, available online at http://aftteis.com/DocumentsandReferences/AFTTDocuments/SupportingTechnicalDocuments.aspx

Dugan, B., and Flemings, P.B., 2000, Overpressure and fluid flow in the New Jersey continental slope: implications for slope failure and cold seeps: Science, 289, 288-291.

Ellison, W. T., B. L. Southall, C. W. Clark, and A. S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology 26(1):21-28

Fine, I.V., Rabinovich, A.B., Bornhold, B.D., Thomson, R.E., Kulikov, E.A., 2005. The Grand Banks landslide-generated tsunami of November 18, 1929; preliminary analysis and numerical modeling. Marine Geology 215(1-2), 45–57.

Finneran, J. J. 2013. Auditory effects of intense sounds on odontocetes: Continuous, intermittent, and impulsive exposures. Bioacoustics 17:301-304.

Geist, E.L., Parsons, T., 2006. Probabilistic analysis of tsunami hazards. Natural Hazards, 37, 277-314.

Geist, E.L., Parsons, T., 2009. Assessment of source probabilities for potential tsunamis affecting the U.S. Atlantic Coast. Marine Geology 264, 98-108.

Hawkins, A. 2013. Effects of noise on aquatic life: The key issues. Bioacoustics 17:7-10.

Heezen, B.C., Ewing, M., 1952. Turbidity currents and submarine slumps, and the 1929 Grand Bank earthquake. American journal of Science 250, 849-873.

Holst, M., W.J. Richardson, W.R. Koski, M.A. Smultea, B. Haley, M.W. Fitzgerald, and M. Rawson. 2006. Effects of large- and small-source seismic surveys on marine mammals and sea turtles. Eos Transactions of the American Geophysical Union 87(36), Joint Assembly Supplement, Abstract OS42A-01. 23-26 May, Baltimore, MD.

Hornbach, M.J., Lavier, L.L., Ruppel, C.D., 2007. Triggering mechanism and tsunamigenic potential of the Cape Fear slide complex. G-cubed, 8, Q12008, 12010.11029/12007GC001722.

Hutchinson, D.R., J.R. Childs, E. Hammer-Klose,S. Dadisman, T. Edgar, and G. Barth. 2004. A preliminary Assessment of Geologic Framework and Sediment Thickness Studies Relevant to Prospective US Submission on Extended Continental Shelf. U.S. Geological Survey Open File Report 2004-1447

Joyce, T.M. 1987. Meteorology and Air-Sea Interactions. In: Milliman, J.D. and W.R. Wright, eds. The Marine Environment of the U.S. Atlantic Continental Slope and Rise. Boston/Woods Hole, MA: Jones and Bartlett Publishers, Inc. Pp. 5-26.

Kasuga, S., A. Nishizawa, Y. Ohara, K. Kusunoki and T. Katsura. 2000. Seismic Reflection and Refraction Methods. Continental Shelf Limits, the Scientific and Legal Interface. Edited by Peter Cook and Chris Carleton. Oxford University Press. Pp 177 – 193.

Kenney R.D. and H.E. Winn. 1987. Cetacean Biomass Densities Near Submarine Canyons Compared to Adjacent Shelf/Slope Areas. Continental Shelf Research 7:107-114.

Ketten, D. R. 2013. Underwater ears and the physiology of impacts: Comparative liability for hearing loss in sea turtles, birds, and mammals. Bioacoustics 17:312-315.

Kight, C. R., and J. P. Swaddle. 2011. How and why environmental noise impacts animals: An integrative, mechanistic review. Ecology Letters.

Locat, J., ten Brink, U., Chaytor, J., 2010. The Block Composite Submarine Landslide, Southern New England Slope, USA: A Morphological Analysis, in: David C. Mosher, R.C.S., Lorena Moscardelli, Jason D. Chaytor, Christopher D. P. Baxter, Homa J. Lee, Roger Urgeles (Ed.), Submarine Mass Movements and Their Consequences. Springer, pp. 267-277.

Løkkeborg, S., E. Ona, A. Vold, A. Salthaug, and J. M. Jech. 2012. Sounds from seismic air guns: Gear- and species-specific effects on catch rates and fish distribution. Canadian Journal of Fisheries and Aquatic Sciences 69(8):1278-1291.

Knowlton, A.R., J. Sigurjósson, J.N. Ciano, and S.D. Kraus. 1992. Long-Distance Movements of North Atlantic Right Whales (Eubalaena glacialis). Mar. Mamml Sci. 8:397-405.

Lentz, S.J., S. Elgar, and R.T. Guza. 2003. Observations of the Flow Field Near the Nose of a Buoyant Coastal Current. Journal of Physical Oceanography 33:933-943.

Lurton, X. and S. DeRuiter. 2011. Sound Radiation of Seafloor-mapping Echosounders in the Water Column, in Relation to the Risks Posed to Marine Mammals. Intl. Hydrographic Review, November 2011. Available at: http://www.iho.int/mtg_docs/IHReview/2011/IHR_Nov032011.pdf.

Lynch, P.D., J.E. Graves, and R.J. Latour. 2011. Challenges in the assessment and management of highly migratory bycatch species: a case study of the Atlantic marlins. Pages 197. 225 in W. W. Taylor, A. J. Lynch, and M. G. Schechter, editors. Sustainable fisheries: multilevel approaches to a global problem. American Fisheries Society, Bethesda, MD.

Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper. 2001. Ultrasound Detection by Clupeiforme Fishes. Journal of the Acoustical Society of America 109:3048-3054.

Mate, B.M., S. L. Nieukirk, and S.D. Kraus. 1997. Satellite-Monitored Movements of the Northern Right Whale Journal of Wildlife Management. 61:1393-1405.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000a. Marine Seismic Surveys: Analysis of airgun signals; and effects of air gun exposure on humpback whales, sea turtles, fishes and squid. Report from Centre for Marine Science and Technology, Curtin University, Perth, Western Australia, for Australian Petroleum Production Association, Sydney, NSW.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch and K. McCabe. 2000b. Marine Seismic Surveys: A study of environmental implications. APPEA Journal 40:692-706.

McCave, I.N., and Tucholke, B.E., 1986, Deep current-controlled sedimentation in the western North Atlantic, in Vogt, P.R., and Tucholke, B.E., eds., The Geology of North America, Volume M, The Western North Atlantic Region: Geological Society of America, chapter 27, 451-468.

McGregor, B.A. 1983. Environmental Geologic Studies on the United States Mid- and North Atlantic Other Continental Shelf Area 1980-1982. U.S. Geological Survey Open File Report 83-824.

McLellan, W.M., A.S. Friedlaender, J.G. Mead, C.W. Potter, and D.A. Pabst. 2003. Analysing 25 Years of Bottlenose Dolphin (Tursiops truncatus) Strandings Along the Atlantic Coast of the USA: do historic records support the coastal migratory stock hypothesis? Journal of Cetacean Research and Management 4:297-304.

Mellinger, D.K., S.L. Nieukirk, K. Klinck, H. Klinck, R.P. Dziak, P.J. Clapham, and B. Brandsdóttir. 2011. Confirmation of Right Whales Near a Nineteenth-Century Whaling Ground East of Southern Greenland. Biol. Lett. 7:411-413.

Mendenhall, V.M. 2004. Seabirds in the Marine Environment. Web reference at http://www.pbs.org/harriman/explog/lectures/mendenhall2.html.\

Michel, J. (ed.). 2013. South Atlantic information resources: data search and literature synthesis. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-01157. 984 pp.

MMS. 2004. Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf Final Programmatic Environmental Assessment. OCS EIS/EA MMS 2004-054. Gulf of Mexico OCS Region, New Orleans, LA. July.

NAMMC (North Atlantic Marine Mammal Commission). 1995. Report of the Joint Meeting of the Scientific Committee Working Groups on Northern Bottlenose and Killer Whales and Management Procedures. p. 89-99 In: NAMMCO Annual Report 1995, NAMMCO, Tromsø, Norway.

National Science Foundation. 2012. Record of Decision for Marine Seismic Research Funded by the National Science Foundation Arlington, Va. http://www.nsf.gov/geo/oce/envcomp/rod-marine-seismic-research-june2012.pdf

National Science Foundation. 2014. Draft Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Atlantic Ocean off Cape Hatteras, September–October 2014 https://www.nsf.gov/geo/oce/envcomp/enam-2014-draftea-2014-2may2014.pdf

National Science Foundation, U.S. Geological Survey, National Oceanic and Atmospheric Administration. 2011. 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. Arlington, Va.

New England Fishery Management Council (NEFMC). 2011. Framework Adjustment 3 to the Red Crab Fishery Management Plan.

New England Fishery Management Council (NEFMC). 2002. Fishery Management Plan for Deep-Sea Red Crab (Chaceon quinquedens) Including an Environmental Impact Statement, an Initial Regulatory Flexibility Act Analysis, and a Regulatory Impact Review. Newburyport, MA. http://www.nefmc.org/crab/index.html. Accessed on November 2, 2013.

NMFS (National Marine Fisheries Service). 1998. Recovery Plan for the Shortnose Sturgeon (Acipenser brevirostrum). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 p.

NMFS (National Marine Fisheries Service). 2000. Small Takes of Marine Mammals Incidental to Specified Activities; marine seismic-reflection data collection in southern California. Federal Register 65:16374-16379.

NMFS (National Marine Fisheries Service). 2001. Stock Structure of Coastal Bottlenose Dolphins Along the Atlantic Coast of the US. Prepared for the Bottlenose Dolphin Take Reduction Team. Southeast Fisheries Science Center, Miami, FL.

NMFS (National Marine Fisheries Service). 2005. Endangered Fish and Wildlife; Notice of Intent to Prepare an Environmental Impact Statement. Federal Register 70:1871-1875.

NMFS (National Marine Fisheries Service). 2012. Sei Whale (Balaenoptera borealis) 5 Year Review: Summary and Evaluation. Silver Spring, MD.

NMFS (National Marine Fisheries Service) and FWS (U.S. Fish and Wildlife Service). 2005. Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (Salmo salar). National Marine Fisheries Service, Silver Spring, MD.

NMFS (National Marine Fisheries Service). 2014. 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 (National Marine Fisheries Service) and FWS (U.S. Fish and Wildlife Service). 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta), Second Revision. National Marine Fisheries Service, Silver Spring, MD.

NRC (National Research Council). 1990. Decline of the Sea Turtles: Causes and Preventions. National Academy Press, Washington, DC.

Nedwell, J.R. and A.W.H. Turnpenny. 1998. The Use of a Generic Frequency Weighting Scale in Estimating Environmental Effect. Proceedings of Workshop on Seismics and Marine Mammals. June 1998, London, UK.

NOAA. n.d. Ecology of the Northeast U.S. Continental Shelf: deep corals. Accessed on 26 June 2013 at www.nefsc.noaa.gov/ecosys/ecology/Corals/.

NOAA and NMFS. 2012. Ecosystem Status Report for the Northeast Shelf Large Marine Ecosystem - 2011. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 12-07; 32 p.

NOAA. 2009. Introduction to the Highly Migratory Species Management Division. December 2009. http://www.nmfs.noaa.gov/sfa/hms/intro_HMS.htm. Accessed October 4, 2013.

NOAA. 2012. 2012 Stock Assessment and Fishery Evaluation (SAFE) Report for Atlantic Highly Migratory Species. Atlantic Highly Migratory Species Management Division, December 2012. 204 pp.

NOAA. 2013a. NOAA Office of Science and Technology – Commercial Fisheries Statistics. http://www.st.nmfs.noaa.gov/st1/commercial. Accessed October 21, 2013.

NOAA. 2013b. 2013 bottlenose dolphin unusual mortality event in the mid-Atlantic. Accessed on 20 March 2014 at: http://www.nmfs.noaa.gov/pr/health/mmume/midatldolphins2013.html

Nowacek, D. 2013. Responsible practices for minimizing and monitoring environmental impacts of marine seismic surveys with an emphasis on marine mammals. Aquatic Mammals 39(4):356-377.

Nowacek, D. P., and P. L. Tyack. 2013. Assessing effects of anthropogenic noise on the behaviour of marine mammals. Bioacoustics 17:338-341.

Offutt, G.C. 1970. Acoustic Stimulus Perception by the American Lobster, Homarus americanus (Decapoda). Experientia 26: 1276-1278.

Palka, D.L. 2006. Summer Abundance Estimates of Cetaceans in US North Atlantic Navy Operating Areas. Northeast Fisheries Science Center Reference Document 06-03. NMFS, Northeast Fisheries Science Center, Woods Hole, MA.

Pickard, G.L. and W.J. Emery. 1990. Descriptive Physical Oceanography, an Introduction. 5th ed. Elsevier, Woburn, MA.

Pierson, M.O., J.P. Wagner, V. Langford, P. Birnie, and M.L. Tasker. 1998. Protection From, and Mitigation Of, the Potential Effects of Seismic Exploration on Marine Mammals. Chapter 7 in M.L. Tasker and C. Weir, eds. Proceedings of the Seismic and Marine Mammals Workshop, London, 23-25 June 1998.

Pike, D.G., G.A. Víkingsson, T. Gunnlaugsson, and N. Øien. 2009. A Note on the Distribution and Abundance of Blue Whales (Balaenoptera musculus) in the Central and Northeast North Atlantic. NAMMCO Sci. Publ. 7:19-29.

Pilkey, O.H., and Cleary, W.J., 1986, Turbidite sedimentation in the northwestern Atlantic Ocean basin, in Vogt, P.R., and Tucholke, B.E., eds., The Geology of North America, Volume M, The Western North Atlantic Region: Geological Society of America, chapter 26, 437-450.

Poag, C.W. 1982. Stratigraphic Reference Section for Georges Bank Basin--Depositional Model for New England Passive Margin. American Association of Petroleum Geologists Bulletin, 66: 1021 – 1041.

Pramik, B., 2013, Marine Vibroseis: Shaking up the Industry, First Break, vol. 11, issue 11, November, 2013, pp. 67-72

Prieto R., M.A. Silva, I. Cascão, M.J. Cruz, C.I.B. Oliveira, G. Waring, and J. Gonçalves. 2010. The Importance of Oceanic Fronts in the Labrador Sea to North Atlantic Sei Whales (Balaenoptera borealis): Clues from satellite telemetry. Presentation at 4th Arctic Frontiers Conf., 24–29 January 2010, Tromsø, Norway.

Ray, G.C., B.P. Hayden, M.G. McCormick-Ray, and T.M. Smith. 1998. Land-Seascape Diversity of the U.S.A. East Coast Coastal Zone with Particular Reference to Estuaries. In: Ormand, R.F.G., J.D. Gage, and M.V. Angel, eds. Marine biodiversity, patterns and processes. Cambridge University Press. Pp. 337-371.

Read, A.J., P.N. Halpin, L.B. Crowder, B.D. Best, and E. Fujioka (eds.). 2009. OBIS-SEAMAP: Mapping marine mammals, birds and turtles. World Wide Web electronic publication. Accessed on 16 June 2013 at http://seamap.env.duke.edu.

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. Guide to Marine Mammals of the World. New York: Alfred A. Knopf. 527 p.

Reilly, S.B., J.L. Bannister, P.B. Best, M. Brown, R.L. Brownell Jr., D.S. Butterworth, P.J. Clapham, J. Cooke, G.P. Donovan, J. Urbán, and A.N. Zerbini. 2008. Balaenoptera edeni. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded on 18 June 2013.

Richards P.M., S.P. Epperly, S.S. Heppell, R.T. King, C.R. Sasso, F. Moncada, G. Nodarse, D.J. Shaver, Y. Medina, and J. Zurita. 2011. Sea Turtle Population Estimates Incorporating Uncertainty: a new approach applied to western North Atlantic loggerheads (*Caretta caretta*). Endangered Species Res 15: 151–158.

Richardson, W. J., C. R. Greene, Jr. C.I. Malme and D. H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

Richardson, W. J. 2013. Effects of noise on aquatic life: Much known, much unknown. Bioacoustics 17(1-3):13-16.

Schilling, M.R., I. Seipt, M.T. Weinrich, S.E. Frohock, A.E. Kuhlberg, and P.J. Clapham. 1992. Behaviour of Individually-Identified Sei Whale Balaenoptera borealis During an Episodic Influx into the Southern Gulf of Maine in 1986. Fisheries Bulletin 90:749-755.

Schreiber, E.A. and J. Burger. 2002. Seabirds in the Marine Environment, pp. 1-15. In: E.A. Schreiber and J. Burger, eds. Biology of marine birds. Boca Raton, FL: CRC Press.

SCRS. 2012. Report of the standing committee on research and statistics. ICCAT SCRS. Madrid, Spain, October 1-5, 2012. http://www.iccat.int/en/scrs.htm. Accessed on October 12, 2013.

Sheridan, R.E. and J.A. Grow, eds. 1988. The Atlantic Continental Margin, U.S.: Geological Society of America, The Geology of North America, v. 1-2, 610 pp.

Shen, C.Y., R.A. Fusina, and L.K. Shay. 2000. An Assessment of Local Coastal Dynamics Observed with High-Frequency Radar. Journal of Geophysical Research 105(C3):6517-6530.

Smith-Vaniz, W.F., B.B. Collette, and B.E. Luckhurst. 1999. Fishes of Bermuda: History, zoogeography, annotated checklist, and identification keys. American Society of Ichthyologists and Herpetologists Special Publication Number 4, Lawrence, KS.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: initial scientific recommendations. Aquatic Mammals 33:411-521.

Southall, B., and coauthors. 2013a. U.S. regulation of the effects of sound on marine life: NOAA's mandates and use of scientific information. Bioacoustics 17:275-278.

Southall, B. L., and coauthors. 2013b. Marine mammal noise-exposure criteria: Initial scientific recommendations. Bioacoustics 17:273-275.

Stevenson, D. K., L. Chiarella, D. Stephan, R. Reid, K. Wilhelm, J. McCarthy, and M. Pentony. 2004. Characterization of the fishing practices and the marine benthic ecosystems of the northeast U.S. shelf, and an evaluation of the potential effects of fishing on Essential Fish Habitat. NOAA Tech. Memo. NMFS-NE-181.

Stevick, P.T., J. Allen, P.J. Clapham, N. Friday, S.K. Katona, F. Larsen, J. Lien, D.K. Mattila, P.J. Palsbøll, J. Sigurjónsson, T.D. Smith, N. Øien, and P.S. Hammond. 2003. North Atlantic Humpback Whale Abundance and Rate of Increase Four Decades After Protection from Whaling. Mar. Ecol. Prog. Ser. 258:263-273.

Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. McLellan, and D.A. Pabst. 1993. Appearance of Juvenile Humpback Whales Feeding in the Nearshore Waters of Virginia. Marine Mammal Science 9(3):309-315.

Templeman, N.D. 2010. Ecosystem Status and Trends Report for the Newfoundland and Labrador Shelf. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/026 vi + 72 p.

ten Brink, U.S., Chaytor, J.D., Geist, E.L., Brothers, D.S., and Andrews, B.D., 2014, Tsunami hazard assessment for the U.S. Atlantic margin: Progress, Procedures, and Processes: Marine Geology, 353, 31-54.

ten Brink, U.S., Lee, H.J., Geist, E.L., Twichell, D., 2009. Assessment of tsunami hazard to the US East Coast using relationships between submarine landslides and earthquakes. Marine Geology 264, 65-73.

Thomas, L., M. O.Hammill and W. D. Bowen. 2011. Estimated Size of the Northwest Atlantic Grey Seal Population 1977-2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/017. iv + 23 p.

Turnpenny, A.W.H. and J.R. Nedwell. 1994. Consultancy Report: The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys. FCR 089/94. Prepared by Fawley aquatic research laboratories, Ltd. for the UK Offshore Operators Association.

Twichell, D., Chaytor, J.D., ten Brink, U.S., and Buczkowski, B., 2009, Morphology of late Quaternary submarine landslides along the U.S. Atlantic margin: Marine Geology, v. 264, p. 4-15.

UNEP-WCMC (United Nations Environment Programme-World Conservation Monitoring Centre). 2013. Convention on International Trade in Endangered Species of Wild Flora and Fauna. Appendices I, II, and III. Valid from 12 June 2013. Accessed on 18 June 2013 at http://www.cites.org/eng/app/appendices.php.

Urick, R.J. 1983. Principles of Underwater Sound, McGraw-Hill Publishing Company.

U.S. Dept. of Commerce, National Marine Fisheries Service. 2010. Final Recovery Plan for the Fin Whale *(Balaenoptera physalus).* Silver Spring, MD. 121 p. Accessed on 21 June 2013 at http://www.nmfs.noaa.gov/pr/pdfs/recovery/finwhale.pdf.http://dx.doi.org/10.1002/ggge.20181

USGS (United States Geological Survey) 2013. Record of Decision for "Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation Conducted by the U.S. Geological Survey" http://woodshole.er.usgs.gov/project-pages/environmental_compliance/reports/FINAL_USGSROD_textonly_signed27Feb2013.pdf

USGS (United States Geological Survey). 2013. The Baltimore Canyon Trough. Accessed on 2 June 2013 at http://3dparks.wr.usgs.gov/nyc/mesozoic/baltimorecanyon.htmhttp://3dparks.wr.usgs.gov/nyc/mesozoic/baltimorecanyon.htm

USGS 2014. Request for an Incidental Harassment Authorization under the Marine Mammal Protection Act. by U.S. Geological Survey . Mapping the U.S. Extended Continental Shelf Region of the Atlantic Seaboard. 2-D Survey Program August-September 2014. January 2014. Submitted to: National Marine Fisheries Service. Office of Protected Resources. 1315 East-West Hwy. Silver Spring, MD 20910.

Verity, P.G., T.N. Lee, J.A. Yoder, G.A. Paffenhofer, J.O. Blanton, and C.R. Alexander. 1993. Outer Shelf Processes. In: Menzel, D.W., ed. Ocean Processes: U.S. Southeast Continental Shelf: A summary of research conducted in the South Atlantic Bight under the auspices of the U.S. Department of Energy from 1977 to 1991. U.S. Department of Energy, Washing, DC. Pp. 45-74.

Víkingsson, G.A., D.G. Pike, G. Desportes, N. Øien, Th. Gunnlaugsson, and D. Bloch. 2009. Distribution and Abundance of Fin Whales (Balaenoptera physalus) in the Northeast and Central Atlantic as Inferred from the North Atlantic Sightings Surveys 1987–2001. NAMMCO Sci. Publ. 7:49-72.

Villa, E., J.D. Hart, A. de C. Baker, and V. Rossin. 2011. Fin Whales Feeding on Northern Krill off Pico Island (Azores) during Spring Migration. Poster, 25th Europ. Cetac. Soc. Conf., Cadiz, Spain, 21-23 March 2011.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2012. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2011. NOAA Tech. Memo. NMFS-NE-221. Nat. Mar. Fish. Serv., Northeast Fish. Sci. Center, Woods Hole, MA. 319 p.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel, (eds.) 2010 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2010. NOAA Tech. Memo. NMFS-NE 219. 598 p.

Watanabe, S., A. Metaxas, J. Sameoto, P. Lawton. 2009. Patterns in Abundance and Size of Two Deep-Water Gorgonian Octocorals, in Relation to Depth and Substrate Features off Nova Scotia. Deep-Sea Research I 56:2235-2248.

Weir, C.R. 2007. Observations of Marine Turtles in Relation to Seismic Airgun Sound off Angola. Marine Turtle Newsletter 116:17-20

Weir, C.R. and S.J. Dolman. 2007. Comparative Review of the Regional Marine Mammal Mitigation Guidelines Implemented During Industrial Seismic Surveys, and Guidance Towards a Worldwide Standard. J. Intl. Wildlife Law & Policy 10:1-27.

Whitehead, H. 2002. Estimates of the Current Global Population Size and Historical Trajectory for Sperm Whales. Mar. Ecol. Prog. Ser. 242:295-304.

Wright, A.J. 2014. Reducing impacts of human ocean noise on cetaceans: knowledge gap analysis and recommendations. 98 p. World Wildlife Fund Global Arctic Programme, Ottawa, Canada.

Wursig, B., T.A Jefferson, and D.J. Schmidly. 2000. The Marine Mammals of the Gulf of Mexico. College Station, TX: Texas A&M University Press. 232 p

8 LIST OF PREPARERS

Sue Belford (YOLO)

Kent Simpson (GeoSpatial)

Sara Bowman (E&E)

David Trimm (E&E)

Tony LaPierre (RPS)

Teresa Trenck (RPS)

Jonathan R. Childs (USGS)

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).

References Cited

Diebold, J.B., M. Tolstoy, L. Doermann, S.L. Nooner, S.C. Webb, and T.J. Crone. 2010. R/V Marcus G. Langseth seismic source: modeling and calibration. Geochem. Geophys. Geosyst. 11(12), Q12012, doi:10.1029/2010GC003126.

Holst, M. and J. Beland. 2008. Marine Mammal and Sea Turtle monitoring during the Lamont-Doherty Earth Observatory's seismic testing and calibration study in the norther Gulf of Mexico, November 2007 – February 2008. LGL Rep. TA4295-2

Holst, M. and M.A. Smultea. 2008. Marine mammal monitoring and sea turtle monitoring during Lamont-Doherty Earth Observatory's marine seismic program off Central America, February – April 2008. LGL Rep. TA4243-3.

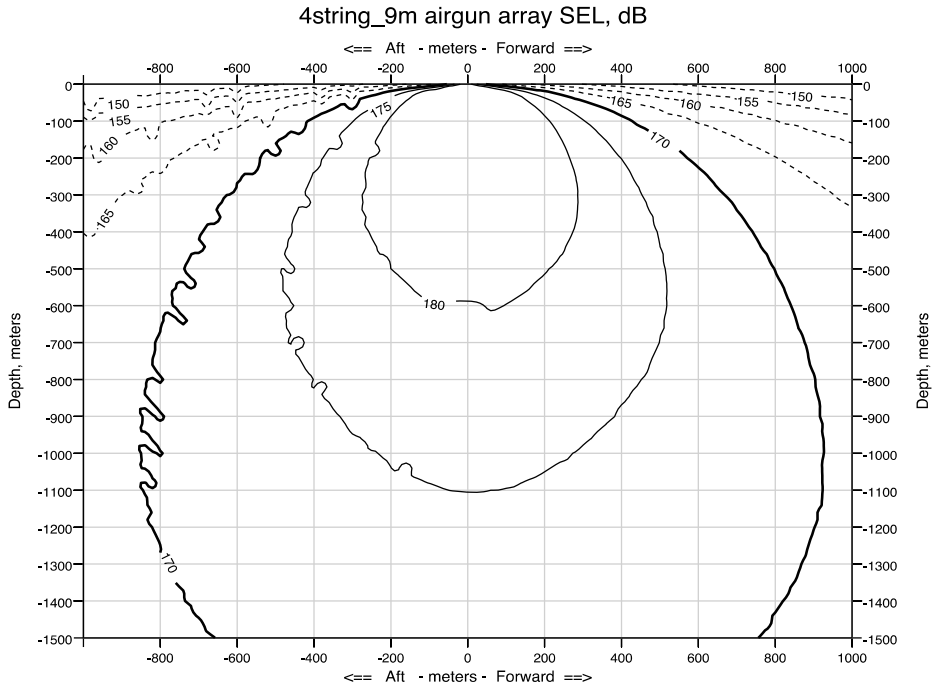
NMFS (National Marine Fisheries Service). 2000. Small Takes of Marine Mammals Incidental to Specified Activities; marine seismic-reflection data collection in southern California. Federal Register 65:16374-16379.

Pierson, M.O., J.P. Wagner, V. Langford, P. Birnie, and M.L. Tasker. 1998. Protection from, and mitigation of, the potential effects of seismic exploration on marine mammals. Chapter 7 In: M.L. Tasker and C. Weir (eds.), Proc. Seismic Mar. Mamm. Worksh., London, U.K., 23–25 June 1998.

Smultea, M.A., M. Holst, W.R. Koski, and S. Stoltz. 2004. Marine mammal monitoring during Lamont-Doherty Earth Observatory's Seismic Program in the Southeast Caribbean Sea and adjacent Atlantic Ocean, April-June 2004. LGL Report TA2822-26.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise expos- ure criteria: initial scientific recommendations. Aquat. Mamm. 33(4):411-522.

Weir, C.R. and S.J. Dolman. 2007. Comparative review of the regional marine mammal mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard. **J. Int. Wildl. Law Policy** 10(1):1-27.



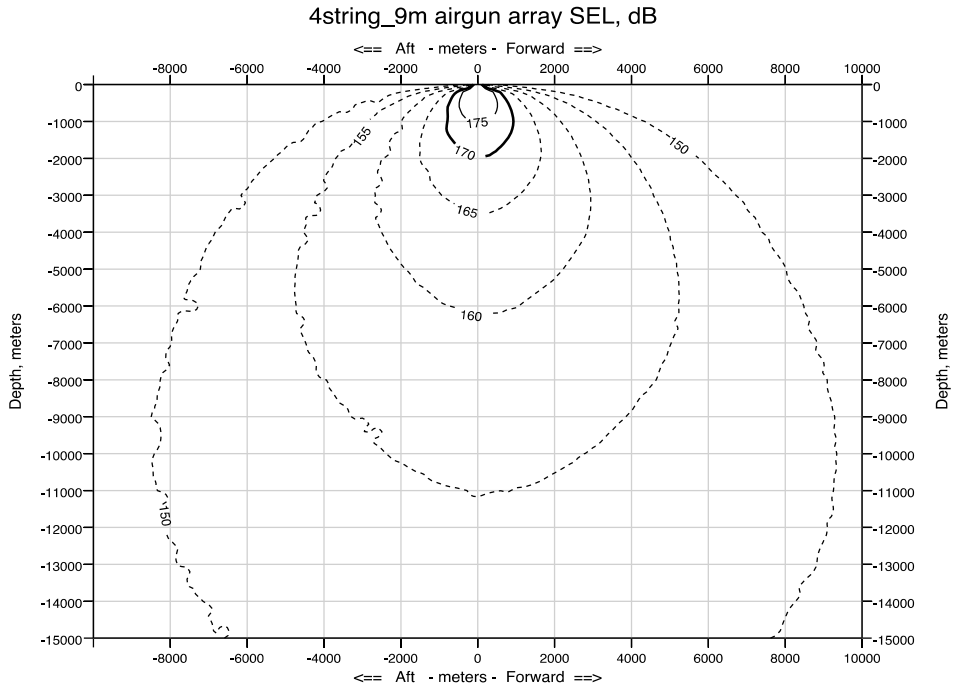


FIGURE A1. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the survey, at a 9-m tow depth. Received RMS levels (SPLs) are expected to be ~10 dB higher. Plot at the top provides radius to the 170 dB SEL isopleths as a proxy for the 180 dB RMS isopleths and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

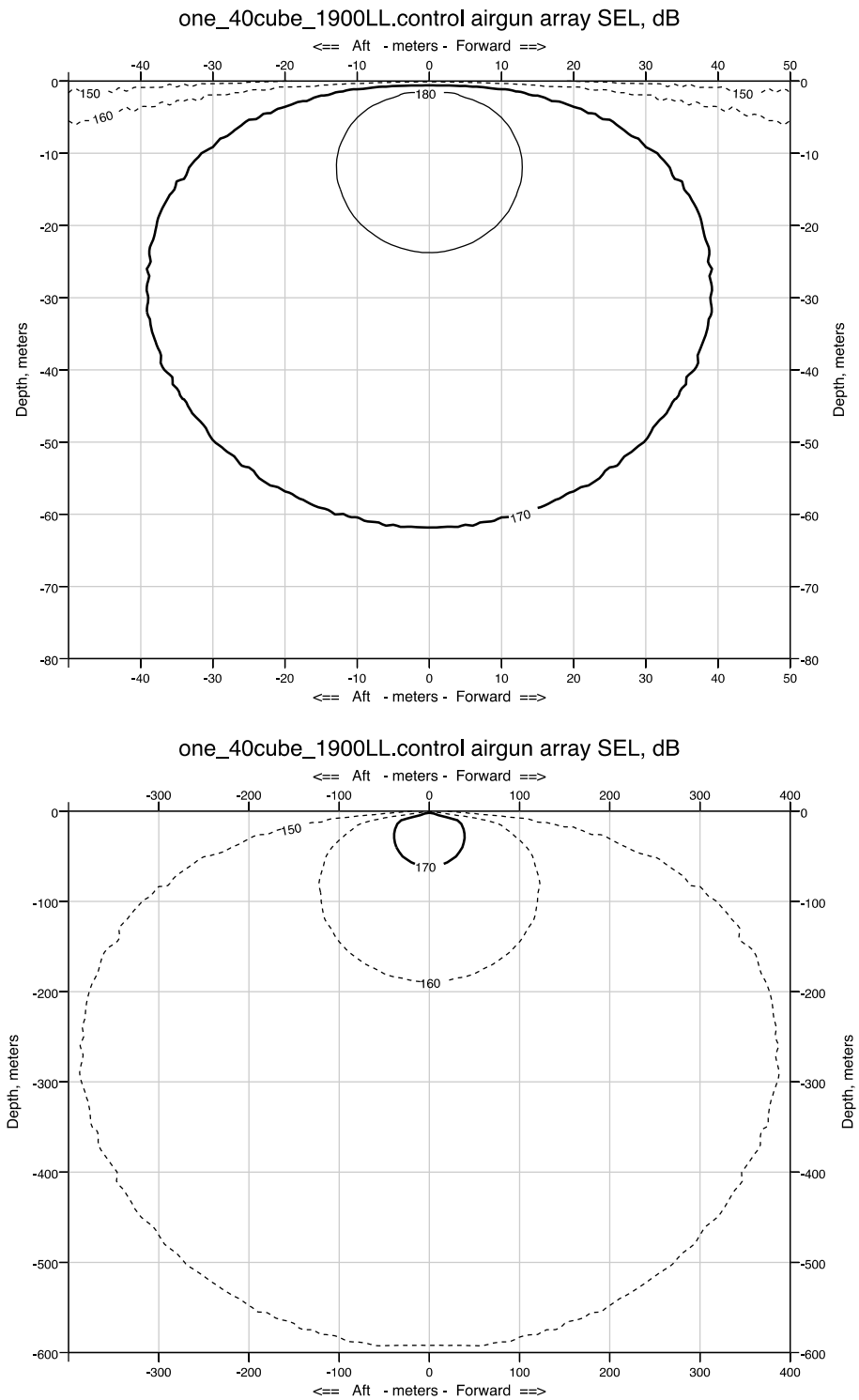


FIGURE A2. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9 m depth, which is planned for use as a mitigation gun during the proposed survey. Received RMS levels (SPLs) are expected to be ~10 dB higher. Plot at the top provides radius to the 170 dB SEL isopleths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

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

12 APPENDIX D: NMFS CONSULTATION (ESSENTIAL FISH HABITAT)

13 APPENDIX E: USFWS CONSULTATION (ENDANGERED SPECIES ACT)

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

15 APPENDIX G: COMMENTS RECEIVED IN RESPONSE TO NMFS FR NOTICE